Hydrogeological Assessment, Potential Geothermal Well (Phase II), Canadian Coast Guard Southside Base, St. John's, NL

Prepared for:
Environmental Services
Public Works and Government Services Canada
10 Barters Hill
St. John's, NL
A1C 5T2

Prepared by:
Stantec Consulting Ltd.
141 Kelsey Drive
St. John's, NL A1B 02L
Tel: (709) 576-1458
Fax: (709) 576-2126

Final Report

File No:121412783

January 17, 2014

Table of Contents

LIST OF APPENDICES

LIST OF DRAWINGS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

1.0 INTRODUCTION

Acting at the request of Public Works and Government Services Canada (PWGSC), Stantec Consulting Ltd. (Stantec), has provided professional hydrogeological services to further assess the potential to utilize seawater as a source of heating and cooling for a new building proposed at Berth 28 on the Canadian Coast Guard (CCG) Southside Base in St. John's, Newfoundland and Labrador (NL), herein referred to as the "site" (Drawing No. 121412783-EE-01, Appendix A). The hydrogeological services consisted of the design of a test water well (i.e., Well 1), supervision of well installation and aquifer testing, and aquifer test analysis.

The purpose of the aquifer testing was to determine the long term sustainable yield, number and optimum separation distances for screened water supply wells, and to evaluate the temperature and chemical quality of groundwater for the design of the geothermal heating system (GHS). Associated investigations included identification of potential site specific issues of concern related to the operation of the GHS and to assess the degree of hydraulic interaction between proposed supply wells and the adjacent harbor. This report contains all the results, conclusions and recommendations for this study, and is intended for the sole use of PWGSC and its agents.

1.1 Background

It is Stantec's understanding that the proponent is considering using seawater as a possible geothermal source for heating and cooling for a new building proposed for the site. In May 2013, a preliminary hydrogeological assessment was completed by Stantec to assess the potential to install a water well(s) at the site to extract the volumes of water that would be required for this application (Stantec, 2013a). The results of the preliminary hydrogeological assessment indicated that there was potential at the site for the proposed application, and recommended that further assessment, including the drilling and testing of one or more screened water wells, be carried out to confirm the suitability of the site.

The current hydrogeological assessment is a follow-up to the May 2013 work. The objective is to determine if a sufficient quantity of water (i.e., 1,900 L/min to 2,700 L/min (500 USgpm to 700 USgpm)) of suitable quality can be obtained from efficiently developed screened water wells installed in the fill and glacial materials underlying the site to be used as a source of heating and cooling for the proposed new building.

1.2 Scope of Work

The scope of work originally proposed by Stantec (Stantec 2013c) involved drilling and hydraulically testing, two (2) specifically designed test wells that could be used as geoexchange production wells. After dialogue with PWGSC, this was modified at the request of PWGSC to one (1) generic test well to meet the current development timeline. The following section outlines

the main components of work completed by Stantec to satisfy the objectives of this investigation:

- Complete a review of available existing reports to confirm the current understanding of site conditions;
- Obtain clearances for potential underground utilities and other buried infrastructure in the area of the proposed hydrogeological investigation;
- Design a generic screened test well assembly to assess the potential of the site to meet the requirements for a geothermal application;
- Supervise the drilling and installation of one 203 mm diameter screened test well;
- Supervise hydraulic testing, including one four-step drawdown test followed by a 24-hour constant rate pumping test, with aquifer water level response monitoring in observation wells that were installed during the preliminary investigations (Stantec). Data obtained from the aquifer test will be used to estimate the hydraulic properties of the underlying aquifer to evaluate potential well interference effects;
- Collect water samples from the test well during pumping and submit for laboratory analysis of general chemistry, dissolved metals, petroleum hydrocarbons (TPH/BTEX) and polycyclic aromatic hydrocarbons (PAHs);
- Evaluate the hydraulic properties of the test well and the host aquifer (i.e., transmissivity, storativity, etc.);
- Review water chemistry analytical results and compare to applicable guideline levels;
- Provide an opinion on long term sustainable well yield and the numbers of wells required to meet various demands; and
- Compile a draft and final report for this investigation. The factual report will outline the scope of the site investigation, the methodology applied and provide a discussion of the results with recommendations for future work, if required.

2.0 SITE DESCRIPTION, GEOLOGY AND HYDROGEOLOGY

The CCG Southside Base is located on Southside Road in an industrial area along the south side of the St. John's Harbour (Drawing No. 121412783-EE-01, Appendix A). The base currently consists of the Administration Building, the Buoy Maintenance Facility, Berth 28 and the Hazardous Materials Storage Area. The study site is bordered by St. John's Harbour to the northwest, the Buoy Maintenance Facility (Pier 29) to the southwest, HMCS Cabot (Pier 27) to the northeast and Southside Road, which provides access to the site, to the southeast. Both the base and adjacent properties are serviced by municipal water and sewer systems. No drinking water wells are reportedly present on the base or in the surrounding area. The Berth 28 property is approximately 1 ha in area and consists of the concrete deck/wharf and the land up-gradient of the wharf.

Berth 28 is currently being used as an equipment storage yard and parking area for the CCG Southside Base. Stantec understands that the area is intended to be the future location of the

CCG Southside Base office tower. The office tower will be located on the eastern portion of the site between the property boundary and the City of St. John's sewer outfall that passes through the site and under the harbor. Although the final design is unknown, it will be a multi-story office tower with a footprint of approximately 1,000 m^2 to 2,000 m^2.

Based on the results of 15 boreholes drilled as part of recent environmental and geotechnical investigations at the site (Stantec 2013a and 2013b), the following section provides a description of the subsurface conditions encountered at the site. Borehole/monitor well locations are shown on Drawing No, 121412783-EE-02 in Appendix A.

Fill: A layer of fill material ranging in thickness from 0.6 to 6.9 m underlies the surficial layer of asphalt or reinforced concrete slab. The fill generally is sub-divided into an upper and lower layer. The upper layer of fill appeared to be a compacted engineered structural fill material described as a dense to very dense, grey to brown to black, silty sand with gravel to well-graded gravel with sand and silt, containing trace amounts of cobbles. The lower fill layer was generally described as very loose to dense, grey to black, silty sand with gravel, to a poorly-graded sand with gravel and silt, containing a varying amount (trace to frequent in content) of one or more of the following: wood debris, wood branches, undifferentiated organic matter and glass debris. This lower fill layer was generally consistent with material placed in an uncontrolled, non-engineered manner.

Marine Sediments: A discontinuous layer of very loose to compact, brown to black, silty sand with gravel with trace to frequent amounts of organic matter consistent with a marine depositional environment was encountered below the fill material.

Glacial Till: A native glacial till layer ranging in thickness from 0.3 m to 4.1m was encountered underlying the fill or marine sediment. The till was generally composed of compact to very dense, brown to grey, silty sand with gravel to poorly or well-graded gravel with silt and sand, and contained trace amounts of cobbles.

Bedrock was encountered below the till layer. The depth to bedrock varied from about 0.8 m on south east boundary of the site to 11.6 m toward the edge of the pier. Bedrock outcrops are noted immediately southeast of the site, and along Southside Road. The bedrock was described as greyish green to bluish grey siltstone and sandstone meta-sedimentary rocks. The quality of the bedrock was generally very severely fractured near the bedrock surface, becoming moderately jointed or intact with depth.

Based on the results of the investigation, it appears that the depth to bedrock and thickness of overburden materials increases in a northwesterly direction across the site toward the harbour as shown on the longitudinal sections and cross sections (e.g., C-C') presented in Drawing No. 121412783-EE-03 in Appendix A.

It is expected that the groundwater system in the vicinity of the proposed well screens will be primarily controlled by sea level with some recharge from upland areas (e.g., from the

southeast). Relatively minimal surface runoff and local recharge contributions are expected given the surrounding urban land use and storm sewer system present in the surrounding area. The depths to groundwater in the boreholes and monitor wells installed in February and March 2013 ranged from 0.50 m to 2.42 m below ground surface (bgs). Given the proximity of the site to St. John's Harbour (i.e., approximately 20 m from the proposed wells), groundwater levels are assumed to be at approximately sea level, and would be expected to vary with diurnal tidal fluctuations. Based on the local topography and the measured groundwater levels, the inferred direction of local groundwater flow at the site is northwest towards the St. John's Harbour as shown on Drawing No. 121412783-EE-02 in Appendix A.

The characteristic permeability of the surficial deposits at the site is expected to be moderate which implies a relatively quick transit time through the site. A review of the grain size distribution data from the geotechnical investigations (Stantec 2013a) suggests that the glacial till could contribute moderate flows to properly designed screened wells.

3.0 FIELD METHODOLOGY

3.1 Well Construction

Well drilling and testing activities were carried out by P. Sullivan and Sons Ltd. (Lic. # 006), of Paradise, NL between September 11, 2013 and September 13, 2013 under the direction of Stantec. Prior to commencing drilling activities, the locations of underground services (i.e., electrical, sewer, etc.) were identified by the appropriate parties. One (1) test water well (i.e., Well 1) was drilled over space No. 50 in an asphalt covered parking/equipment laydown area at Berth 28 using a Star 30K-DH water well drill rig (Photo 1). Well 1 was located approximately 20 m from the edge of the wharf and 4 m northwest of existing monitor well MW1. Four (4) existing monitor wells (i.e., MW1 to MW4), which were installed during February and March, 2013 as part of the Phase II ESA, were used as observation wells during the subsequent aquifer testing. The monitor wells were located equidistant (i.e., approximately 20 m) from the edge of the wharf and at distances ranging from approximately 4 m (monitor well MW1) to 68 m (monitor well MW4) from Test Well 1. The locations of the test well and monitor wells are shown on Drawing No. 121412783-EE-02 in Appendix A. Monitor Well Records are provided in Appendix B.

Photo 1 Well drilling at Well 1

The construction details for Well 1 including depth and stratigraphic information recorded during drilling are provided in the Well Record in Appendix B. The borehole was drilled using a Super Jaws (Numa, Thompson, CT) overburden drilling system to advance a 300 mm (12 inch) diameter steel surface casing through the thin layer of overburden (11.6 m) and about 1.4 m into bedrock to a total depth of 13.0 mbgs. The unconsolidated aquifer materials within the casing were expelled and logged by Stantec as the casing was advanced, which provided a good check on expected stratigraphy. Once the casing had been advanced to 13.0 m depth, water and air were circulated to ensure that all residual material was removed.

A 200 mm (8 inch) diameter well screen assembly was welded together on surface and lowered down the borehole inside the surface casing. The well assembly included a 3.0 m long section of manually-slotted screen with an approximate slot size of No. 150 (0.150 inch (4.0 mm) openings) set from 8.53 mbgs to 11.58 mbgs. The screen was custom fabricated by P. Sullivan and Sons Ltd., because a manufactured stainless steel V-notch screen could not be shipped in time to meet the revised project timeline. The calculated percent open area (43 %) of the custom fabricated screen was less than the percent open area (51%) of a comparable No. 95 (0.095 inch (2.4 mm) openings) manufactured continuous slot screen that would likely be used in the geothermal well design, which may result in a slightly less efficient well; however, this was considered in the interpretation. Once the well screen assembly was lowered into place, the surface casing was pulled back to above the top of the well screen to a depth of 8.08 mbgs in approximately 1 m intervals while placing filter material consisting of 0.6 mm to 1.2 mm (0.25 inch to 0.5 inch size) clean washed gravel. The well was then developed for approximately 2 hours by air lift pumping using the drill rig. Following well development, a bentonite plug was placed above the filter material and the remaining annular space was filled with natural fill material to ground surface. The surface casing was cut off at approximately 0.76 m above ground surface.

The preliminary well yield estimated by the well driller from the short term (2 hour) air lift pumping test (i.e., well development) indicated that the well could potentially yield approximately 570 L/min (150 USgpm) from the bottom of the well; actual yield would depend on the pump and screen setting limitations. The static water level was 2.28 mbgs (measured immediately prior to the step drawdown test) but fluctuates with the harbour water level.

3.2 Hydraulic Testing

Photo 2 Aquifer testing setup at Well 1

The hydraulic testing was carried out by P. Sullivan and Sons Ltd. under the direction of Stantec between September 18, and September 19, 2013. The hydraulic testing program consisted of a step drawdown test and a 24-hour constant rate test, followed by water level recovery monitoring. For this program, a submersible pump was set at approximately 9.5 mbgs. The discharge was controlled using a ball valve in a discharge/return manifold (Photo 2), and flow rates were measured by recording the time to fill a container of known volume. During testing, the discharge water was directed to a storm water catch basin located approximately 10 m south of Well 1. Water levels were measured manually in the pumping well (i.e., Well 1) using a Heron Water Level Meter (Heron Instruments Inc., Dundas, ON). Water levels were measured both automatically and manually in the four observation wells (i.e., MW1 to MW4) and the harbour using HOBO U20-001-02 water level loggers (Onset, Cape Cod, MA) and a Solinst Water Level Meter Model 101 (Solinst Canada Ltd., Georgetown, ON), respectively. Additionally, water temperature was automatically recorded by the water level loggers. The following terms are used in this report.

Aquifer - a geological formation, group of formations or part of a formation that contains sufficient saturated permeable material to yield economical quantities of groundwater to wells or springs.

Transmissivity (T), expressed as cubic metres per second per metre of drawdown ($m^3/s/m$ or m^2/s), is the volume of groundwater transmitted through a unit width of aquifer over its entire effective or saturated thickness.

Storage Coefficient or Storativity (S) is the volume of water that an aquifer releases from storage (pumping) or takes into storage (recharge) per unit surface area, per unit change in hydraulic head, expressed as a percentage.

Specific capacity (Q/s) of a pumping well is the ratio of well pumping rate to water level drawdown, expressed as cubic metres per second per metre of drawdown ($m^3/s/m$ or m^2/s); this property typically decreases with time of pumping (e.g., 30 minute, 2 day, or long term specific capacities) in unsteady state non-equilibrium conditions.

Safe Well Yield - the practical volume of water discharged from a well within a specific time period (e.g., 1 day, 10 day, continuous) in litres per minute (L/min), imperial or US gallons per minute (igpm or USgpm) or cubic metres per day (m^3/d), based on the apparent transmissivity of the well, and allowable drawdown to a pump intake, top of a screen or a major water-bearing zone.

3.2.1 Step Drawdown Test

Step drawdown tests are conducted to evaluate the drawdown behavior and efficiency of wells at various pumping rates, and to determine the optimum pumping rate for subsequent constant rate testing. A step drawdown test was conducted on Well 1 on September 18, 2013. The step drawdown test consisted of pumping the well at four incrementally higher pumping rates (159 L/min to 338 L/min) with no recovery between steps while monitoring the water level in the well. The time intervals for each step averaged 30 minutes for a total pumping duration of 125 minutes. Recovery measurements were made following cessation of pumping. Table 3.1 provides a summary of the step drawdown test conducted on Well 1 during the current investigation.

Table 3.1 Summary of Step Drawdown Test

Well ID	Step Drawdown Test				
	Date	Step	Pumping Rate (Q) (L/min)	Time Interval (min)	Total Time (min)
Well 1	18-Sep-13	1	159	30	125
		2	204	30	
		3	241	35	
		4	338	30	

3.2.2 Constant Rate Pumping Test

A constant rate pumping test was carried out to collect information on the hydraulic characteristics of the pumping well (i.e., apparent transmissivity (T) and specific capacity) and of the host aquifer underlying the property (i.e., transmissivity (T) and storativity (S) using water level responses from the observation wells). Based on the results of the step drawdown test in Well 1, a constant rate pumping test was conducted in Well 1 on September 18, 2013 and continued for a 24-hour period before the test was terminated. Well 1 was pumped at a rate of 339 L/min (90 USgpm). During the constant rate test, water level measurements were recorded at pre-determined time intervals in the pumping well, four observations wells and the harbour adjacent to the pier. The discharge rate from the pumping well was monitored periodically during the test and was found to be relatively constant. The water level recovery in the pumping and observation wells was monitored immediately following the completion of the constant rate test until the water level had returned to over 90% of its initial static water level (< 30 minutes). Manual measurements of the harbour level were also collected to correct the

water level responses for tidal bias and to assist in determining the potential tidal effects on water levels during the constant rate test.

Table 3.2 summarizes the 10 minute, 1 hour and 24 hour drawdown and the total recovery responses for the pumping well, and the total drawdown and recovery responses for the observation wells.

Table 3.2 Summary of Drawdown Responses during Constant Rate Test

Well ID	Well 1
Test Date	**Sep 18-19/13**
Pumping Well Drawdown Responses (m)	
10 min	6.82
1 h	6.86
24 h	6.86
Pumping Well Recovery Responses (m)	
2 min	6.43
Total	6.70
% (min)	83.6 (2)
Observation Well Total Drawdown Responses (m)	
MW1	1.61
MW2	0.34
MW3	0.29
MW4	0.15
Notes: m – metres; % - percent ; min – minutes since pumping stopped	

3.2.3 Water Quality Testing

Water samples were collected from well 1 and analyzed to provide a baseline of the quality of water expected to be returned to the harbor by the GHS, to identify any potential historical site issues of concern related to the operation of the GHS and to identify potential migration of impacts previously identified at the site (Stantec 2013b). Two (2) water samples were collected: approximately 1 hour following the initiation of the constant rate test (WS1) and approximately 30 minutes prior to the termination of the constant rate test (WS2). All water samples were collected in clean plastic and glass bottles and stored on ice in a cooler until they were submitted to Maxxam Analytics Inc. laboratories in St. John's, NL and Bedford, Nova Scotia for analysis of general chemistry parameters, dissolved metals, petroleum hydrocarbons (i.e., total petroleum hydrocarbons (TPH) and benzene, toluene, xylene and ethylbenzene (BTEX)) and polycyclic aromatic hydrocarbons (PAHs).

Additionally, conductivity and temperature were monitored in the pumping well discharge throughout the constant rate test to monitor the degree of expected intrusion of seawater. These field measurements were recorded using a YSI Professional Plus handheld multi-parameter meter.

4.0 INTERPRETATION OF RESULTS

4.1 Step Drawdown Tests

A step drawdown test was conducted in Well 1 to evaluate the drawdown behavior and efficiency of the well, and to determine the optimum discharge rate for the constant rate test. Table 4.1 presents a summary of pumping rates (Q), drawdowns (s), step duration (t) and calculated specific capacities (Q/s) for the test. Time-drawdown data and a plot of the time-drawdown response (Figure C-1) for the step drawdown test are presented in Appendix C.

Table 4.1 Summary of Specific Capacity Data for Step Drawdown Tests

Well ID	Step	Pumping Rate (Q) (L/min)	Water Level (mbgs)	Drawdown (s) (m)	Step Duration (min)	Specific Capacity (Q/s) (L/min/m)
Well 1 (July 18/13)	1	159	3.20	0.92	30	172
	2	204	4.06	1.78	30	115
	3	241	5.16	2.88	35	84
	4	338	8.27	5.99	30	56

The step drawdown test indicated that for all four (4) steps (i.e., from 159 L/min to 338 L/min) the water levels declined nearly instantaneously and then flattened out (i.e., stabilized within 2 min), indicating that water levels had stabilized for each pumping rate before the pumping rate was increased for the next step (Figure C-1,Appendix C). The step drawdown pumping test was terminated at the end of the fourth step as the water level was approaching the pump intake and consequently there was a risk of damaging the pump should it run dry. The water level stabilized at approximately 8.27 mbgs for a total drawdown of 5.99 m when the test was terminated. Given that the majority of water level response related to pumping in Well 1 was generally observed within the early time data (i.e., approximately the first 5 minutes of initiating pumping) and that tide level fluctuations were considered negligible over the early time periods, water level response data was not corrected for tidal influence.

An estimate of the optimum pumping rate for the production well can be obtained by plotting the drawdown divided by pumping rate (s/Q) versus pumping rate (Q) for each step (refer to Figure C-2 in Appendix C). The slope and intercept of a regression line fitted to these points gives the coefficients of the equation describing drawdown in a pumping well.

$$dd = BQ + CQ^2$$

where: dd = drawdown (m);

Q = pumping rate (L/min);

B = coefficient for laminar component of drawdown (intercept); and,

C = coefficient for turbulent component of drawdown (slope).

The slope of the line also provides an indication of the efficiency of the well relative to the host aquifer. The flatter the slope the greater the efficiency of the well, since there is less head loss in the well as a result of increased pumping. This is also indicated by the ratio of the BQ term (drawdown due to laminar flow) to total drawdown. The calculated coefficients of laminar and turbulent flow are provided in Table 4.2, along with predicted drawdowns at the proposed 339 L/min constant rate test pumping rate.

Table 4.2 Summary of Step Drawdown Test Analysis Results

Well ID	Intercept (B)	Slope (C)	Ratio Laminar/ Total Drawdown (%)	Pumping Rate* (Q) (L/min)	BQ	CQ^2	Predicted 30 minute Drawdown* (m)	Actual 30 minute Drawdown* (m)
Well 1	-0.0048	0.000067	26.4	339	-1.612	7.706	6.094	6.863
Notes: * For the constant rate test								

Based on the above calculations, the computed slope (C) for Well 1 is relatively low, with a determined value of 6.7E-05. However, an increase in drawdown with higher pumping rates is indicated by the decrease in specific capacity from 172 L/min/m to 56 L/min/m over the course of step drawdown test (refer to Table 4.1). This would suggest that the well was not fully developed. Additionally, the ratio of the BQ term (i.e., drawdown due to laminar flow) to total drawdown is relatively low at 26.4%, which also suggests that the well is not operating at optimum efficiency.

4.2 Constant Rate Test

The results of the constant rate test conducted on Well 1 are presented in the following section and time-drawdown data and plots of the time-drawdown and recovery response (Figures D-1 and D-2) are presented in Appendix D. Analysis of the constant rate test data was performed using a variety of methods applicable for confined/unconfined aquifers, including the Cooper-Jacob, Theis and Theis Recovery methods with the aid of the computer program AQTESOLV® Version 4.50.002 (HydroSOLVE Inc., Reston, VA). The analysis results are presented in the following section and graphical displays are presented in Appendix E.

Based on the results of the step drawdown test in Well 1, the pumping rate for the constant rate test was set at 339 L/min (90 USgpm). The flow rate was monitored at regular intervals and was found to be relatively constant (i.e., 339 L/min +/- 45 L/min) during the test. After 24 hours of pumping, the water level in Well 1 was 8.61 mbgs for a total drawdown of 6.86 m. At this time,

the water levels in the observation wells ranged from 2.18 mbgs (0.31 m total drawdown) in observation well MW4 to 3.21 mbgs (1.57 m total drawdown) in observation well MW1. Given that the majority of water level response related to pumping in Well 1 was generally observed within the early time data (i.e., approximately the first 6 minutes after initiating or terminating pumping) and that harbour water level fluctuations were considered negligible over the early time periods, water level response data was not corrected for tidal influence.

Upon initiation of pumping, the water level in Well 1 declined nearly instantaneously (i.e., within < 6 min) and then flattened out, indicating that water levels had stabilized (Figures D-1 and D-2 in Appendix D). A tidal influence was not observed in the pumping well (i.e., Well 1), however, a tidal influence is very evident in observations wells MW1 to MW4, as their water level responses follow a similar trend to that of the recorded harbour water levels (Figures D.1 and D.2 in Appendix D). Over the constant rate pumping test period, tide levels ranged 1.28 m from 0.965 mbgs to 2.205 mbgs (Figures D.1 and D.2 in Appendix D). It should be noted that the tidal influence may be slightly greater during other times of year. For example, for 2012, tides in St. John's, NL are predicted to be as low as 0.2 m over the chart datum reference and as high as 1.6 m over the chart datum reference (e.g., 1.4 m range).

The steady state conditions indicated that the pumping well had reached an equilibrium condition and that a positive recharge boundary had been encountered (i.e., the harbour acting as a constant source of recharge). Based on an average pumping rate of 339 L/min, the specific capacity at the end of the pumping period was 49 L/min/m, which is slightly less than the specific capacity (i.e., 56 L/min/m) observed during the step drawdown test at a similar pumping rate (i.e., 338 L/min).

During the constant rate test, changes in water levels were detected in observation wells MW1 to MW4, located approximately 4 m (observation well MW1) to 68 m (observation well MW4) from the pumping well. Upon initiation of pumping in Well 1, the water levels in the observation wells declined nearly instantaneously (i.e., < 6 min) to levels ranging from 2.11 mbgs (0.15 m total drawdown) in observation well MW4 to 3.25 mbgs (1.61 m total drawdown) in observation well MW1 (refer to Figures D-1 and D-2 in Appendix D). Following the initial water level drop, water level responses in all observations wells (i.e., MW1 to MW4) followed a similar trend to that of the recorded harbour water level (refer to Figures D.1 and D.2 in Appendix D), indicating that water levels had stabilized.

Recovery monitoring carried out in the pumping well (i.e., Well 1) and observation wells (i.e., MW1 to MW4) indicated that water levels in all wells essentially fully recovered nearly instantaneously (i.e., < 6 min), after which water levels followed a similar trend to that of the recorded harbour water level. The time-recovery response data is provided in Appendix D and is shown in Figure D-3 in Appendix D.

The pumping well provides an indication of apparent transmissivity since the well is not considered to be 100% hydraulically efficient relative to the host aquifer. Data from the

pumping well is used to determine apparent transmissivity, hydraulic conductivity, sustainable individual well yields, well specific capacity and well efficiency relative to the aquifer. The aquifer hydraulic properties (T and S) are determined from observation well responses during the constant rate test. Table 4.3 provides a summary of apparent T values for the pumping well, and the T and S values for the aquifer using the initial few minutes of response before the pumping well achieved steady state. The geometric mean apparent transmissivity for Well 1 was calculated to be 2.3E-04 m^2/s.

The geometric mean T and S for the aquifer was calculated to be 2.2E-03 m^2/s and 3.3E-04, respectively. Given the relatively small observed water level response (i.e., 0.29 m in observation well MW3 to 0.15 m in observation well MW4), analyses were not carried out using data from these wells.

Table 4.3 Aquifer Hydraulic Properties

Well	Status[1]	r[2] (m)	T (m^2/s)	S[3] (units)	24 hr. Q/s (L/min/m)	Method
Well 1 (24 Hour Constant Rate Test - Sep 18-19, 2013)						
Well 1	PW	-	2.1E-04	-	49.0	CJ Drawdown
				-		
		-	2.6E-04	-		Theis Recovery
MW1	OW	4	1.7E-03	1.9E-04	-	CJ Drawdown
			1.8E-03	1.5E-03		Theis Drawdown
			7.9E-04	-		Theis Recovery
MW2	OW	25	3.6E-03	2.5E-04	-	CJ Drawdown
			4.6E-03	1.4E-04		Theis Drawdown
			2.5E-03	-		Theis Recovery
Apparent Transmissivity (Pumping Wells)						
Mean Well 1			2.3E-04	-	49.0	-
Aquifer Hydraulic Properties (Observation Wells)						
Geometric Mean Aquifer			2.2E-03	3.3E-04	-	
Arithmetic Mean Aquifer			2.5E-03	6.0E-04	-	

Notes:
1 - PW - Pumping Well (Pumping); OW - Observation Well
2 - r - distance from pumping well in meters
3 - S = storage coefficient (dimensionless percentage of rock mass)

4.3 Safe Well Yield

The maximum theoretical yield of a well is a function of available drawdown, well (screen) efficiency, predicted interference from other pumping wells and practical limitations such as pumping lift. The available drawdown for Well 1 is estimated as the drawdown to the top of the

well screen less the depth to static water. The usual approach for estimating sustainable yield of a pumping well is based on the modified Cooper-Jacob non-equilibrium equation, expressed as:

$$Q_t = \frac{0.7 \times T \times \Delta s}{0.183 \times \log(t)}$$

Where: T = aquifer/well transmissivity (m^2/s);

S = available drawdown (m);

T = time (minutes); and,

Q_t = continuous pumping rate for a given time t (m^3/s)

A safety factor of 0.7 is incorporated into the theoretical safe yield values to account for any uncertainties in the computed values of transmissivity and to account for undetected negative boundary conditions, seasonal water level fluctuations and borehole head losses.

Given the confirmed recharge from the harbour and the rapid on-set of steady state draw down in the pumping well, a 1-day safe yield is considered to be a representative estimate of the theoretical long-term safe yield of a screened water supply well at the site. Application of the Cooper-Jacob (1946) non-equilibrium approach suggests a 1-day continuous safe yield of 100 L/min (26 USgpm) using a geometric mean apparent T of 2.3E-04 m^2/s and a maximum available drawdown of approximately 6.0 m.

This estimate does not match the observed 24 hour steady-state yield of 339 L/min (90 USgpm). There is considerable uncertainty in determining apparent transmissivity from a well that reaches steady state as quickly as Well 1. The non-equlibrium approach is therefore considered to be invalid in this case, as it assumes continuing drawdown; testing has confirmed a positive recharge boundary (e.g., the harbour) early in the test. When a well is at steady state; the apparent T approaches the specific capacity (in this case 49.4 L/min/m). Using this value gives us a one day sustainable yield in the order of 355 L/min (94 USgpm), similar to the pumping test.

The test well was operating relatively inefficiently, likely due to a combination of the less efficient fabricated screen (Section 3.1), the well screened zone may not have been fully developed by two hours of air-lift pumping (Section 4.1) and the relatively low ratio of drawdown due to laminar flow to total drawdown (Table 4.2) which implies significant turbulent flow. A comparison of the aquifer T (2.2E-03 m^2/s) and the apparent well T (2.3E-04 m^2/s) suggests a well efficiency of about 10% relative to the aquifer matrix. Some of this is a consequence of the screen, and some is due to the fine materials in the aquifer. Therefore, a properly designed and thoroughly developed well screen may produce a greater yield than the test well.

The maximum yield that a 100% efficient well could achieve would be estimated with the interpreted aquifer T and S. Applying the Cooper-Jacob approach, using the geometric mean

aquifer T (2.2E-03 m^2/s) and a maximum available drawdown of approximately 6.0 m would be in the order of 959L/min (253 USgpm). From a practical standpoint, 100% screen efficiency is unlikely in consideration of the percentage fine materials (10 to 15%) in the sand till matrix. However, a properly designed well screen that could reach 50 to 70 % efficiency with respect to the aquifer could theoretically result in individual well yields of 125 to 180 USgpm.

The calculated theoretical long-term safe yields for Well 1 are presented in Table 4.4. These estimates were made using the steady state specific capacity for Well 1, and 50 % of the tested aquifer transmissivity (e.g., simulating 50 % screen efficiency).

Table 4.4 Theoretical Safe Pumping Yields for Well 1 for Specified Time Periods

Time Period	Time Period	Yields using Well Q/s = T			Yields using 50 % of Aquifer T		
		Q_t	Q_t	Q_t	Q_t	Q_t	Q_t
	(min)	(m^3/s)	(L/min)	(USgpm)	(m^3/s)	(L/min)	(USgpm)
1-hour	60	1.1E-02	638	168	1.4E-02	852	225
8-hour	480	7.0E-03	423	112	9.4E-03	565	149
1-day	1,440	6.0E-03	359	95	8.0E-03	480	127
30-days	43,200	4.1E-03	245	65	5.4E-03	327	86
100-days	144,000	3.7E-03	220	58	4.9E-03	294	78
1-year	525,600	3.3E-03	198	52	4.4E-03	265	70
20-years	10,512,000	2.7E-03	161	43	3.6E-03	216	57

4.4 Well Interference Potential

The above analysis was completed assuming that Well 1 was the only production well for the GHS, and no consideration was given to the effects of additive drawdown interference that may occur should additional water wells be utilized to meet the GHS operating requirements. However, given the relatively small amount of drawdown (i.e., <0.5 m) observed in observation wells MW2 to MW4 located approximately 25 m to 65 m from the pumping well during the constant rate pumping test, well interference is not considered to be significant (i.e., >0.5 m) if the wells are spaced at distances greater than approximately 20 m. Alternatively, wells could be spaced closer together if well interference can be tolerated and more efficient screens are achieved.

It is suspected that the degree of mutual well interference will be reduced due to the proximity of a significant recharge boundary (e.g., the harbour).

Interference drawdown between pumping wells can limit the sustainable yield of individual wells, especially where limited saturated thickness is available. In the case of the CCG wells, the available drawdown is considered to be the distance between the low static water level and the top of the screen or the top of the pump, whichever is reached first. Assuming an aquifer transmissivity of 2.2E-3 m^2/s, a storage coefficient of 3.3E-4, and assuming steady state conditions

within a few minutes to hours of initiation of pumping, Table 4.5 presents calculated interference drawdowns for a series of four wells each pumping at 125 USgpm at various separation distances. The pumping well drawdown was corrected (e.g., increased) to assume a reasonable screen efficiency of 60% relative to the aquifer. Since the non-equilibrium method over-predicts observed drawdown by > 50%, the predicted drawdown at observation wells are reduced by 50% (e.g., steady state recharge from the harbour expected). Assuming an available drawdown of 7 m in each pumping well (assuming installation of shorter screens), this approach shows that a separation distance of 20 m is optimum with four wells each pumping at 125 USgpm (500 USgpm total). Further refinement of these predictions can be done as new aquifer testing data is received.

Table 4.5 Predicted Interference Ddrawdowns for a 4-Well GHS System

Well	Well 1		Well 2		Well 3		Well 4	
	r (m)	DD (m)	r (m)	DD (m)	r (m)	DD (m)	r (m)	DD (m)
10 m Well Separation								
Well 1	pumping	4.84	10	0.79	20	0.60	30	0.48
Well 2	10	0.79	pumping	4.84	10	0.79	20	0.60
Well 3	20	0.60	10	0.79	pumping	4.84	10	0.79
Well 4	30	0.48	20	0.60	10	0.79	pumping	4.84
Total Drawdown		**6.70**		**7.02**		**7.02**		**6.70**
15 m well Separation								
Well 1	pumping	4.84	15	0.68	30	0.48	45	0.36
Well 2	15	0.68	pumping	4.84	15	0.68	30	0.48
Well 3	30	0.48	15	0.68	pumping	4.84	15	0.68
Well 4	45	0.36	30	0.48	15	0.68	pumping	4.84
Total Drawdown		**6.36**		**6.67**		**6.67**		**6.36**
20 m Well Separation								
Well 1	pumping	4.84	20	0.60	40	0.40	60	0.28
Well 2	20	0.60	pumping	4.84	20	0.60	40	0.40
Well 3	40	0.40	20	0.60	pumping	4.84	20	0.60
Well 4	60	0.28	40	0.40	20	0.60	pumping	4.84
Total Drawdown		**6.11**		**6.42**		**6.42**		**6.11**
30 m Well separation								
Well 1	pumping	4.84	30	0.48	30	0.48	90	0.17
Well 2	30	0.48	pumping	4.84	60	0.28	60	0.28
Well 3	60	0.28	30	0.28	pumping	4.84	30	0.48
Well 4	90	0.17	60	0.28	30	0.48	pumping	4.84

Well	Well 1		Well 2		Well 3		Well 4	
	r (m)	DD (m)	r (m)	DD (m)	r (m)	DD (m)	r (m)	DD (m)
Total Drawdown		**5.76**		**5.88**		**6.08**		**5.76**

Notes:
Assumed screen efficiency 60%;
Pumping Rate 125 USgpm x 4 = 500 USgpm;
available drawdown = 6.5 m (3 m screen), 7.5 m for 2 m screen
aquifer T = 2.2E-3 m3/s; S = 2.3E-4

4.5 Well Design Considerations

Several factors influence the volumes of sea water that can be transmitted between the harbour and the screened well(s), including the physical properties of the aquifer and the design of the well screens. The hydraulic conductivity of the overburden materials limits the rate at which water can be transmitted. In particular, the percentage of fine materials in the soil matrix have the great effect on hydraulic conductivity (K) and the volume of water that can be abstracted from a screened well. A review of the grain size distribution data (Stantec 2013a) suggests that the aquifer materials below 3 m depth are comprised of 43.3 percent gravel fraction, 46.9 percent sand fraction and 9.8 percent silt and clay fraction (N = 9). The percentage of silt and clay also increases with depth (e.g., 6.6% at 3.2 m to 13.5 % at 9.3 m).

The grain size distributions also control the degree of permeability variability in the materials. Using the 50 % passing grain size value for screen slot design, a wide range is indicated ranging from 75 slot to 233 slot, with a mean of 146 slot (median 150 slot, geomean 138 slot). When designing the well, consideration should be given to optimize the slot size to be small enough to retain up to 50% of the aquifer material, yet large enough to minimize friction losses in the screen openings for the proposed pumping rates. A properly sized filter material placed around the well screen can also allow for the use of a larger slot size, if required.

Screen length also affects the hydraulic capability of a well. While longer screens cover a greater saturated thickness of aquifer, the available drawdown is limited by the top of the screen (e.g., to prevent bio fouling or scaling due to turbulent flow through a screen). Although there may be some losses in well efficiency, if a longer well screen is used it is possible to allow the water levels in the well to be lowered drawdown below the top of the well screen to increase the available drawdown. In the case of the CCG site, and depending on the screen transmission capacity for the selected slot size, assuming a specific capacity of 49 L/min/m (70.5 m^3/d/m), the theoretical yield of Well 1 could have been increased at least 10%. With one additional metre of drawdown; a more efficient screen should provide additional increases in well yield.

A proposed well design is provided based on information obtained during a geotechnical and environmental sub-surface investigation completed at the site in April 2013. More specifically

the well was designed primarily based on data obtained for boreholes BH1, BH2, BH3 and BH4 (Stantec 2013a) and includes the following assumptions:

- Groundwater level is approximately 2 m below surface of concrete deck of the pier.
- Each well will produce up to 750 L/min (200 USgpm).
- Soil conditions are similar to those encountered in the geotechnical boreholes.
- Depth to bedrock is similar to that encountered in geotechnical boreholes.

Based on these assumption it is suggested that the a 200 mm (8") diameter well be construction using a 3 m (10') length of 100 slot V-notch wire wrapped stainless steel well screen and would be installed using the following methodology.

1. Advance a 300 mm diameter steel well casing to top bedrock at a depth of approximately 11 m below surface of concrete deck of the pier. Then advance or drill 250 mm diameter borehole an additional 1.5 m into bedrock.
2. Remove all unconsolidated material from within the 300 mm diameter casing.
3. Install 200 mm diameter well screen assembly consisting of the following components:
   a. Bottom plate
   b. 1.5 m (5') section of blank 200 diameter stainless steel well casing
   c. 3.28 m (10') section of 200 m diameter 100 slot stainless steel V-notch wire wrapped well screen
   d. 9.1 m (30') section of blank 200 diameter stainless steel well casing (to about 1.3 m above ground surface).
4. Pull back exterior casing to a depth of approximately 0.5 m above the top of well screen while placing filter material consisting of 3 to 6 mm (1/8" to 1/4") size clean washed silica sand. It is estimated that approximately 0.5 m^3 of filter pack material will be required.
5. Place a 1 to 1.5 m thick bentonite plug above the filter material.
6. Fill the remaining annular space with gravel and fill material to approximately 2 m below concrete deck of pier.
7. Cut 300 mm diameter steel casing flush with surface of deck of pier.
8. Fill remaining annular space between 300 mm diameter surface casing and 200 mm diameter well casing with concrete grout.
9. Develop the well using a combination of the following techniques:
   a. Suring with 0.5 m surge block while simultaneously air lifting
   b. High pressure jetting with water
   c. Conventional airlifting

4.6 Water Quality

4.6.1 Field Indicators

Conductivity and water temperature data (Tables F.1 and F.2, respectively) and plots (Figures F-1 and F-2, respectively) collected during the constant rate test carried out in Well 1 are presented in Appendix F.

Results of field measurements of conductivity show that a relatively constant (mean 46,467 µS/cm +/- 2,750 µS/cm) saline condition existed in Well 1 throughout aquifer testing, indicating that saltwater was drawn into Well 1 relatively quickly as pumping progressed. As a reference, typical conductivities of "fresh" drinking water and seawater are approximately 50 µS/cm to 500 µS/cm and 50,000 µS/cm, respectively. A general increase in conductivity (and salinity) was observed between 500 and 1100 minutes of pumping; this may reflect the displacement of less saline seaward moving groundwater with harbor water, and further confirms hydraulic interaction between the pumping well and the harbour.

The pumping well exhibited consistent temperature (mean 11.9 degrees C) throughout the 24 hours of pumping. The observation wells MW1, MW3 and MW4 followed a similar trend to that observed in the harbour. It appears that when the harbour water levels were at the highest point, saltwater was drawn into the observation wells and the warmer seawater (relatively constant temperature at approximately 11.9 °C) was raising the observation well water temperatures. Conversely, when the harbour water level fell below the static observation well water levels, observation well water temperatures appeared to be controlled by the cooler ambient groundwater temperature. This indicates a high degree of connectivity between the observation wells and the harbour and that the GHS may have a greater capacity for heating in sub-zero environments without risk of freezing, as compared to a GHS supplied by fresh water. It is unclear why there was no temperature response in observation well MW2, as water level responses during the constant rate test indicate that observation well MW2 was also influenced by the harbour water level, but may be due to the possible presence of lower permeability materials in this area. Water temperature was not monitored in Well 1 since no water level logger was placed in the pumping well.

4.6.2 Laboratory Analytical Results

The results of the laboratory analysis for general chemistry parameters, dissolved metals, petroleum hydrocarbons (i.e., TPH and BTEX) and PAHs are summarized in Tables G.1 to G.4, respectively in Appendix G. Full analytical results for the chemical analysis are presented in certificates of analysis from Maxxam Analytics provided in Appendix G.

For comparison to previous environmental investigations carried out at the site (Stantec 2013b), and in accordance with the Federal Contaminated Sites Action Plan (FCSAP), all analyzed groundwater parameters were compared to the Environment Canada (EC) Federal Interim Groundwater Quality Guidelines (FIGQGs), last updated November 2012. Based on the existing site conditions for the subject site, the FIGQGs for marine life for a site with commercial/industrial land use and coarse-grained soil are applicable to the site. All groundwater parameters were also compared to the Ontario Ministry of the Environment's (MOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, April 2011, for a full-depth generic site with non-potable groundwater. The Ontario MOE groundwater guidelines are protective of aquatic receptors in surface waters which could be affected by the discharge of groundwater.

Based on the final chemistry sample (WS2), the groundwater discharged from Well 1 is described as a slightly colored (color 30 TCU, turbidity 8.8 NTU), very hard (4,300 mg/L), neutral (alkalinity 87 mg/L, pH 6.9), sodium chloride water type of high dissolved solids (TDS 22,000). The water quality is consistent with a mixture of fresh groundwater and about 65% sea water (Hem, 1992), and is dominated by induced saline intrusion from the nearby harbour. All analyzed parameters were within the applicable EC FIGQGs or OMOE Guidelines, with the exceptions of:

- pH (EC FIGQG 7.0 to 8.7) – Water sample WS2 (6.90)
- Cadmium (EC FIGQG guideline 0.12 µg/L) - Water samples WS1 (0.60 µg/L) and WS2 (0.33 µg/L); and,
- Sodium (Ontario MOE guideline of 180 mg/L) - WS1 (6,000 mg/L) and WS2 (6,700 mg/L).

None of these exceedences are detrimental to the operation of the proposed geoexchange system. The pH was only slightly less than the applicable guideline and consistent with findings of the Phase II ESA (Stantec, 2013b) in the vicinity of Well 1. This pH is considered to be normal for shallow aquifers in Newfoundland.

Cadmium concentrations exceeded only the EC FIGQG (0.12 µg/L) and were well within the Ontario MOE guideline (2.1 µg/L); no cadmium exceedances were detected in groundwater during the Phase II ESA (Stantec, 2013b). When considering the salt water intrusion and proximity of Well 1 to St. John's Harbour, it is possible that the observed low level cadmium may be related to saline intrusion, (e.g., the saline water movement through the aquifer displaces multi-valent cationic metals from the soil media). Also, sea water contains about 0.11 µg/L cadmium (Hem, 1992).

The elevated sodium (and associated chloride, sulfate, potassium, calcium, magnesium, boron, strontium, TDS, hardness and conductance) is attributed to salt water intrusion, and is consistent with findings of the Phase II ESA (Stantec, 2013b). No EC FIGQG exists for sodium.

All analyzed petroleum hydrocarbon parameters were within the applicable EC FIGQGs and/or Ontario MOE Standards. Despite reported petroleum hydrocarbon exceedances in groundwater in the vicinity of Well 1 during the Phase II ESA (Stantec, 2013b), the absence of hydrocarbon during the pumping period indicates that the aquifer testing did not induce migration of petroleum hydrocarbons towards Well 1.

No PAH compounds were detected in any of the groundwater samples analyzed. The Phase II ESA (Stantec, 2013) reported PAH exceedances in groundwater samples collected from boreholes (i.e., BH1, BH2, BH5, BH6, BH8 and BH11) on the eastern portion of the site (i.e., in the vicinity of Well 1). This suggests that the aquifer testing did not induce migration PAHs towards Well 1.

5.0 CONCLUSIONS

Based on the results of the aquifer testing, the following conclusions and recommendations are made:

5.1 Aquifer and well Hydraulic Properties

- The poorly graded sand with silt and gravel aquifer underlying the CCG site has a transmissivity of 2.3E-3 m^3/s and a storage coefficient in the order of 2.2E-4.
- Testing of Well 1 suggested a steady state yield of 339 L/min (90 USgpm), a 24 hour (steady state) specific capacity of 49 L/min/m of drawdown, an apparent Transmissivity of 8E-4 m^3/s (approximating the specific capacity) and a screen efficiency of about 37 % relative to the aquifer (ratio well vs. aquifer T).
- The pumping wells are expected to reach steady state within 10 minutes due to the proximity of the St. John's harbour.
- Because the test well screen was inefficient, a properly designed and developed, efficient well could produce a greater yield based on the calculated T of the aquifer. Assuming a practical screen efficiency of 60% and 6 m of available drawdown, a well yield of up to 500 L/min (125 USgpm per well) is possible based on the aquifer data.
- Based on the work completed to date, the sandy glacial till aquifer underlying the CCG site is considered to be capable of providing moderate yields to efficiently screen water supply wells. This aquifer is less permeable that other areas around St. John's Harbour due to greater proportion of fine materials in the matrix (e.g., mean 9.8% silt and clay fraction).
- It is Stantec's opinion that practical yields in the order of 100 to 150 USgpm may be achieved from 11 m deep screened wells in this location. Further confidence on this prediction can only be obtained through the installation and hydraulic testing of additional supply wells.

5.2 Water Quality

- The water chemistry at the CCG site is considered to be acceptable for the geoexchange.
- Results of field measurements of temperature indicate a high degree of connectivity between the observation wells and the harbour and that the GHS may have a greater capacity for heating in sub-zero environments without risk of freezing, as compared to a GHS supplied by fresh water.
- The water temperature appears to follow temperatures in the harbour. While harbour temperatures were warmer (11 ^oC) than the ambient groundwater temperature (8 ^oC) during the test period, some fluctuation may occur during colder winter and warmer summer months.
- The water chemistry is consistent with sea water intrusion (about 65% sea water) into the sand aquifer. All analyzed parameters met respective guidelines with the exceptions of minor cadmium and high sodium, both of which are attributed to saline intrusion. No petroleum hydrocarbons or PAH compounds were detected during the 24 hour pumping test.

5.3 Geoexchange Development Potential

- This study suggests that a geoexchange system could be developed in the sand aquifer adjacent to St. John's Harbour. The main limitations to well development and cumulative well field yield include the moderate permeability of the sand aquifer, screen development efficiency, pumping well interference drawdowns and limited available drawdown (6 to 7.5 m depending on final screen length).
- The saline groundwater should not pose a problem to geoexchange operation; all components must be designed in consideration of brackish to saline water quality.
- Water quality monitoring during the test pumping indicates that the water can be discharged back into St. Johns's Harbour without treatment. No petroleum hydrocarbons or PAH compounds were detected, and trace cadmium is the only exceedance of regulations.
- Based on the observed well interference drawdown during testing of Well 1, and calculation of potential interferences for a line of four supply wells, a well separation distance of 20 m is suggested. Closer separations may be possible pending further well installation and testing. Closer separations can be considered for back-up wells.
- The current testing and theoretical calculations suggest that a series of four, 203 mm diameter screened supply wells will be required to meet the project demand estimated at between 1,900 and 2700 L/min (500 to 700 USgpm). Assuming similar hydrogeology along the pier, individual well yields in the order of 100 to 125 USgpm should be possible, provided the well screens are properly placed and developed to improve efficiency.

6.0 RECOMMENDATIONS

- New supply wells should be constructed with efficient v-notch stainless steel well screens.
- All new wells should be thoroughly developed with a surge block until screens are as efficient as possible (50-65%), and then subjected to a step drawdown pumping test.
- New well screens should be set over the bottom 3.0 m of the sand aquifer in a 5 m or longer sand pack. If necessary, although there may be some reduction in well efficiency, it may be possible to lower the water level in the well below the top of the well screed to increase available drawdown and increase well yield.
- The pumps should be set below the top of the screens (e.g., within the screen and/or lower tail pipe) to maximize available drawdown.
- Depending on the total yield demand, the wells should be separated about 20 m; pending results of testing, additional wells may be installed between these.
- The sequence of the GHS well field development should be as follows:
    - Install the next well 10 to 15 m from Well No. 1, and conduct step test and a second 12 to 24 hour pumping test to evaluate interference drawdowns at closer separations. Pending the results of this work, revise optimum separation distances.
    - Complete the remaining wells in the same manner, and conduct step tests for each.
    - Conduct a confirmation pumping test with all four wells in operation.

- Standard precautions should be taken in completion of the water wells, such as installation of a low level switch at the top of the pump assembly to prevent breaking suction by drawing the water below the pump intake.
- Water levels in the wells should be monitored regularly (e.g., bi-weekly) for a period of one year after commissioning to determine the reliability of the safe yield predictions.
- If work is not to proceed immediately, a water level/temperature data logger should be placed in the harbour and in one of the aquifer wells (8 to 11 m depth) to monitor temperatures over the winter months.
- While no issues were identified in the 24 hour test period, routine water quality monitoring in production wells during GHS operation is recommended to confirm expected low concentrations of petroleum hydrocarbon or PAH known to be present on site at residual levels.

7.0 CLOSURE

This report has been prepared for the sole benefit of PWGSC and its agents. The report may not be relied upon by any other person or entity without the expressed written consent of Stantec Consulting Ltd. and PWGSC.

The recommendations and predictions contained in the above report are based solely on the scope of work completed to date. While the recommendations and predictions of an individual well and aquifer performance are based on sound hydrogeological principles, undetected hydraulic conditions may occur which were not apparent from limited duration aquifer tests. Since these could result in variations in predicted water levels and well interferences over time, it is strongly recommended that the well be closely monitored over the initial year of operation. The results of this initial period of monitoring should be reviewed by a qualified hydrogeologist to determine if adjustments in pumping rates are warranted. Any significant deviations from the predicted well performance should be immediately reported to Stantec Consulting Ltd.

CLOSURE
January 17, 2014

This report was prepared by Michael Haverstock, M.Sc, P.Eng. and was reviewed by Robert MacLeod, M.Sc., P.Geo and David MacFarlane, M.Sc., P.Geo. We trust that this report meets your present requirements. If you have any questions or require additional information, please contact our office at your convenience.

Respectfully submitted,

STANTEC CONSULTING LTD.

Michael Haverstock, M.Sc., P.Eng.
Environmental Engineer

Robert MacLeod, M.Sc., P.Geo.
Principal
Senior Hydrogeologist

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEGNL Newfoundland and Labrador PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
PERMIT HOLDER
This Permit Allows
STANTEC CONSULTING LTD.
To practice Professional Geoscience in Newfoundland and Labrador.
Permit No. as issued by PEG 50291
which is valid for the year 2014

NEWFOUNDLAND & LABRADOR ASSOCIATION OF PROFESSIONAL GEOSCIENTISTS
ROBERT MACLEOD
SIGNATURE
Jan 17/2014
DATE
NEWFOUNDLAND & LABRADOR

8.0 REFERENCES

Cooper, H.H. & C.E. Jacob, 1946. A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History. Trans Amer. Geophysical Union 27, pp. 526-534.

Environment Canada 2012. (EC) Federal Interim Groundwater Quality Guidelines (FIGQGs), last updated November 2012.

Hem, J.D., 1992. Study and Interpretation of the Chemical Characteristics of Natural Water. USGS Water Supply Paper 2254. 3rd Edition.

HydroSOLVE Inc., 2007. Reston, VA. AQTESOLV® Version 4.50.002.

OMOE 2011. Ontario Ministry of the Environment (OMOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, April 2011, for a full-depth generic site with non-potable groundwater.

Stantec 2013a. Geotechnical Investigation, Part of the Phase II Environmental Site Assessment: Canadian Coast Guard, Southside Base, St. John's, NL. Revised Final Report No. 121412551. May 10, 2013.

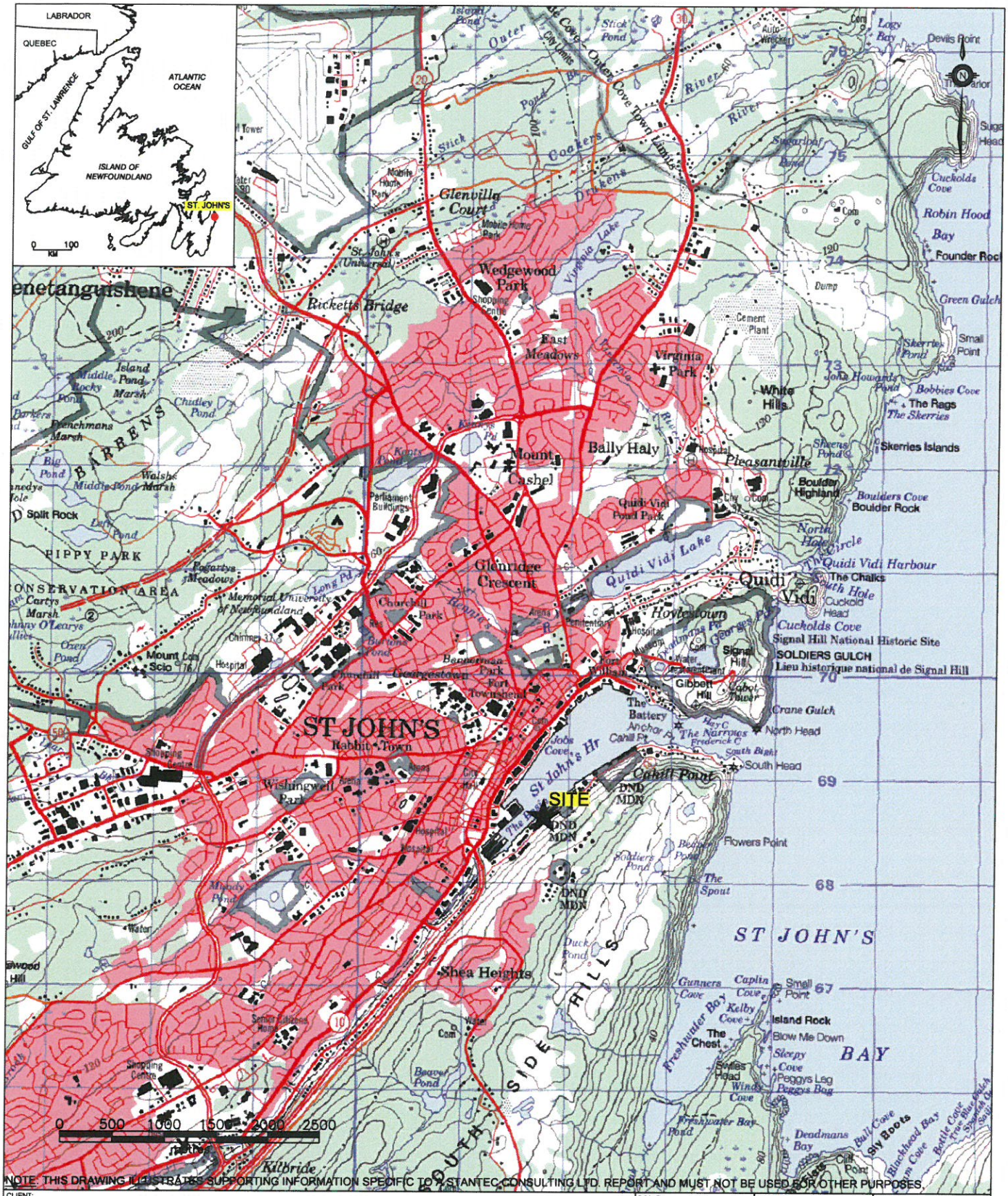
Stantec 2013b. Phase II Environmental Site Assessment: Canadian Coast Guard Southside Base, Berth 28, Southside Road, St. John's, NL. Report No. 121412551. May 6, 2013.

Stantec 2013c. Proposal for Hydrogeological Services for Potential Geothermal Well (Phase II), Canadian Coast Guard Southside Base, St. John's, NL. Report No. 121412600. July 26, 2013.

Theis, C.V., 1935. The Relationship between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well using Groundwater Storage. Trans. Amer. Geophysical Union 2, pp. 519-524.

APPENDIX A

Drawings



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

CLIENT:
ENVIRONMENTAL SERVICES,
PUBLIC WORKS & GOVERNMENT SERVICES CANADA

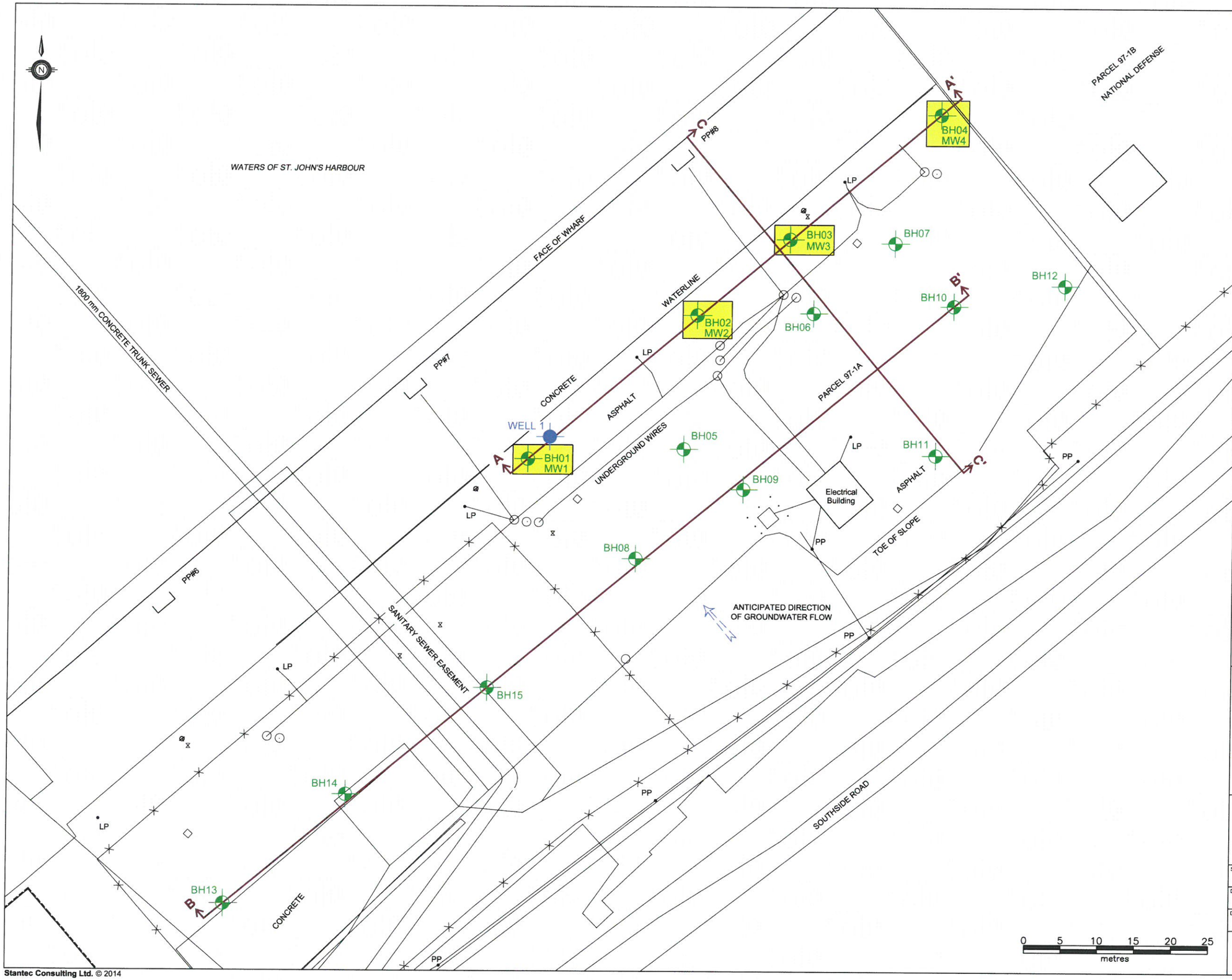
PROJECT TITLE:
HYDROGEOLOGICAL ASSESSMENT, POTENTIAL GEOTHERMAL WELL (PHASE II), CANADIAN COAST GUARD SOUTHSIDE BASE, ST. JOHN'S, NL

DRAWING TITLE:
SITE LOCATION PLAN

SCALE:	DATE:	REV. No.
1:50,000	JAN. 17, 2014	0
DRAWN BY:	EDITED BY:	CHECKED BY:
N.M.	-	
DRAWING No:	CAD FILE:	
121412783-EE-01	121412783-EE-01.DWG	

Stantec

17JAN14 11:00AM



LEGEND

- STANTEC BOREHOLE/MONITOR WELL LOCATION (2013)
- WATER WELL
- OBSERVATION WELL

NOTES:

1) THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.
2) DO NOT SCALE FROM DRAWING.
3)AUTOCAD BASEMAP (S-5716-ID.dwg) PROVIDED BY CLIENT, 2013.
4) AS-ADVANCED BOREHOLE COORDINATES PROVIDED BY HAWCO KING RENOUF | ALLNORTH CONSULTANTS OF ST. JOHN'S, NL (2013).

CLIENT:

ENVIRONMENTAL SERVICES, PUBLIC WORKS & GOVERNMENT SERVICES CANADA

PROJECT TITLE:

HYDROGEOLOGICAL ASSESSMENT, POTENTIAL GEOTHERMAL WELL (PHASE II), CANADIAN COAST GUARD SOUTHSIDE BASE, ST. JOHN'S, NL

DRAWING TITLE:

SITE LAYOUT PLAN

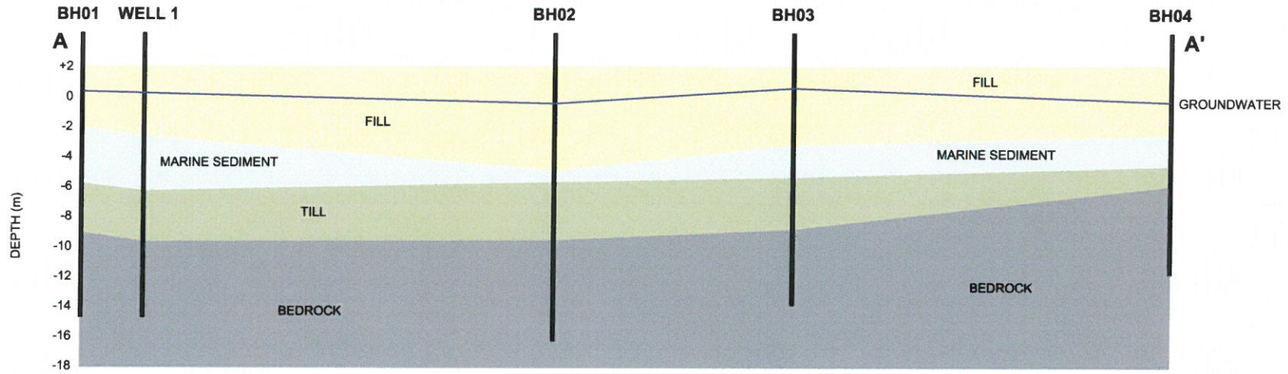
Stantec Consulting Ltd.

SCALE:	DATE:	REV. No.
1:500	JAN. 16 2014	0
DRAWN BY:	EDITED BY:	CHECKED BY:
N.M.	-	
DRAWING No:	CAD FILE:	
121412783-EE-02	121412783-EE-02.DWG	

Stantec

16JAN14 11:00AM

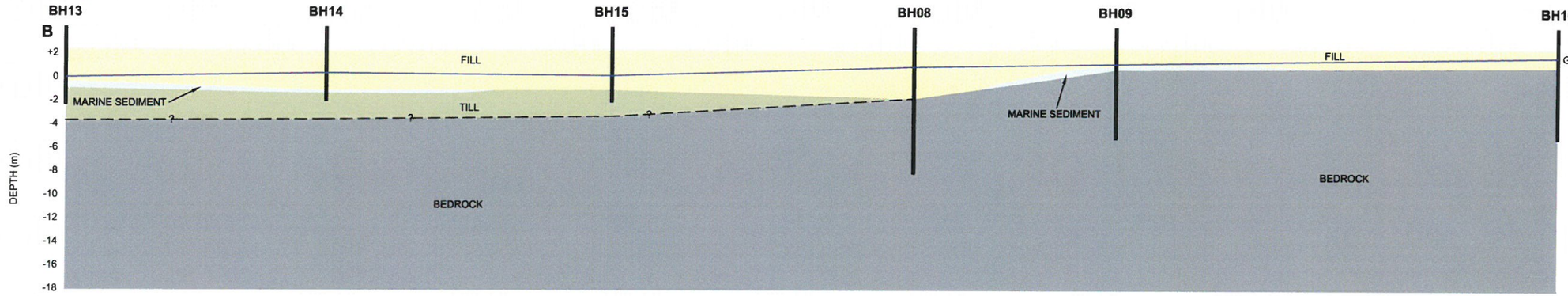
LONGITUDINAL SECTION A - A'



(LOOKING NORTHWEST TOWARDS ST. JOHN'S HARBOUR)

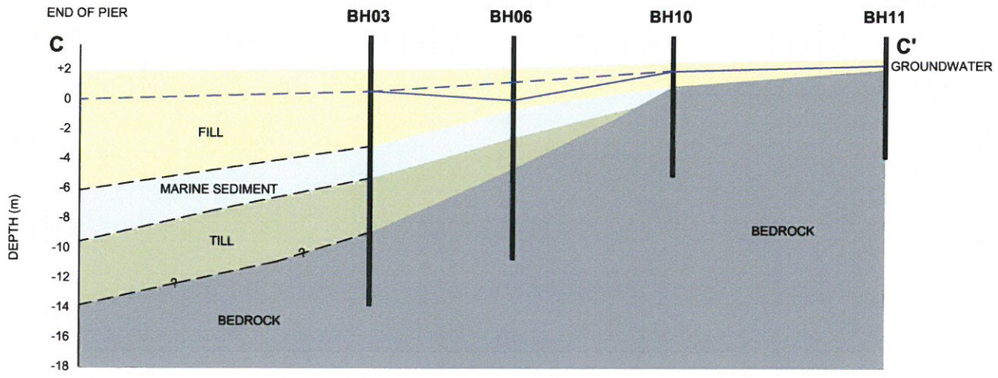
LEGEND
- FILL
- MARINE SEDIMENT
- TILL
- BEDROCK

LONGITUDINAL SECTION B - B'



(LOOKING NORTHWEST TOWARDS ST. JOHN'S HARBOUR)

SECTION C - C'



0 3 6 9 12 15
metres

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

CLIENT: ENVIRONMENTAL SERVICES, PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

PROJECT TITLE: HYDROGEOLOGICAL ASSESSMENT, POTENTIAL GEOTHERMAL WELL (PHASE II), CANADIAN COAST GUARD SOUTHSIDE BASE, ST. JOHN'S, NL

DRAWING TITLE: CROSS SECTIONS OF THE SITE

SCALE:	DATE:	REV. No.
1:400	JAN. 17, 2014	0
DRAWN BY:	EDITED BY:	CHECKED BY:
N.M.	-	
DRAWING No:	CAD FILE:	
121412783-EE-03	121412783-EE-03.DWG	

Stantec

17JAN14 11:00AM

APPENDIX B

Water Well Record and Monitor Well Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- Vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Homogeneous	- same color and consistency throughout
Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index) in accordance with ASTM D1586. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality		
0-25	*Very Poor Quality*	*Very Severely Fractured*	*Crushed*
25-50	*Poor Quality*	*Severely Fractured*	*Shattered or Very Blocky*
50-75	*Fair Quality*	*Fractured*	*Blocky*
75-90	*Good Quality*	*Moderately Jointed*	*Sound*
90-100	*Excellent Quality*	*Intact*	*Very Sound*

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD determined in accordance with ASTM D6032.

Terminology describing rock with respect to discontinuity spacing:

Spacing (mm)	Discontinuity	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	< 1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	> 250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

Solid Core Recovery (SCR):
Solid core recovery is defined as the cumulative length of all solid core in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis (i.e. length of core run excluding broken, crushed or rubble zones)

Fracture Index (FI):
Fracture Index is defined as the number of naturally occurring fractures occurring per given length of core. The Fracture Index is reported as a simple count of fractures.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery (or total core recovery - TCR) is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (762 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. In accordance with ASTM D1586, the N-value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (152 to 457 mm). However, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (305 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the total number of blows are reported over sampler penetration in millimeters (e.g., 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

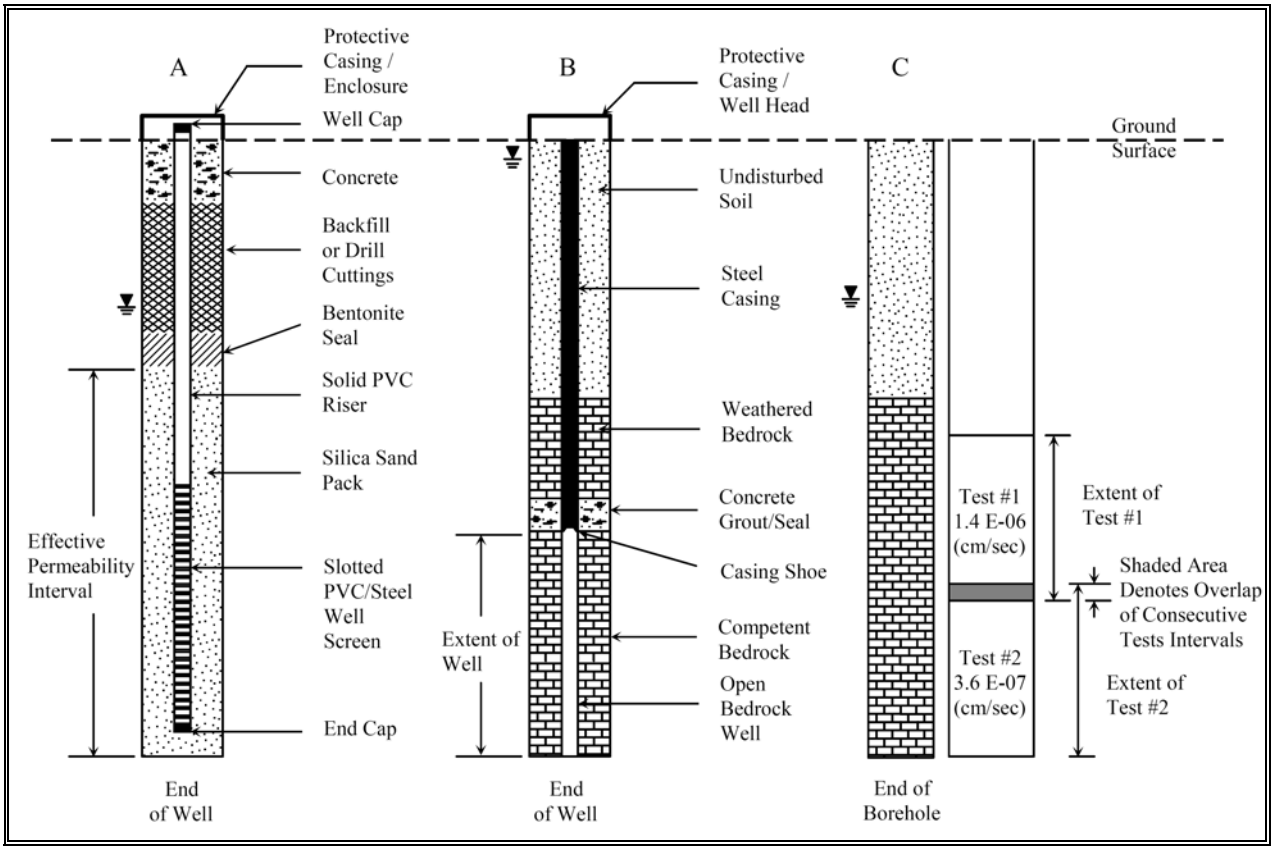
S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

SYMBOLS AND TERMS USED ON MONITOR WELL, WATER WELL AND ENVIRONMENTAL RECORDS

Well Construction and Permeability Testing

Basic symbols used in typical monitor or water well and piezometer construction are shown below. The well construction symbols or materials shown below may be combined or altered to suit a particular application. The diagram shows: A) a typical piezometer or monitor well in overburden; B) a typical water well in bedrock; C) borehole permeability test results in bedrock.



Apparent Moisture Content

Terminology used to describe apparent moisture content at the time of borehole drilling or test pit excavation.

Symbol	Description
D	Dry – containing little or no moisture
M	Moist – containing some moisture without having 'free' moisture
S	Saturated – 'free' moisture can drain from material

Terminology Describing Contamination

Symbol	Description
PID	Photo Ionization Detector (readings in ppm)
TPH	Total Petroleum Hydrocarbon concentration (readings in ppm based on mass)
ppm	Parts Per Million (measurement of concentration, mg/kg or mg/L)
nd	Not Detected – below limit of quantification (LOQ)

Apparent Hydrocarbon Odour

Terminology used to describe apparent hydrocarbon odour at the time of borehole drilling or test pit excavation.

Value	Description
0	No apparent odour
1	Slight odour
2	Moderate odour
3	Strong odour

MONITOR WELL RECORD

BOREHOLE No. **BH01**
PAGE **1** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **3-4-13** to **3-6-13** WATER LEVEL **1.64m** **3-12-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS (-0.13 m STICK UP)
	2.06						mm						FLUSH MOUNTED STEEL WELL HEAD ENCLOSURE
0	1.96	Asphalt											BENTONITE
		Dense to very dense, grey to brown, silty GRAVEL with sand (GM): FILL			SS	1	405	56			0.2		
1	0.59				SS	2	380	47			0.2		50 mm DIAMETER SOLID PVC RISER PIPE
		Loose to compact, grey to brown, silty SAND with gravel (SM) to SAND with silt and gravel (SP-SM); some debris (wood matter): FILL		▼	SS	3	280	4			9.3	700	in No. 3-4 SILICA SAND PACK
2					SS	4	610	29			-		
					SS	5	205	9			0.9		50 mm DIAMETER No. 10 or 20 SLOT PVC SCREEN in No. 3-4 SILICA SAND PACK
3					SS	6	100	26			-		
	-1.95	Very loose to loose, grey to brown, silty SAND with gravel (SM) to SAND with silt and gravel (SP-SM); with occasional to frequent organic matter [Inferred Marine Sediments]											
4					SS	7	150	6			3.6		
					SS	8	0	6			-		
5					SS	9	305	3			48.9	150	
					SS	10	125	4			3.2		
6					SS	11	405	6			26.1		
	-5.71	Very dense, grey with brown, poorly graded GRAVEL silt and sand (GP-GM) to silty GRAVEL with sand (GM): TILL			SS	12	330	77			26.5		
7					SS	13	305	53			19.7		
					SS	14	305	52			15.5		
8					SS	15	230	52			4.0		
					SS	16	255	116/300			12.8		
9	-8.99				SS	17	125	80/280			15.4		
		Very severely fractured to moderately jointed, fresh to slightly weathered, grey to green to blue, siltstone to sandstone; some infilling of fractures and some quartz partings: BEDROCK			~~HQ~~	~~18~~	~~89%~~	~~0%~~					
10					HQ	19	100%	0%					
					HQ	20	100%	37%					
11					~~HQ~~	~~21~~	~~100%~~	~~0%~~					
					HQ	22	100%	88%					
12													
					HQ	23	100%	78%					
13													
14													
15													

Stantec

MONITOR WELL RECORD

BOREHOLE No. **BH01**
PAGE **2** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **3-4-13** to **3-6-13** WATER LEVEL **1.64m** **3-12-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS
		Continued from Previous Page					mm						
15													
16					HQ	24	97%	90%					
	-14.70												END CAP
17		End of Borehole											
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

MONITOR WELL RECORD

BOREHOLE No. **BH02**
PAGE **1** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **2-27-13** to **2-28-13** WATER LEVEL **2.30m** **3-12-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS (-0.1 m STICK UP)
	2.08						mm						FLUSH MOUNTED STEEL WELL HEAD ENCLOSURE
0	1.98	Asphalt											BENTONITE
	1.27	Very dense, grey to brown, poorly graded GRAVEL with silt and sand (GP-GM): FILL			SS	1	510	56			0.5		
1					SS	2	255	18			0.5		50 mm DIAMETER SOLID PVC RISER PIPE in No. 3-4 SILICA SAND PACK
2		Very loose to compact, brown to black, silty SAND with gravel (SM); frequent debris (organic matter): FILL		▼	SS	3	255	6			23.8		
					SS	4	150	8			320		
3					SS	5	100	12			379	2500	50 mm DIAMETER No. 10 or 20 SLOT PVC SCREEN in No. 3-4 SILICA SAND PACK
4					SS	6	75	19			14.3		
					SS	7	50	5			78.5	230	
5					SS	8	25	2			-		
6					SS	9	0	5			-		
	-4.93				SS	10	50	7			67.1		
7	-5.39	Compact, brown, silty SAND with gravel (SM); occasional organic matter [Inferred Marine Sediments]			SS	11	50	11			2.7		
					SS	12	175	27			48.9		
8					SS	13	205	105/400			19.4		
		Compact to very dense, brown to grey, silty SAND with gravel (SM) to SAND with silt and gravel (SP-SM): TILL			SS	14	380	46			3.8		
9													
10		-Strata of gravel and cobbles encountered at 10.5 m depth below ground surface.											
11													
	-9.50				SS	17	255	67			26.1		
12		Severely fractured to intact, fresh to slightly weathered, grey to green, siltstone to sandstone; some infilling of fractures and some quartz partings: BEDROCK			HQ	18	60%	25%					
					HQ	19	97%	32%					
13					HQ	20	92%	81%					
14					HQ	21	100%	83%					
					HQ	22	100%	92%					
15													

Stantec

MONITOR WELL RECORD

BOREHOLE No. **BH02**
PAGE **2** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **2-27-13** to **2-28-13** WATER LEVEL **2.30m** **3-12-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS
		Continued from Previous Page					mm						
15													
16					HQ	23	98%	90%					
					HQ	24	100%	100%					
17					HQ	25	97%	87%					
18	-16.26												END CAP
		End of Borehole											
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

MONITOR WELL RECORD

BOREHOLE No. **BH03**
PAGE **1** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **3-6-13** to **3-7-13** WATER LEVEL **1.40m** **3-6-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS (-0.1 m STICK UP)
	2.07						mm						FLUSH MOUNTED STEEL WELL HEAD ENCLOSURE
0	1.97	Asphalt											BENTONITE
		Dense to very dense, grey to brown, silty GRAVEL with sand (GM): FILL			SS	1	355	68			1.2		
1	0.57			▽	SS	2	205	49			1.0		50 mm DIAMETER SOLID PVC RISER PIPE in No. 3-4 SILICA SAND PACK
		Very loose to compact, grey to black, silty SAND with gravel (SM); occasional debris (wood): FILL											
2					SS	3	100	9			388		
3					SS	4	150	11			678	40000	
					SS	5	150	9			325		50 mm DIAMETER No. 10 or 20 SLOT PVC SCREEN in No. 3-4 SILICA SAND PACK
4					SS	6	0	3			-		
5	-3.11				SS	7	0	6			-		
		Very loose to compact, brown, silty SAND with gravel (SM); trace to some organic matter (wood): [Inferred Marine Deposits]			SS	8	230	2			24.2		
6					SS	9	0	2			-		
7	-5.25				SS	10	50	11			-		
		Very dense, grey to brown, well-graded GRAVEL with silt and sand (GW-GM) to silty GRAVEL with sand (GM): TILL			SS	11	50	77			51		
8					SS	12	280	95			59.3		
9					SS	13	125	82/260			50.3		
10					SS	14	205	109/360			64.7		
	-8.88				SS	15	75	74/230			10.1		
11		Moderately jointed to intact, fresh weathering, grey to green to blue, siltstone to sandstone; some infilling of fractures and some quartz partings: BEDROCK - Fractured, weathered zone from 12.24 m to 14.33 m depth			HQ	16	100%	100%					
12					HQ	17	94%	86%					
13					HQ	18	100%	100%					
14					HQ	19	100%	82%					
15													

Stantec

MONITOR WELL RECORD

BOREHOLE No. **BH03**
PAGE **2** of **2**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **3-6-13** to **3-7-13** WATER LEVEL **1.40m** **3-6-13**

PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS
		Continued from Previous Page					mm						
15													
	-13.86				HQ	20	100%	96%					END CAP
16		End of Borehole											
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

MONITOR WELL RECORD

Stantec

BOREHOLE No. **BH04**
PAGE **1** of **1**
PROJECT No. **121412551**
DRILLING METHOD **STA/Dia**
SIZE **96mm (HWT/HQ)**
DATUM **NAD83**

CLIENT **Environmental Services; Public Works & Government Services Canada**
PROJECT **Phase II Environmental Site Assessment**
LOCATION **Canadian Coast Guard Southside Base; St. John's,NL**
DATES (mm-dd-yy): BORING **2-28-13 to 3-1-13** WATER LEVEL **2.36m 3-12-13**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS (-0.1 m STICK UP)
	2.15						mm						FLUSH MOUNTED STEEL WELL HEAD ENCLOSURE
0	2.05	Asphalt											BENTONITE
		Very loose to very dense, grey to brown, silty SAND with gravel (SM); trace debris and organic matter (wood): FILL			SS	1	455	42			0.7		
1					SS	2	305	56			0.3		50 mm DIAMETER SOLID PVC RISER PIPE in No. 3-4 SILICA SAND PACK
					SS	3	205	44			0.4		
2				▼	SS	4	150	48			3.8		
					SS	5	175	8			7.8	2400	50 mm DIAMETER No. 10 or 20 SLOT PVC SCREEN in No. 3-4 SILICA SAND PACK
3					SS	6	50	15			1.7		
					SS	7	50	3			-		
4	-2.50												
		Very loose to loose, brownish grey to black, silty SAND with gravel (SM); with organic matter: [Inferred Marine Sediments]			SS	8	125	8			3.5		
5					SS	9	150	3			1.9		
					SS	10	205	8			3.7		
6	-4.56												
		Compact to very dense, grey, well-graded GRAVEL with silt and sand (GW-GM): TILL			SS	11	280	21			3.9		
7					SS	12	406	61			2.7		
	-5.88				~~SS~~	~~13~~	~~50~~	~~55/75~~			5.6		
8		Very severely fractured to intact, fresh to slight weathering, grey to green to blue, siltstone to sandstone; some infilling of fractures and some quartz partings: BEDROCK			HQ	14	93%	73%					
					HQ	15	100%	67%					END CAP
9					HQ	16	100%	93%					
					HQ	17	94%	94%					
10					~~HQ~~	~~18~~	~~60%~~	~~0%~~					
					HQ	19	98%	0%					ROCK stuck in bit, pull HQ rods and set well to where hole stays open
11					HQ	20	94%	67%					
					HQ	21	81%	50%					
12	-11.77												
		End of Borehole											
13													
14													
15													

WATER WELL RECORD

BOREHOLE No. **WELL 1**
PAGE **1** of **1**
PROJECT No. **121412783**
DRILLING METHOD **Numa Super**
SIZE **200mm** **Jaws**
DATUM

CLIENT **Enviromental Services**
PROJECT **Hydrogeological Services, Potential Geothermal Well (Phase II)**
LOCATION **Canadian Coast Guard, Southside Base**
DATES (mm-dd-yy): BORING **9-11-13 to 9-13-13** WATER LEVEL **2.28m 9-18-13**

DEPTH (m)	ELEVATION (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR RQD %	HYDROCARBON ODOUR	APPARENT MOISTURE CONTENT	PID (ppm)	TPH (ppm)	WELL CONSTRUCTION DETAILS (0.76 m STICK UP)
0		ASPHALT											CAST IRON WELL HEAD
1		Dense, grey to brown, silty GRAVEL with sand (GM): FILL											FILL
2				▼									
3													
4													
5		Loose, black to brown, silty SAND with gravel (SM)											GROUT
6		-some wood											
7													1/4"-1/2" GRAVEL FILTER PACK
8													
9		Dense, grey, silty GRAVEL with sand (GM): TILL											50 mm DIAMETER No. 10 SLOT PVC SCREEN IN 1/4"-1/2" GRAVEL FILTER PACK
10													
11													
12		Grey, Siltstone: BEDROCK											BEDROCK
13		End of Borehole											
14													
15													

APPENDIX C

Step Test Data & Plots

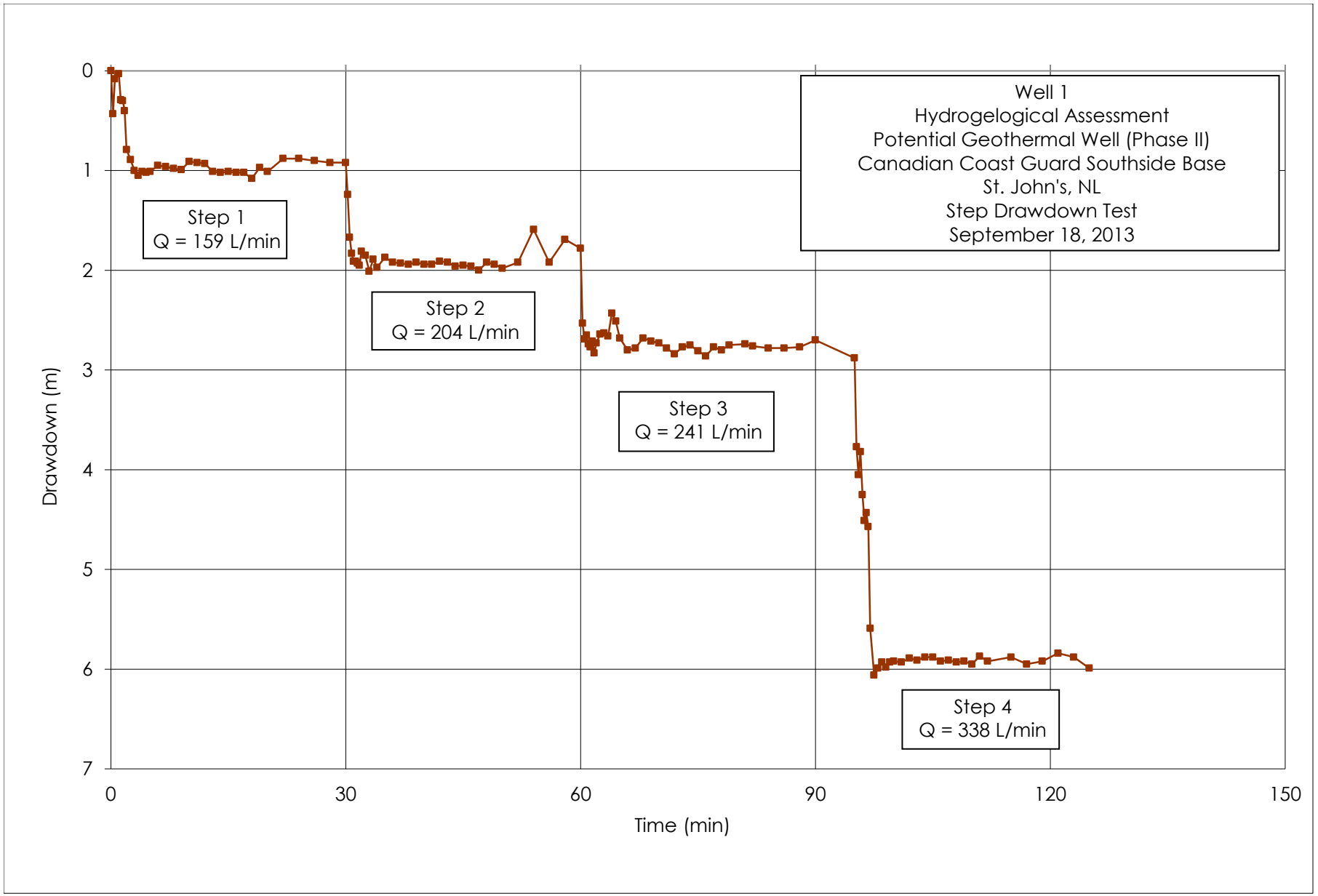


Figure C-1 Step Drawdown Test Time-Drawdown Response (Well 1)

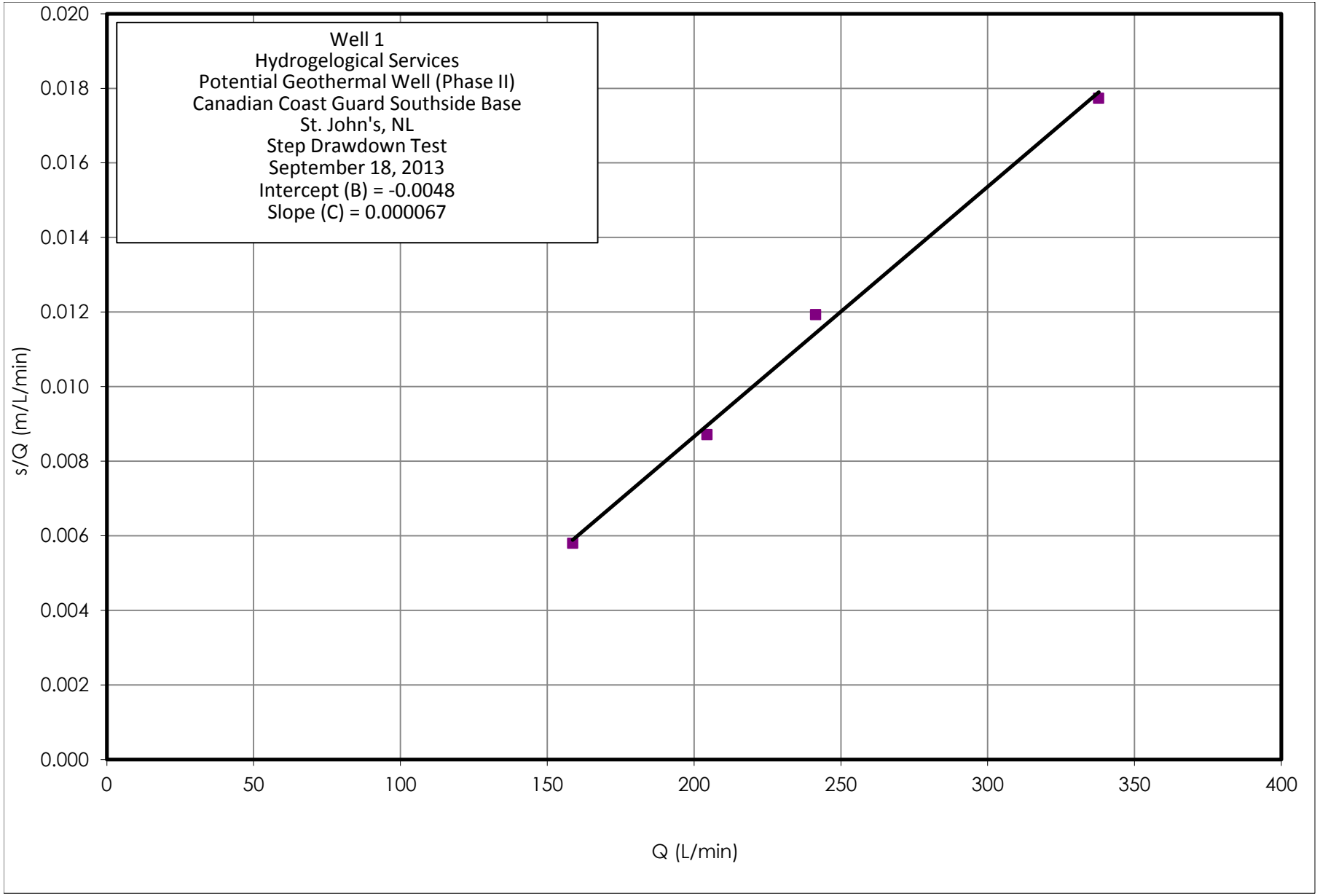


Figure C-2 Graphical Step Drawdown Test Analysis (Well 1)

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
0	2.28	0.00	159	42
0.25	2.71	0.43		
0.5	2.36	0.08		
0.75	2.06	-0.22		
1	2.31	0.03		
1.25	2.57	0.29		
1.5	2.58	0.30		
1.75	2.68	0.40		
2	3.07	0.79		
2.5	3.17	0.89		
3	3.28	1.00		
3.5	3.33	1.05		
4	3.29	1.01		
4.5	3.30	1.02		
5	3.29	1.01		
6	3.23	0.95		
7	3.24	0.96		
8	3.26	0.98		
9	3.27	0.99		
10	3.19	0.91		
11	3.20	0.92		
12	3.21	0.93		
13	3.29	1.01		
14	3.30	1.02		
15	3.29	1.01		
16	3.30	1.02		
17	3.30	1.02		
18	3.36	1.08		
19	3.25	0.97		
20	3.29	1.01		
22	3.16	0.88		

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
24	3.16	0.88		
26	3.18	0.90		
28	3.20	0.92		
30	3.20	0.92		
30.25	3.52	1.24	204	54
30.5	3.95	1.67		
30.75	4.11	1.83		
31	4.19	1.91		
31.25	4.19	1.91		
31.5	4.21	1.93		

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
31.75	4.23	1.95		
32	4.09	1.81		
32.5	4.13	1.85		
33	4.29	2.01		
33.5	4.17	1.89		
34	4.25	1.97		
35	4.15	1.87		
36	4.20	1.92		
37	4.21	1.93		
38	4.22	1.94		
39	4.20	1.92		
40	4.22	1.94		
41	4.22	1.94		
42	4.19	1.91		
43	4.20	1.92		
44	4.24	1.96		
45	4.23	1.95		
46	4.24	1.96		
47	4.28	2.00		
48	4.20	1.92		
49	4.22	1.94		
50	4.26	1.98		
52	4.20	1.92		
54	3.87	1.59		
56	4.20	1.92		
58	3.97	1.69		
60	4.06	1.78		
60.25	4.81	2.53	241	64
60.5	4.97	2.69		
60.75	4.93	2.65		

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
61	5.02	2.74		
61.25	5.05	2.77		
61.5	4.99	2.71		
61.75	5.11	2.83		
62	5.01	2.73		
62.5	4.92	2.64		
63	4.91	2.63		
63.5	4.94	2.66		
64	4.71	2.43		
64.5	4.79	2.51		

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
65	4.96	2.68		
66	5.08	2.80		
67	5.06	2.78		
68	4.96	2.68		
69	4.99	2.71		
70	5.01	2.73		
71	5.06	2.78		
72	5.12	2.84		
73	5.05	2.77		
74	5.03	2.75		
75	5.09	2.81		
76	5.14	2.86		
77	5.05	2.77		
78	5.08	2.80		
79	5.03	2.75		
81	5.02	2.74		
82	5.04	2.76		
84	5.06	2.78		
86	5.06	2.78		
88	5.05	2.77		
90	4.98	2.70		
95	5.16	2.88		
95.25	6.05	3.77	338	89
95.5	6.33	4.05		
95.75	6.10	3.82		
96	6.53	4.25		
96.25	6.79	4.51		
96.5	6.71	4.43		
96.75	6.85	4.57		
97	7.87	5.59		

Step Drawdown Test Data 18-Sep-13

Project 121412783 Start Time = 11:54 AM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Drawdown (m)	Flowrate (L/min)	Flowrate (USgpm)
97.5	8.34	6.06		
98	8.27	5.99		
98.5	8.21	5.93		
99	8.26	5.98		
99.5	8.21	5.93		
100	8.20	5.92		
101	8.21	5.93		
102	8.17	5.89		
103	8.19	5.91		
104	8.16	5.88		
105	8.16	5.88		
106	8.20	5.92		
107	8.19	5.91		
108	8.21	5.93		
109	8.20	5.92		
110	8.23	5.95		
111	8.15	5.87		
112	8.20	5.92		
115	8.16	5.88		
117	8.23	5.95		
119	8.20	5.92		
121	8.12	5.84		
123	8.16	5.88		
125	8.27	5.99		

APPENDIX D

Constant Rate Test Data & Plots

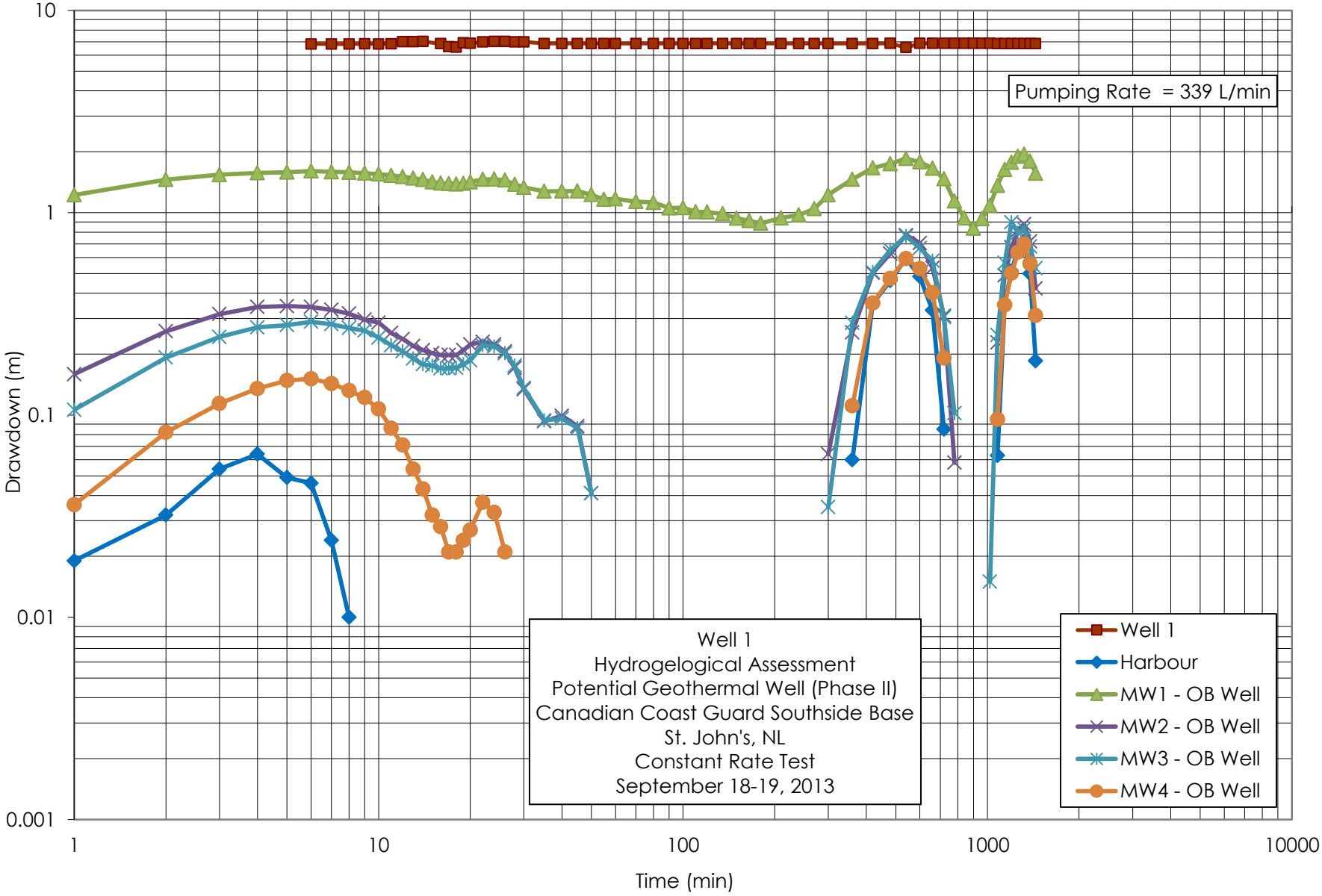


Figure D-1 Constant Rate Test Log-Log Time-Drawdown Response (Well 1)

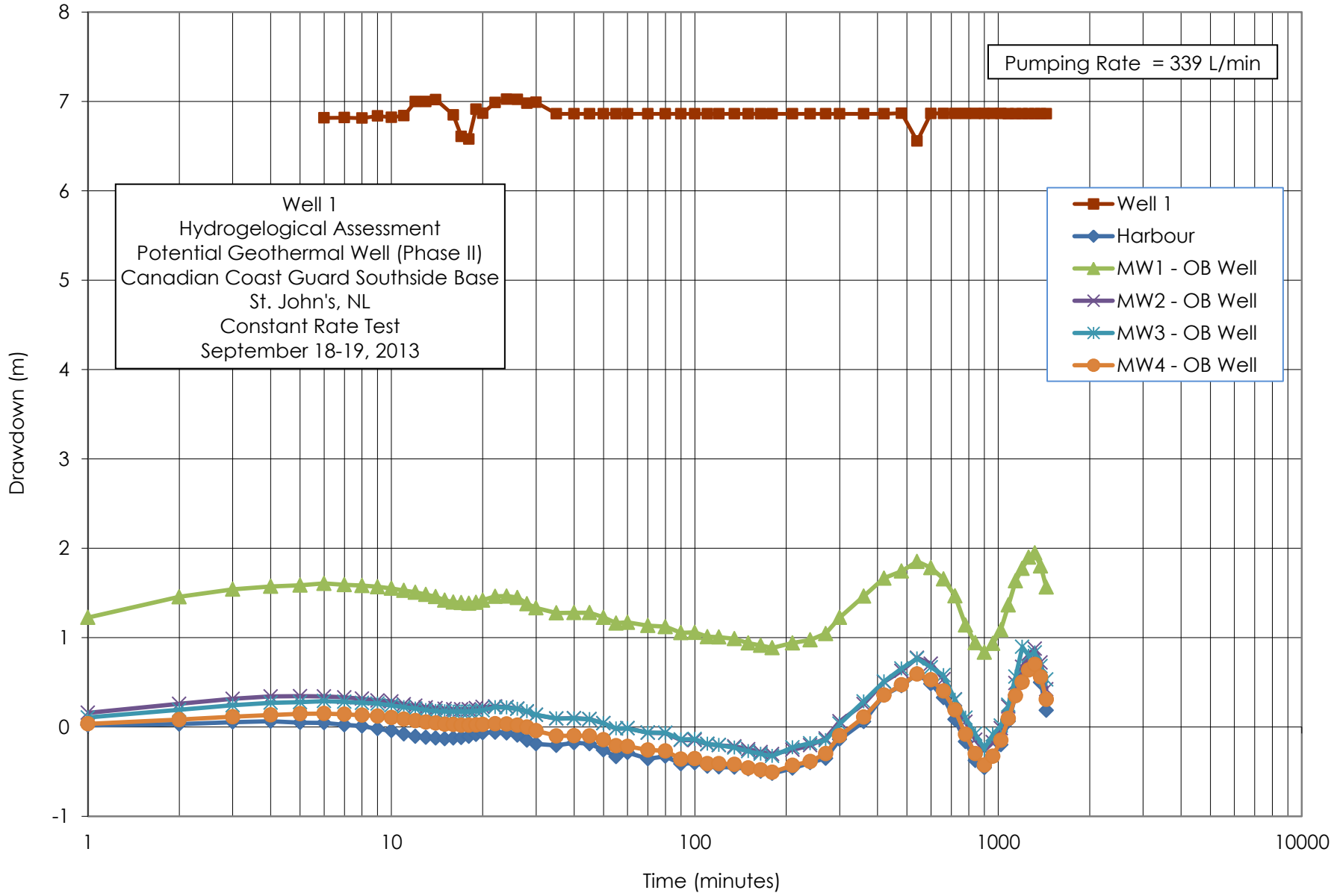


Figure D-2 Constant Rate Test Semi-Log Time-Drawdown Response (Well1)

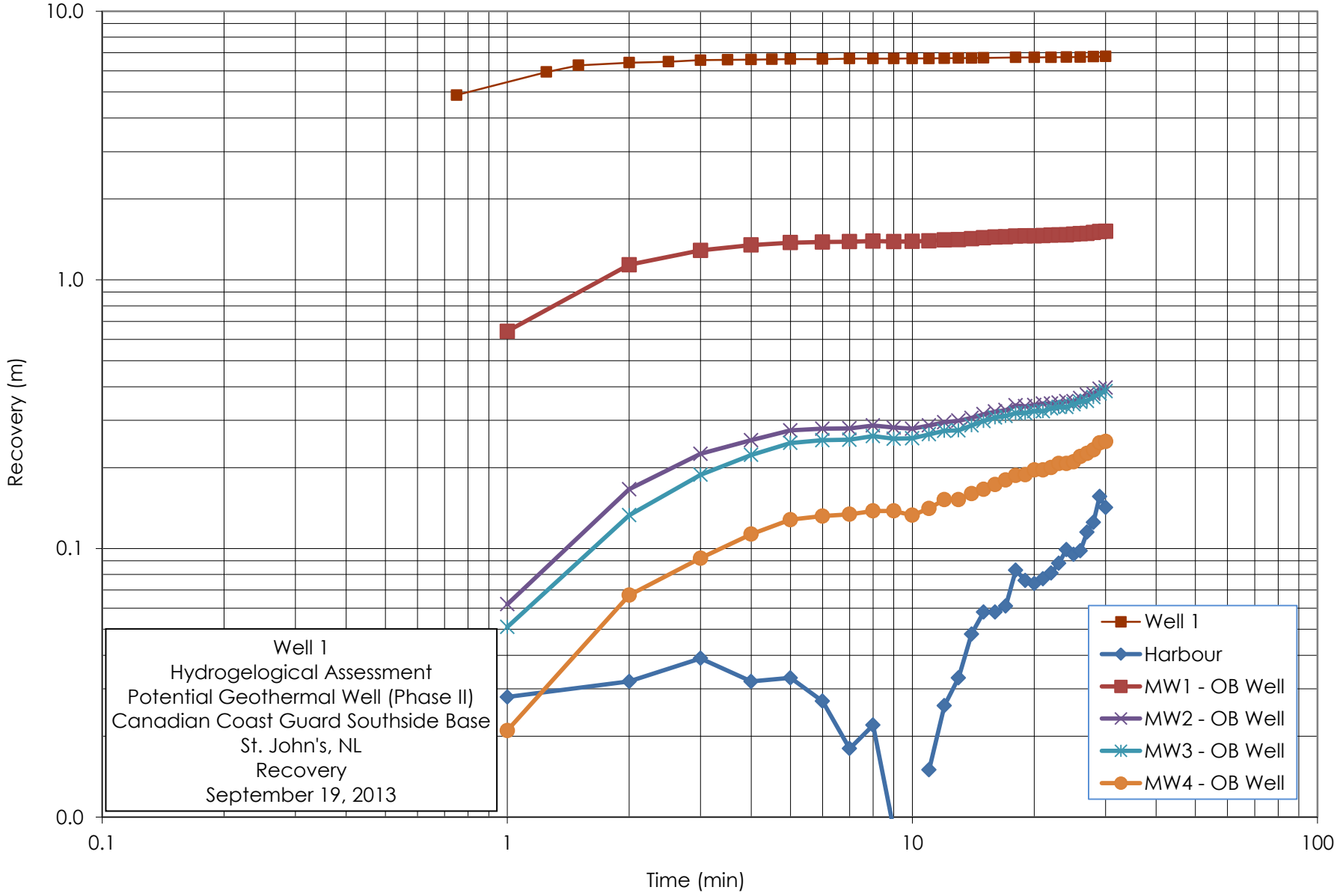


Figure D-3 Recovery Log-Log Time-Drawdown Response (Well 1)

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1 Pumping Rate = 339 L/min

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.748	0.000
6	8.565	6.817
7	8.568	6.820
8	8.562	6.814
9	8.586	6.838
10	8.571	6.823
11	8.589	6.841
12	8.748	7.000
13	8.748	7.000
14	8.769	7.021
16	8.599	6.851
17	8.358	6.610
18	8.327	6.579
19	8.663	6.915
20	8.617	6.869
22	8.736	6.988
24	8.775	7.027
26	8.772	7.024
28	8.730	6.982
30	8.739	6.991
35	8.611	6.863
40	8.611	6.863
45	8.611	6.863
50	8.611	6.863
55	8.611	6.863

Harbour

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.485	0.000
1	1.504	0.019
2	1.517	0.032
3	1.539	0.054
4	1.549	0.064
5	1.534	0.049
6	1.531	0.046
7	1.509	0.024
8	1.495	0.010
9	1.464	-0.021
10	1.443	-0.042
11	1.407	-0.078
12	1.379	-0.106
13	1.368	-0.117
14	1.362	-0.123
15	1.354	-0.131
16	1.361	-0.124
17	1.365	-0.120
18	1.379	-0.106
19	1.400	-0.085
20	1.421	-0.064
22	1.424	-0.061
24	1.417	-0.068
26	1.393	-0.092
28	1.337	-0.148

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1 Pumping Rate = 339 L/min

Time (min)	Water Level (mbgs)	Drawdown (m)
60	8.611	6.863
70	8.611	6.863
80	8.611	6.863
90	8.611	6.863
100	8.611	6.863
110	8.611	6.863
120	8.611	6.863
135	8.611	6.863
150	8.611	6.863
165	8.611	6.863
180	8.611	6.863
210	8.611	6.863
240	8.611	6.863
270	8.611	6.863
300	8.611	6.863
360	8.611	6.863
420	8.611	6.863
480	8.617	6.869
540	8.306	6.558
600	8.614	6.866
660	8.614	6.866
720	8.614	6.866
780	8.614	6.866
840	8.614	6.866
900	8.614	6.866

Harbour

Time (min)	Water Level (mbgs)	Drawdown (m)
30	1.296	-0.189
35	1.278	-0.207
40	1.308	-0.177
45	1.298	-0.187
50	1.226	-0.259
55	1.152	-0.333
60	1.198	-0.287
70	1.129	-0.356
80	1.157	-0.328
90	1.071	-0.414
100	1.084	-0.401
110	1.044	-0.441
120	1.036	-0.449
135	1.034	-0.451
150	1.015	-0.470
165	0.990	-0.495
180	0.965	-0.520
210	1.023	-0.462
240	1.085	-0.400
270	1.134	-0.351
300	1.347	-0.138
360	1.545	0.060
420	1.840	0.355
480	1.946	0.461
540	2.080	0.595

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1 Pumping Rate = 339 L/min

Time (min)	Water Level (mbgs)	Drawdown (m)
960	8.614	6.866
1020	8.614	6.866
1080	8.611	6.863
1140	8.611	6.863
1200	8.611	6.863
1260	8.611	6.863
1320	8.611	6.863
1380	8.611	6.863
1440	8.611	6.863

Harbour

Time (min)	Water Level (mbgs)	Drawdown (m)
600	1.968	0.483
660	1.814	0.329
720	1.570	0.085
780	1.320	-0.165
840	1.109	-0.376
900	1.029	-0.456
960	1.155	-0.330
1020	1.287	-0.198
1080	1.548	0.063
1140	1.841	0.356
1200	2.000	0.515
1260	2.152	0.667
1320	2.205	0.720
1380	1.984	0.499
1440	1.670	0.185

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW1

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.645	0.000
1	2.870	1.225
2	3.102	1.457
3	3.186	1.541
4	3.218	1.573
5	3.231	1.586
6	3.251	1.606
7	3.237	1.592
8	3.227	1.582
9	3.214	1.569
10	3.197	1.552
11	3.173	1.528
12	3.153	1.508
13	3.127	1.482
14	3.103	1.458
15	3.063	1.418
16	3.043	1.398
17	3.037	1.392
18	3.030	1.385
19	3.040	1.395
20	3.064	1.419
22	3.107	1.462
24	3.110	1.465
26	3.094	1.449
28	3.024	1.379

Observation Well - MW2

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.767	0.000
1	1.926	0.159
2	2.026	0.259
3	2.082	0.315
4	2.109	0.342
5	2.112	0.345
6	2.109	0.342
7	2.098	0.331
8	2.084	0.317
9	2.063	0.296
10	2.053	0.286
11	2.021	0.254
12	2.004	0.237
13	1.986	0.219
14	1.976	0.209
15	1.969	0.202
16	1.965	0.198
17	1.965	0.198
18	1.965	0.198
19	1.976	0.209
20	1.990	0.223
22	1.997	0.230
24	1.990	0.223
26	1.973	0.206
28	1.938	0.171

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW1

Time (min)	Water Level (mbgs)	Drawdown (m)
30	2.978	1.333
35	2.921	1.276
40	2.924	1.279
45	2.924	1.279
50	2.872	1.227
55	2.808	1.163
60	2.816	1.171
70	2.779	1.134
80	2.768	1.123
90	2.699	1.054
100	2.704	1.059
110	2.655	1.010
120	2.651	1.006
135	2.633	0.988
150	2.584	0.939
165	2.558	0.913
180	2.531	0.886
210	2.586	0.941
240	2.619	0.974
270	2.690	1.045
300	2.871	1.226
360	3.108	1.463
420	3.310	1.665
480	3.390	1.745
540	3.497	1.852

Observation Well - MW2

Time (min)	Water Level (mbgs)	Drawdown (m)
30	1.901	0.134
35	1.860	0.093
40	1.866	0.099
45	1.855	0.088
50	1.808	0.041
55	1.749	-0.018
60	1.753	-0.014
70	1.702	-0.065
80	1.699	-0.068
90	1.621	-0.146
100	1.620	-0.147
110	1.574	-0.193
120	1.562	-0.205
135	1.550	-0.217
150	1.518	-0.249
165	1.486	-0.281
180	1.464	-0.303
210	1.511	-0.256
240	1.562	-0.205
270	1.638	-0.129
300	1.831	0.064
360	2.023	0.256
420	2.270	0.503
480	2.395	0.628
540	2.541	0.774

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW1

Time (min)	Water Level (mbgs)	Drawdown (m)
600	3.427	1.782
660	3.302	1.657
720	3.113	1.468
780	2.786	1.141
840	2.587	0.942
900	2.482	0.837
960	2.579	0.934
1020	2.733	1.088
1080	3.009	1.364
1140	3.280	1.635
1200	3.420	1.775
1260	3.544	1.899
1320	3.592	1.947
1380	3.445	1.800
1440	3.211	1.566

Observation Well - MW2

Time (min)	Water Level (mbgs)	Drawdown (m)
600	2.475	0.708
660	2.300	0.533
720	2.076	0.309
780	1.825	0.058
840	1.624	-0.143
900	1.504	-0.263
960	1.597	-0.170
1020	1.752	-0.015
1080	1.995	0.228
1140	2.257	0.490
1200	2.441	0.674
1260	2.585	0.818
1320	2.644	0.877
1380	2.487	0.720
1440	2.189	0.422

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW3

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.759	0.000
1	1.865	0.106
2	1.951	0.192
3	2.002	0.243
4	2.030	0.271
5	2.037	0.278
6	2.048	0.289
7	2.040	0.281
8	2.028	0.269
9	2.020	0.261
10	2.000	0.241
11	1.980	0.221
12	1.965	0.206
13	1.949	0.190
14	1.937	0.178
15	1.934	0.175
16	1.929	0.170
17	1.929	0.170
18	1.930	0.171
19	1.937	0.178
20	1.945	0.186
22	1.980	0.221
24	1.977	0.218
26	1.961	0.202
28	1.934	0.175

Observation Well - MW4

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.867	0.000
1	1.903	0.036
2	1.949	0.082
3	1.981	0.114
4	2.002	0.135
5	2.015	0.148
6	2.018	0.151
7	2.010	0.143
8	1.999	0.132
9	1.989	0.122
10	1.974	0.107
11	1.953	0.086
12	1.938	0.071
13	1.921	0.054
14	1.910	0.043
15	1.899	0.032
16	1.895	0.028
17	1.888	0.021
18	1.888	0.021
19	1.891	0.024
20	1.894	0.027
22	1.904	0.037
24	1.900	0.033
26	1.888	0.021
28	1.867	0.000

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW3

Time (min)	Water Level (mbgs)	Drawdown (m)
30	1.895	0.136
35	1.853	0.094
40	1.855	0.096
45	1.845	0.086
50	1.800	0.041
55	1.743	-0.016
60	1.744	-0.015
70	1.696	-0.063
80	1.695	-0.064
90	1.619	-0.140
100	1.624	-0.135
110	1.570	-0.189
120	1.556	-0.203
135	1.527	-0.232
150	1.487	-0.272
165	1.458	-0.301
180	1.434	-0.325
210	1.531	-0.228
240	1.577	-0.182
270	1.610	-0.149
300	1.794	0.035
360	2.044	0.285
420	2.268	0.509
480	2.414	0.655
540	2.525	0.766

Observation Well - MW4

Time (min)	Water Level (mbgs)	Drawdown (m)
30	1.825	-0.042
35	1.768	-0.099
40	1.769	-0.098
45	1.768	-0.099
50	1.723	-0.144
55	1.657	-0.210
60	1.650	-0.217
70	1.610	-0.257
80	1.599	-0.268
90	1.508	-0.359
100	1.513	-0.354
110	1.458	-0.409
120	1.456	-0.411
135	1.450	-0.417
150	1.409	-0.458
165	1.387	-0.480
180	1.361	-0.506
210	1.437	-0.430
240	1.481	-0.386
270	1.570	-0.297
300	1.769	-0.098
360	1.978	0.111
420	2.224	0.357
480	2.340	0.473
540	2.459	0.592

Constant Rate Test 18-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW3

Time (min)	Water Level (mbgs)	Drawdown (m)
600	2.427	0.668
660	2.338	0.579
720	2.063	0.304
780	1.861	0.102
840	1.682	-0.077
900	1.512	-0.247
960	1.675	-0.084
1020	1.774	0.015
1080	2.007	0.248
1140	2.323	0.564
1200	2.656	0.897
1260	2.555	0.796
1320	2.591	0.832
1380	2.439	0.680
1440	2.290	0.531

Observation Well - MW4

Time (min)	Water Level (mbgs)	Drawdown (m)
600	2.396	0.529
660	2.269	0.402
720	2.058	0.191
780	1.785	-0.082
840	1.569	-0.298
900	1.440	-0.427
960	1.540	-0.327
1020	1.719	-0.148
1080	1.962	0.095
1140	2.217	0.350
1200	2.369	0.502
1260	2.504	0.637
1320	2.567	0.700
1380	2.427	0.560
1440	2.177	0.310

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
0	9.443	0.000	0.0
0.75	4.572	4.871	63.3
1.25	3.505	5.938	77.2
1.5	3.155	6.288	81.7
2	3.008	6.434	83.6
2.5	2.957	6.486	84.3
3	2.871	6.572	85.4
3.5	2.850	6.593	85.7
4	2.835	6.608	85.9
4.5	2.826	6.617	86.0
5	2.807	6.636	86.2
6	2.807	6.636	86.2
7	2.786	6.657	86.5
8	2.783	6.660	86.6
9	2.780	6.663	86.6
10	2.777	6.666	86.6
11	2.777	6.666	86.6
12	2.765	6.678	86.8
13	2.755	6.687	86.9
14	2.749	6.693	87.0
15	2.740	6.703	87.1
18	2.716	6.727	87.4
20	2.713	6.730	87.5
22	2.710	6.733	87.5
24	2.704	6.739	87.6
26	2.691	6.751	87.7
28	2.676	6.767	87.9

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Well 1

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
30	2.658	6.785	88.2

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Harbour

Time (min)	Water Level (mbgs)	Drawdown (m)
0	1.670	0.004
1	1.646	0.028
2	1.642	0.032
3	1.635	0.039
4	1.642	0.032
5	1.641	0.033
6	1.647	0.027
7	1.656	0.018
8	1.652	0.022
9	1.665	0.009
10	1.674	0.000
11	1.659	0.015
12	1.648	0.026
13	1.641	0.033
14	1.626	0.048
15	1.616	0.058
16	1.616	0.058
17	1.613	0.061
18	1.591	0.083
19	1.598	0.076
20	1.600	0.074
21	1.597	0.077
22	1.593	0.081
23	1.586	0.088
24	1.575	0.099
25	1.579	0.095
26	1.576	0.098

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Harbour

Time (min)	Water Level (mbgs)	Drawdown (m)
27	1.559	0.115
28	1.549	0.125
29	1.518	0.156
30	1.532	0.142

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW1

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
0	3.211	0.000	0
1	2.568	0.643	46
2	2.073	1.138	82
3	1.924	1.287	93
4	1.864	1.347	97
5	1.836	1.375	99
6	1.828	1.383	100
7	1.825	1.386	100
8	1.817	1.394	101
9	1.823	1.388	100
10	1.822	1.389	100
11	1.814	1.397	101
12	1.803	1.408	102
13	1.800	1.411	102
14	1.790	1.421	103
15	1.776	1.435	104
16	1.770	1.441	104
17	1.766	1.445	104
18	1.756	1.455	105
19	1.755	1.456	105
20	1.754	1.457	105
21	1.751	1.460	106
22	1.744	1.467	106
23	1.741	1.470	106
24	1.741	1.470	106
25	1.734	1.477	107
26	1.728	1.483	107

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW1

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
27	1.722	1.489	108
28	1.712	1.499	108
29	1.699	1.512	109
30	1.695	1.516	110

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW2

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
0	2.189	0.000	0
1	2.127	0.062	22
2	2.023	0.166	59
3	1.964	0.225	81
4	1.936	0.253	91
5	1.914	0.275	99
6	1.910	0.279	100
7	1.909	0.280	100
8	1.902	0.287	103
9	1.907	0.282	101
10	1.910	0.279	100
11	1.902	0.287	103
12	1.894	0.295	106
13	1.890	0.299	107
14	1.883	0.306	110
15	1.873	0.316	113
16	1.866	0.323	116
17	1.862	0.327	117
18	1.848	0.341	122
19	1.851	0.338	121
20	1.847	0.342	123
21	1.843	0.346	124
22	1.843	0.346	124
23	1.840	0.349	125
24	1.836	0.353	127
25	1.836	0.353	127
26	1.826	0.363	130

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW2

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
27	1.816	0.373	134
28	1.813	0.376	135
29	1.796	0.393	141
30	1.792	0.397	142

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW3

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
0	2.290	0.000	0
1	2.239	0.051	20
2	2.157	0.133	53
3	2.102	0.188	74
4	2.067	0.223	88
5	2.043	0.247	98
6	2.037	0.253	100
7	2.036	0.254	100
8	2.028	0.262	104
9	2.034	0.256	101
10	2.033	0.257	102
11	2.024	0.266	105
12	2.016	0.274	108
13	2.015	0.275	109
14	2.003	0.287	113
15	1.992	0.298	118
16	1.983	0.307	121
17	1.979	0.311	123
18	1.971	0.319	126
19	1.971	0.319	126
20	1.966	0.324	128
21	1.966	0.324	128
22	1.958	0.332	131
23	1.954	0.336	133
24	1.954	0.336	133
25	1.946	0.344	136
26	1.939	0.351	139

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW3

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
27	1.936	0.354	140
28	1.924	0.366	145
29	1.913	0.377	149
30	1.905	0.385	152

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW4

Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
0	2.177	0.000	0
1	2.156	0.021	16
2	2.110	0.067	51
3	2.085	0.092	70
4	2.064	0.113	86
5	2.049	0.128	97
6	2.045	0.132	100
7	2.043	0.134	102
8	2.039	0.138	105
9	2.039	0.138	105
10	2.044	0.133	101
11	2.036	0.141	107
12	2.025	0.152	115
13	2.025	0.152	115
14	2.017	0.160	121
15	2.011	0.166	126
16	2.004	0.173	131
17	1.997	0.180	136
18	1.990	0.187	142
19	1.989	0.188	142
20	1.981	0.196	148
21	1.981	0.196	148
22	1.977	0.200	152
23	1.970	0.207	157
24	1.970	0.207	157
25	1.967	0.210	159
26	1.957	0.220	167

Recovery 19-Sep-13

Project 121412783 Start Time = 5:00 PM

Hydrogeological Assessment, Potential Geothermal Well (Phase II)

Location: Canadian Coast Guard Southside Base, St. John's, NL

Observation Well - MW4

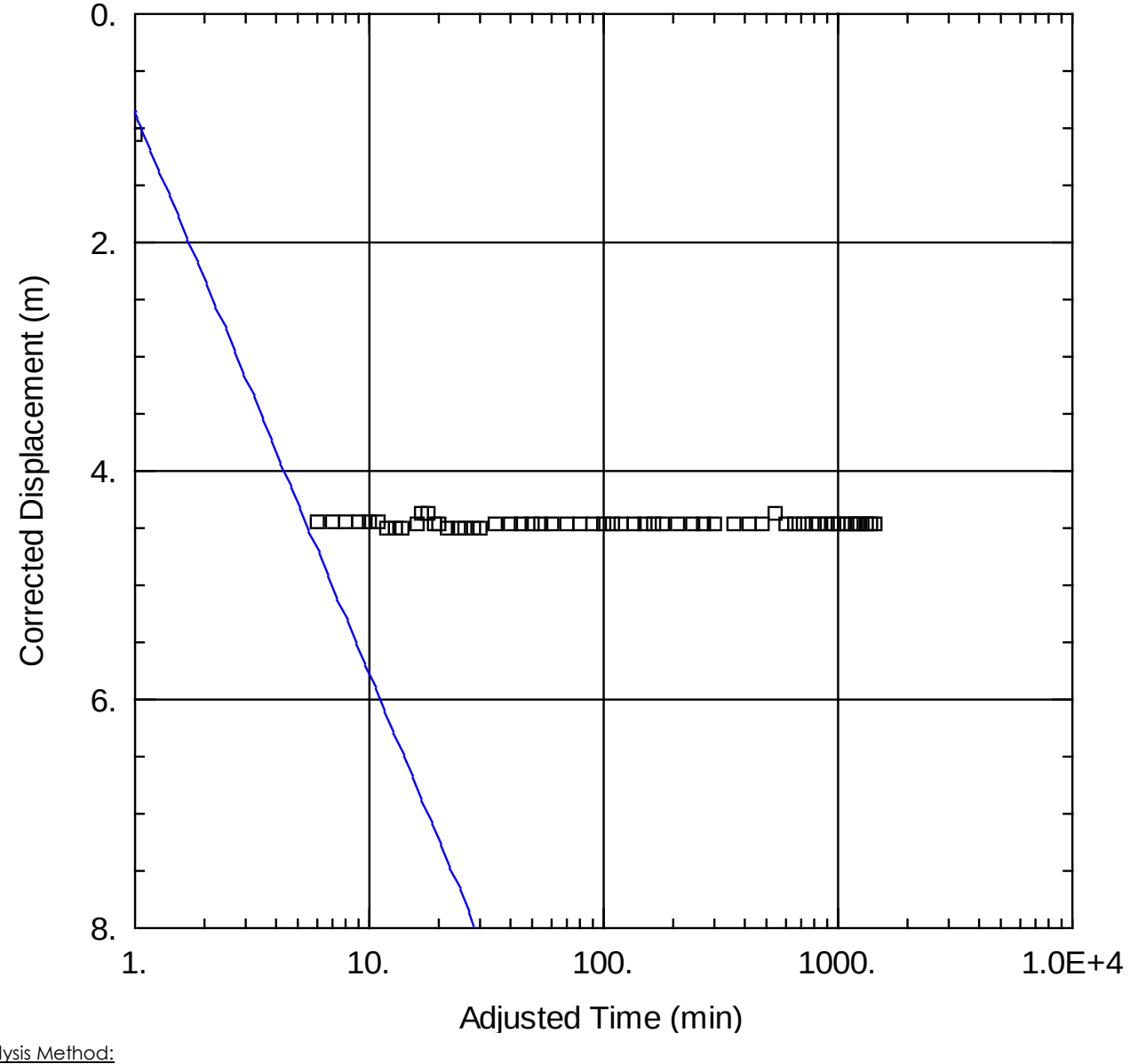
Time (min)	Water Level (mbgs)	Recovery (m)	Recovery %
27	1.951	0.226	171
28	1.944	0.233	177
29	1.930	0.247	187
30	1.927	0.250	189

APPENDIX E

Graphical Results of AQTESOLV® Analysis

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Cooper-Jacob Time-Drawdown

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	Well 1	
Transmissivity:	2.1E-04	m^2/s
Storativity:	-	

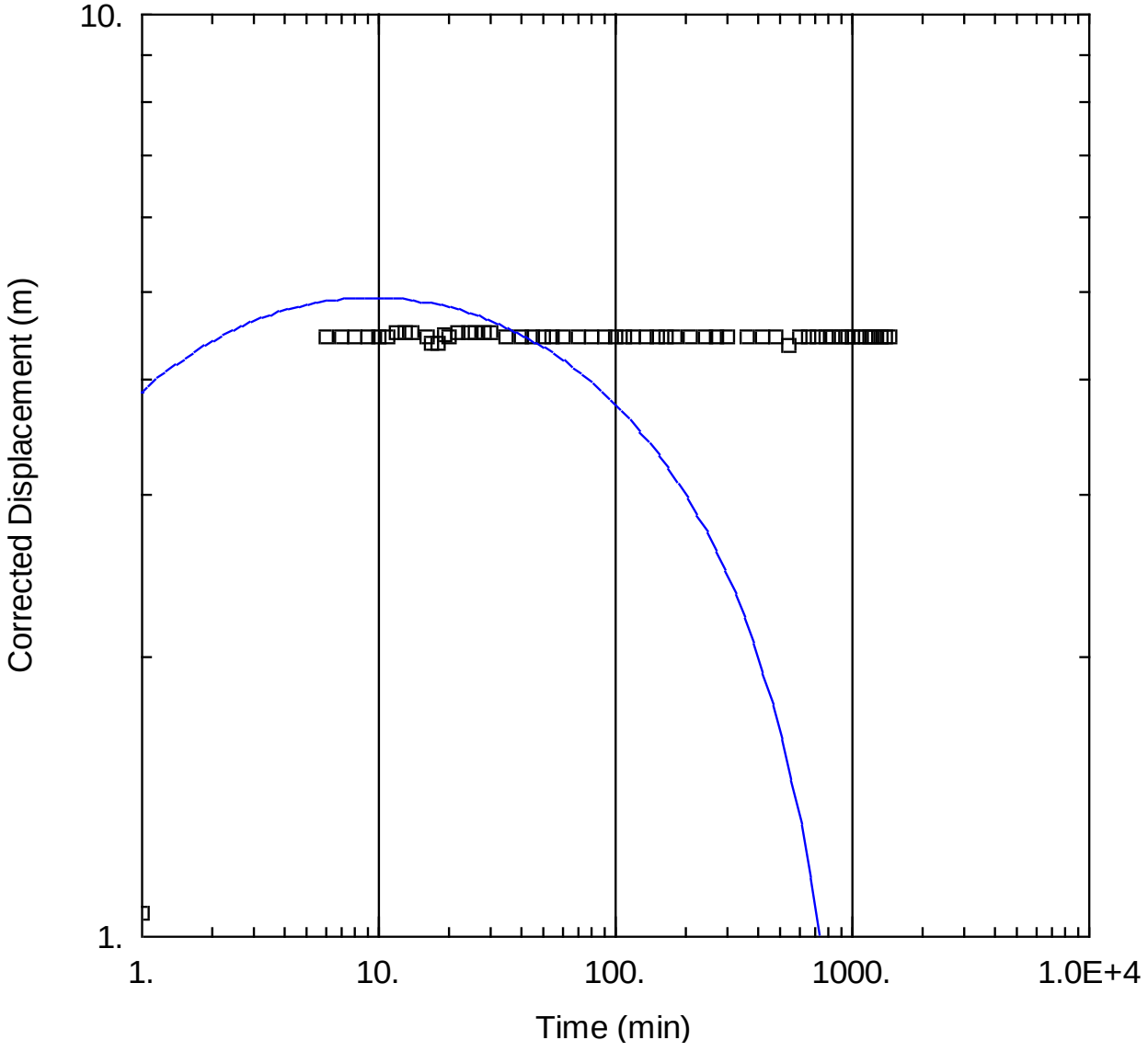
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	Well 1	
Transmissivity:	2.2E-04	m^2/s
Storativity:	-	

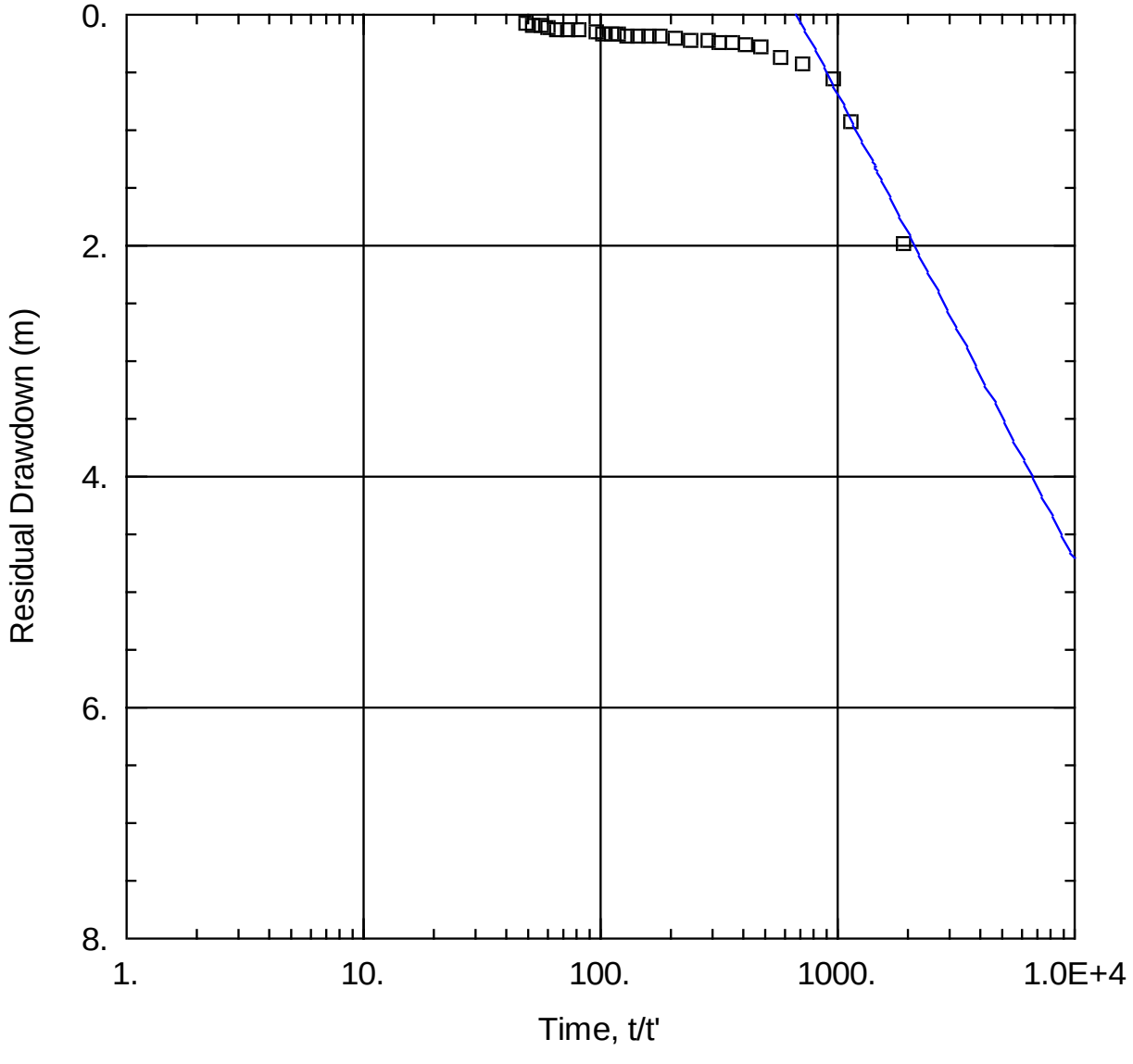
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis Recovery

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	Well 1	
Transmissivity:	2.6E-04	m^2/s
Storativity:	-	

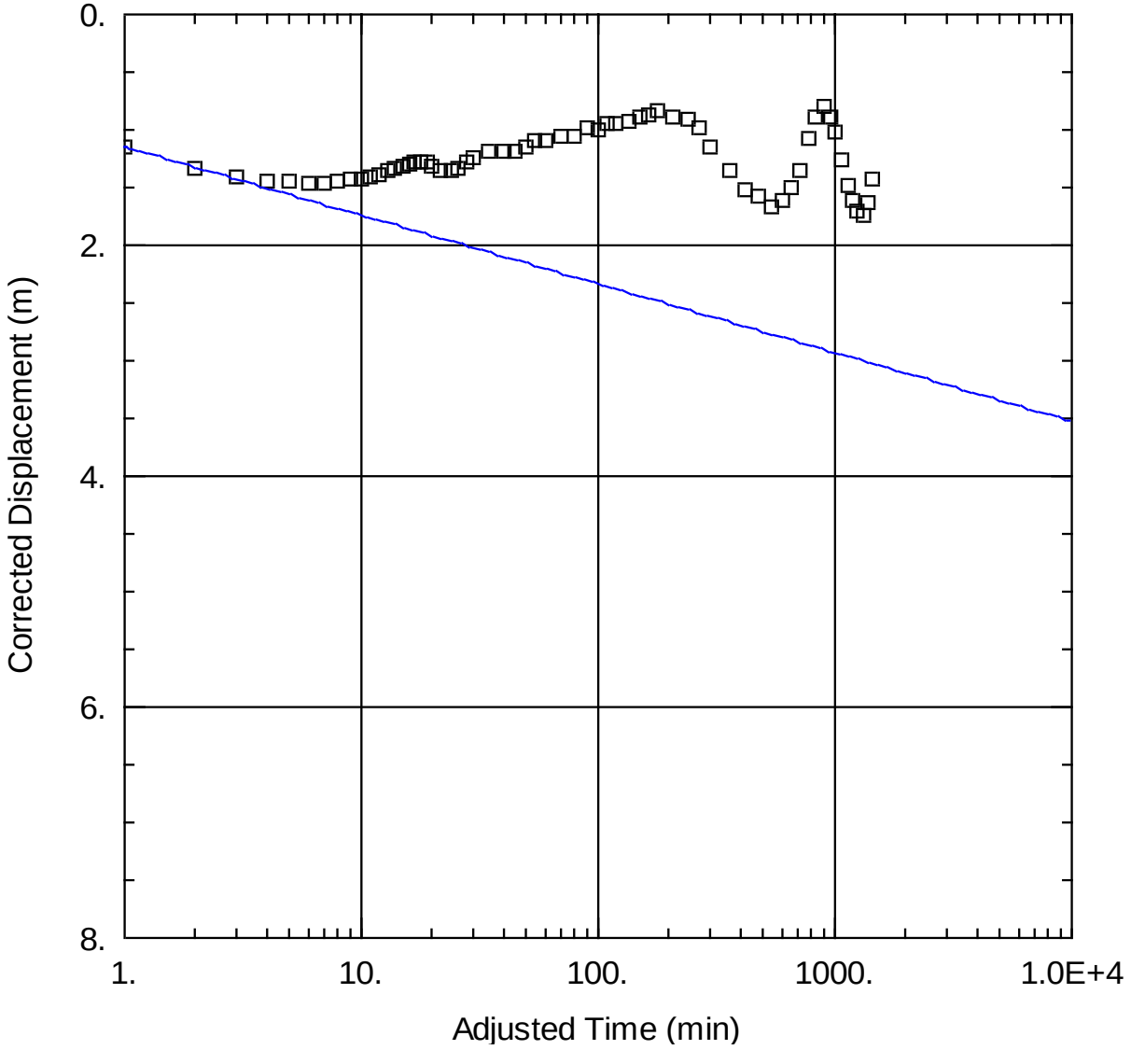
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Cooper-Jacob Time-Drawdown

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW1	
Transmissivity:	1.7E-03	m^2/s
Storativity:	1.9E-04	

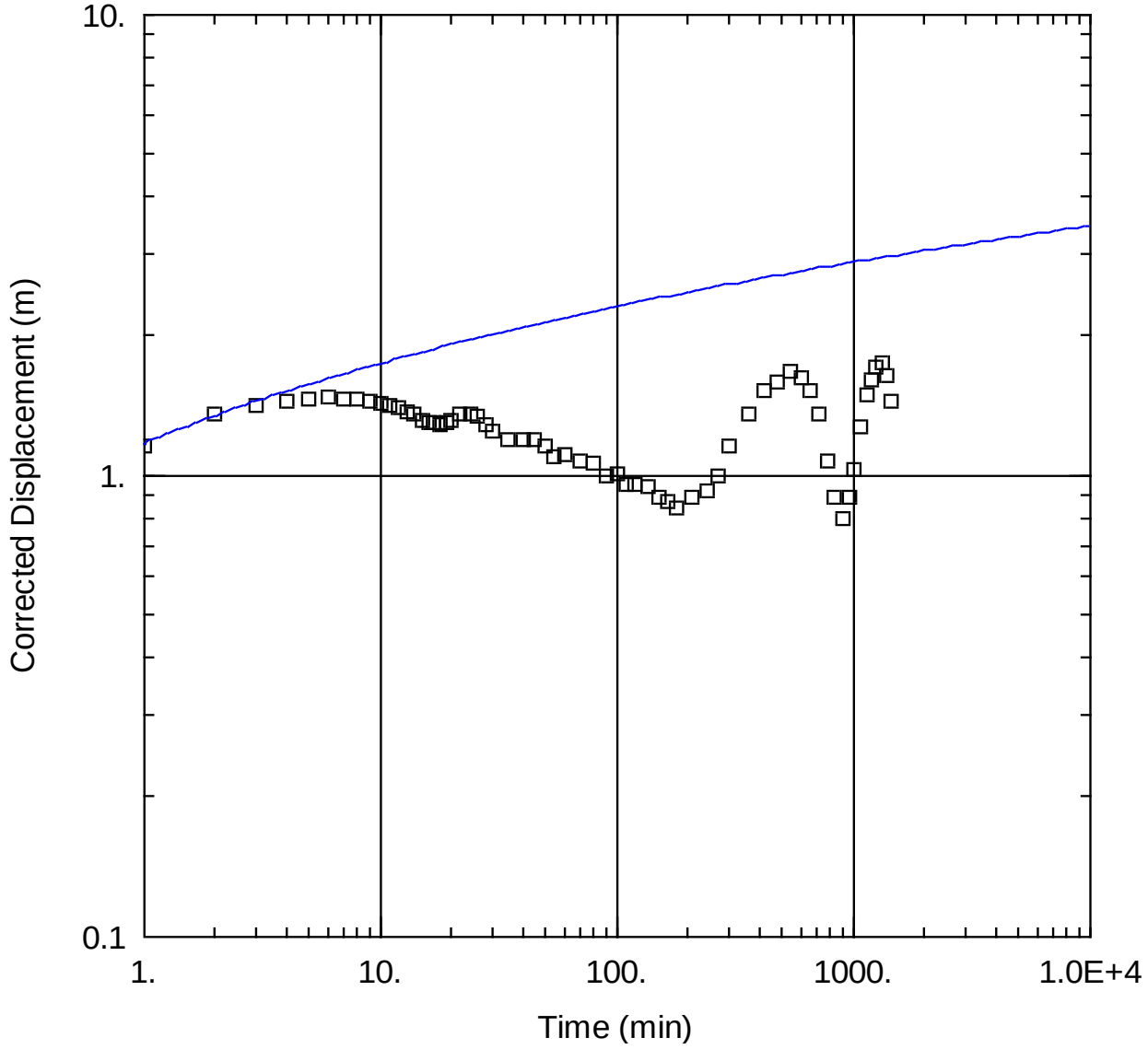
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW1	
Transmissivity:	1.8E-03	m^2/s
Storativity:	1.5E-04	

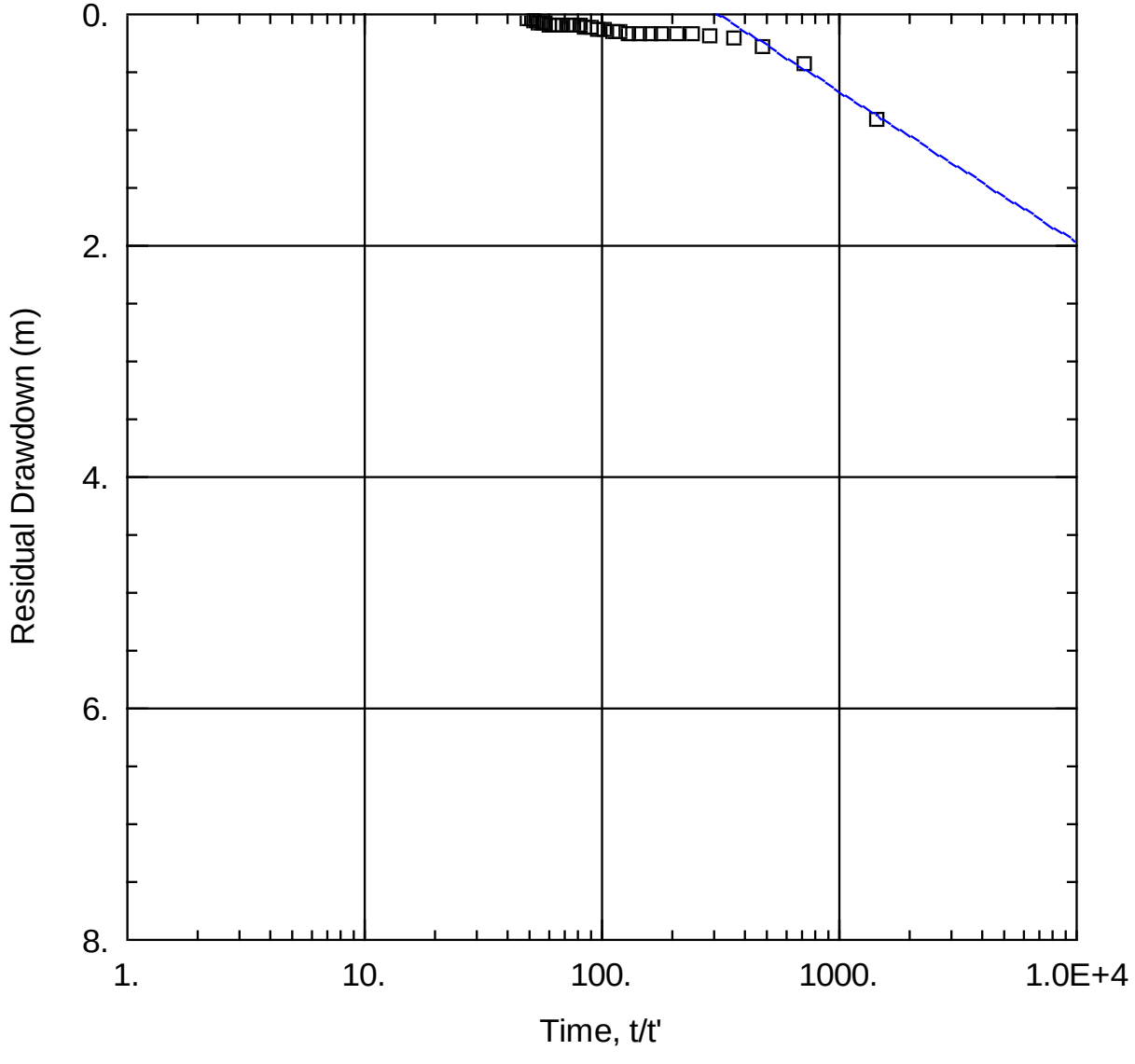
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis Recovery

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW1	
Transmissivity:	7.9E-04	m^2/s
Storativity:	-	

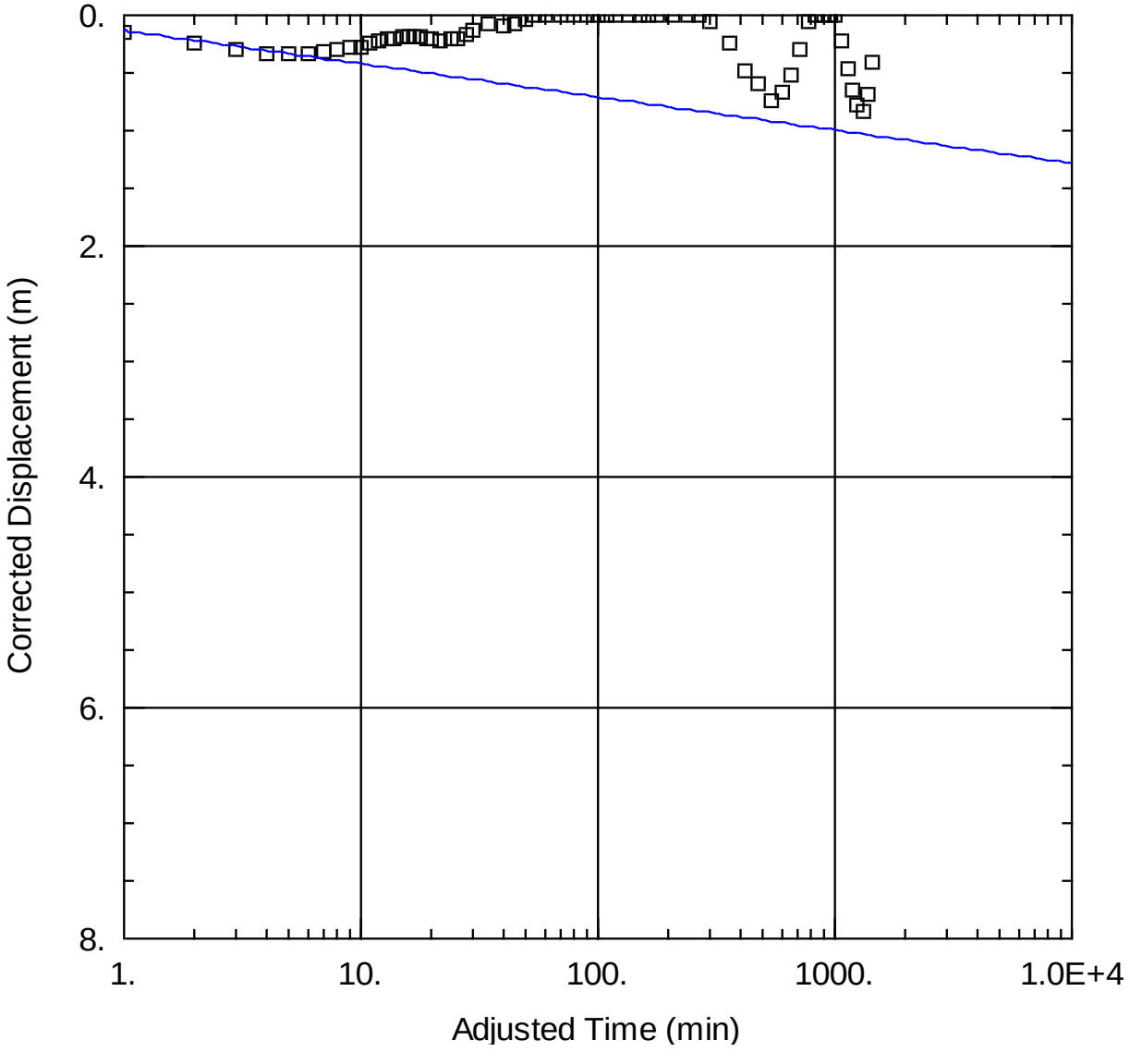
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Cooper-Jacob Time-Drawdown

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW2	
Transmissivity:	3.6E-03	m^2/s
Storativity:	2.5E-04	

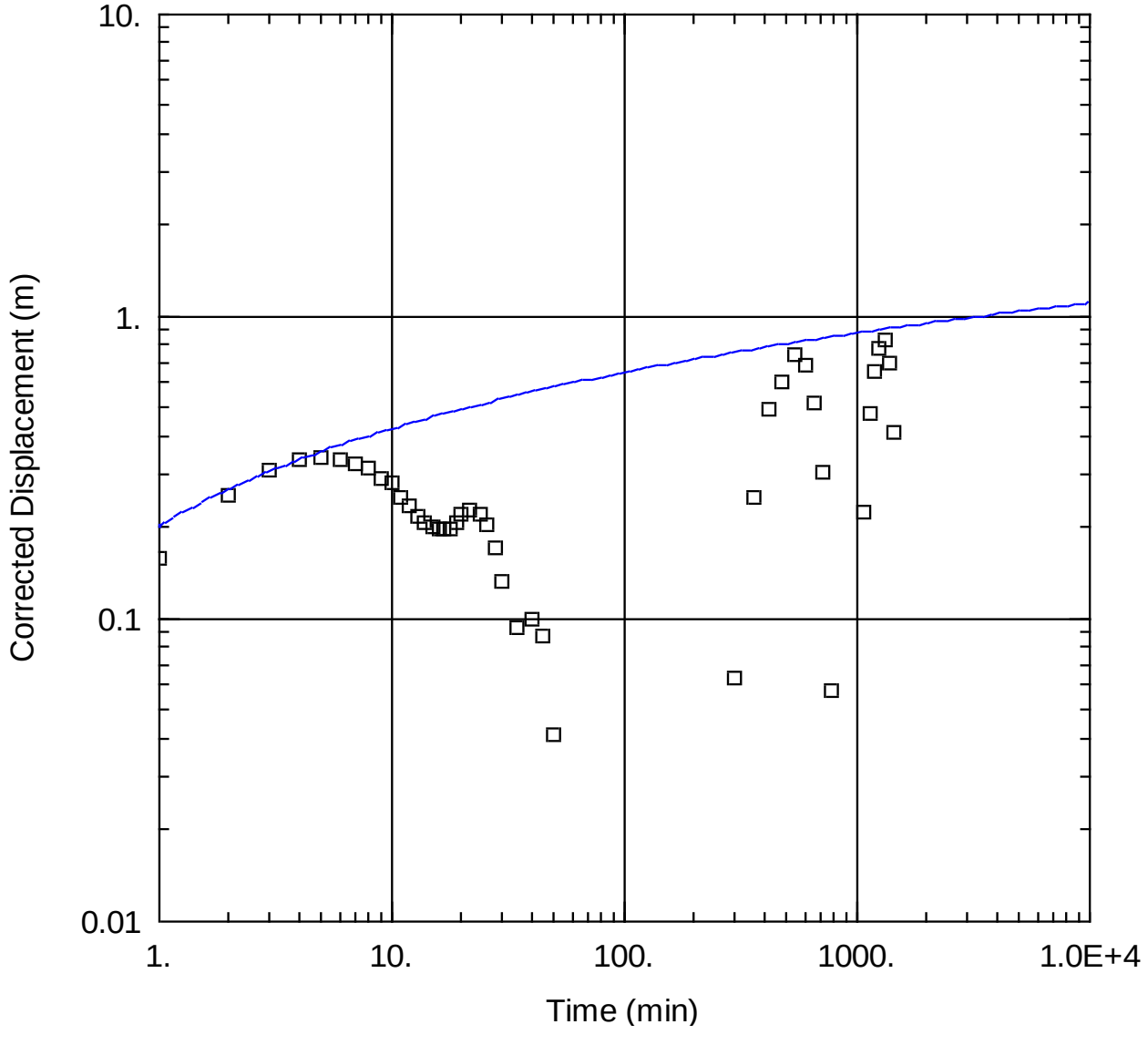
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW2	
Transmissivity:	4.6E-03	m^2/s
Storativity:	1.4E-04	

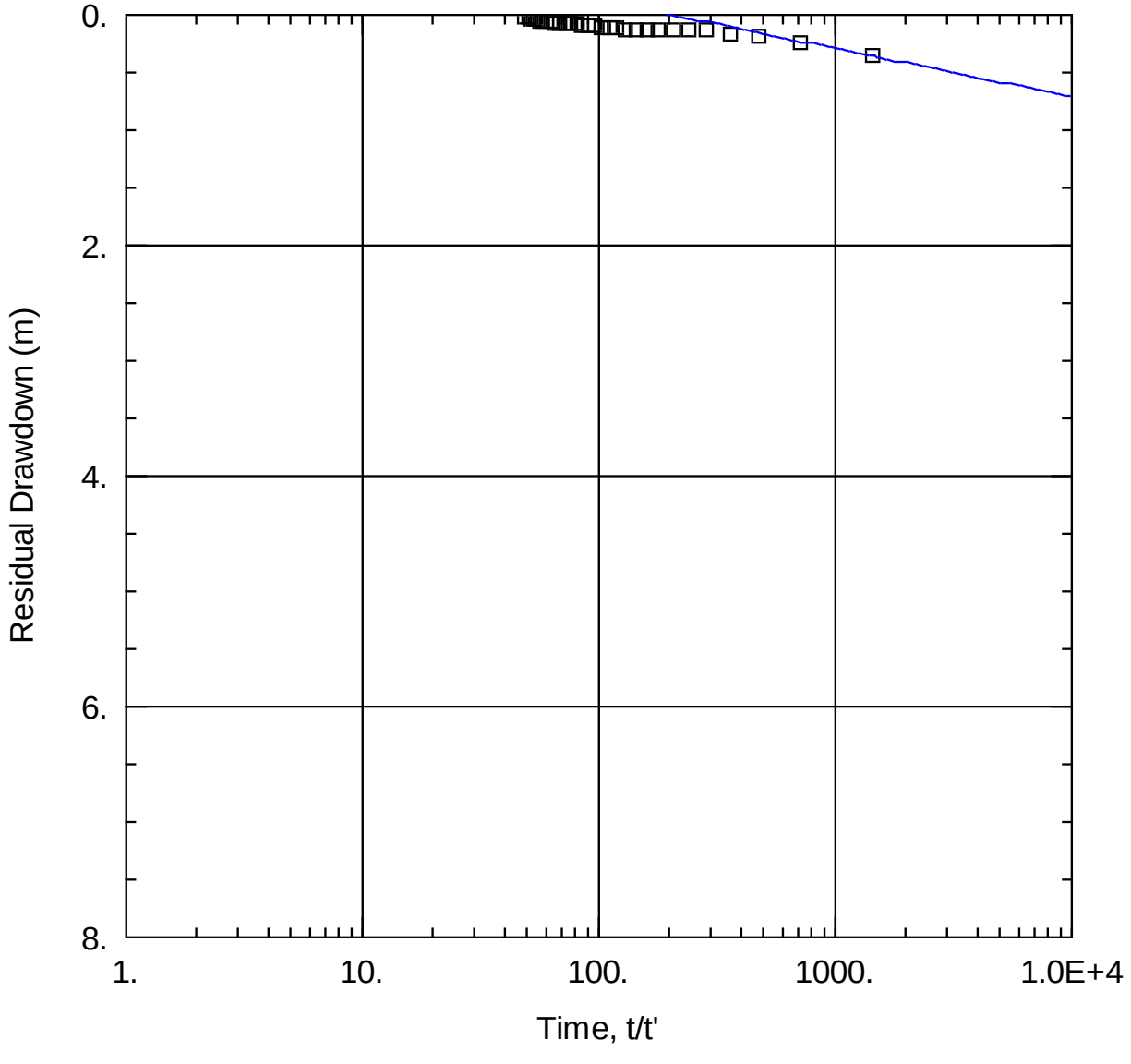
Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

Stantec Consulting Ltd.
607 Torbay Road
St. John's, NL
Phone: 709 576-1458

Aquifer Test Analysis Report
Project: Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Proposed Eagle Nest Ridge Development
Canadian Coast Guard Southside Base, St. John's, NL
Project Number: 121412783
Client: Environmental Services, PWGSC



Analysis Method:

Theis Recovery

Analysis Results:

Well Pumped and Rate:	Well 1 @ 339 L/min	
Wells Analyzed:	MW1	
Transmissivity:	2.5E-03	m^2/s
Storativity:	-	

Comments:

Evaluated by: M. Haverstock

Evaluation date: 2013-09-30

APPENDIX F

Field Inidicators Data & Plots

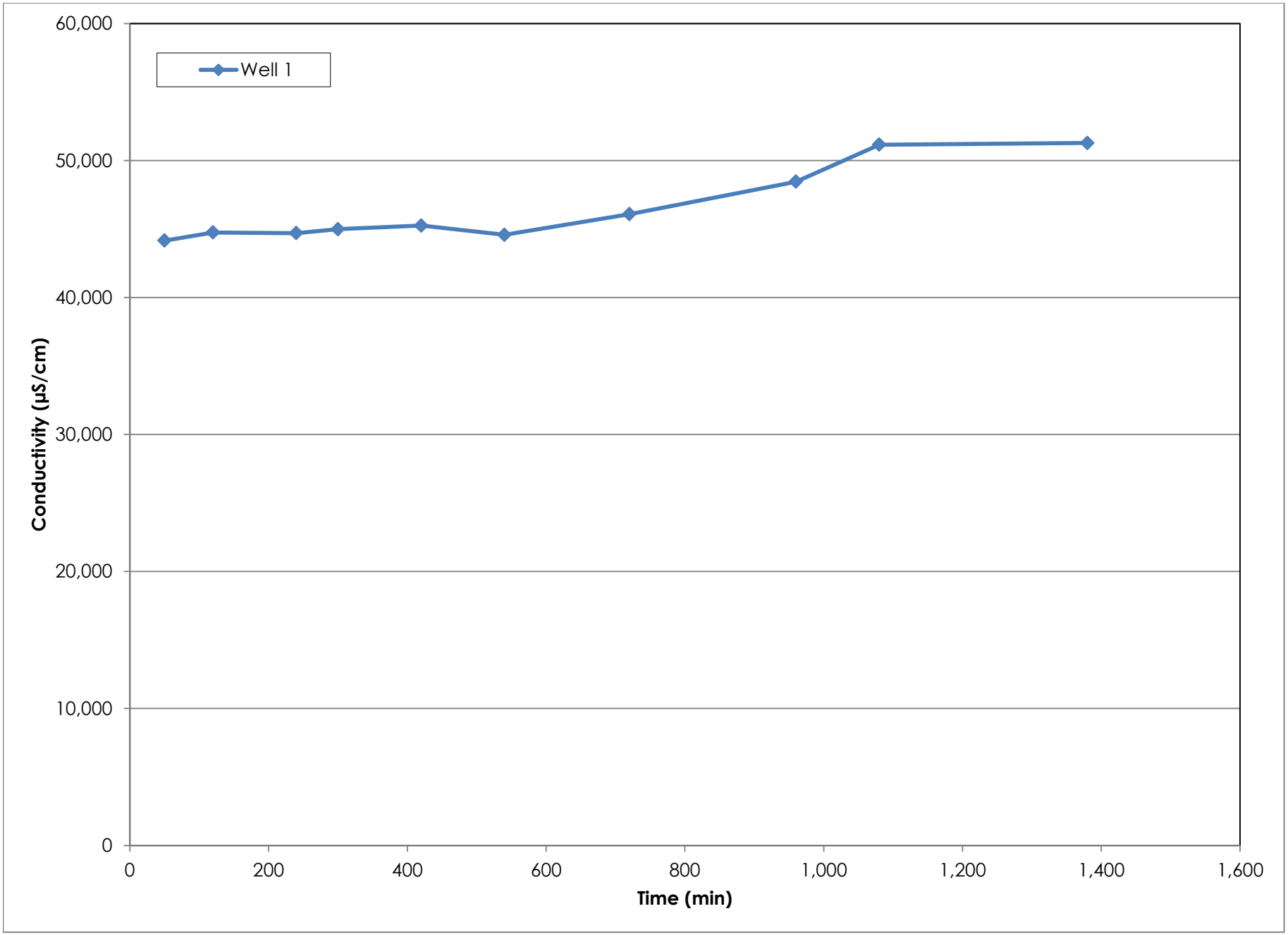


Figure F-1 Groundwater Conductivty versus Time in Well 1 during the Constant Rate Test

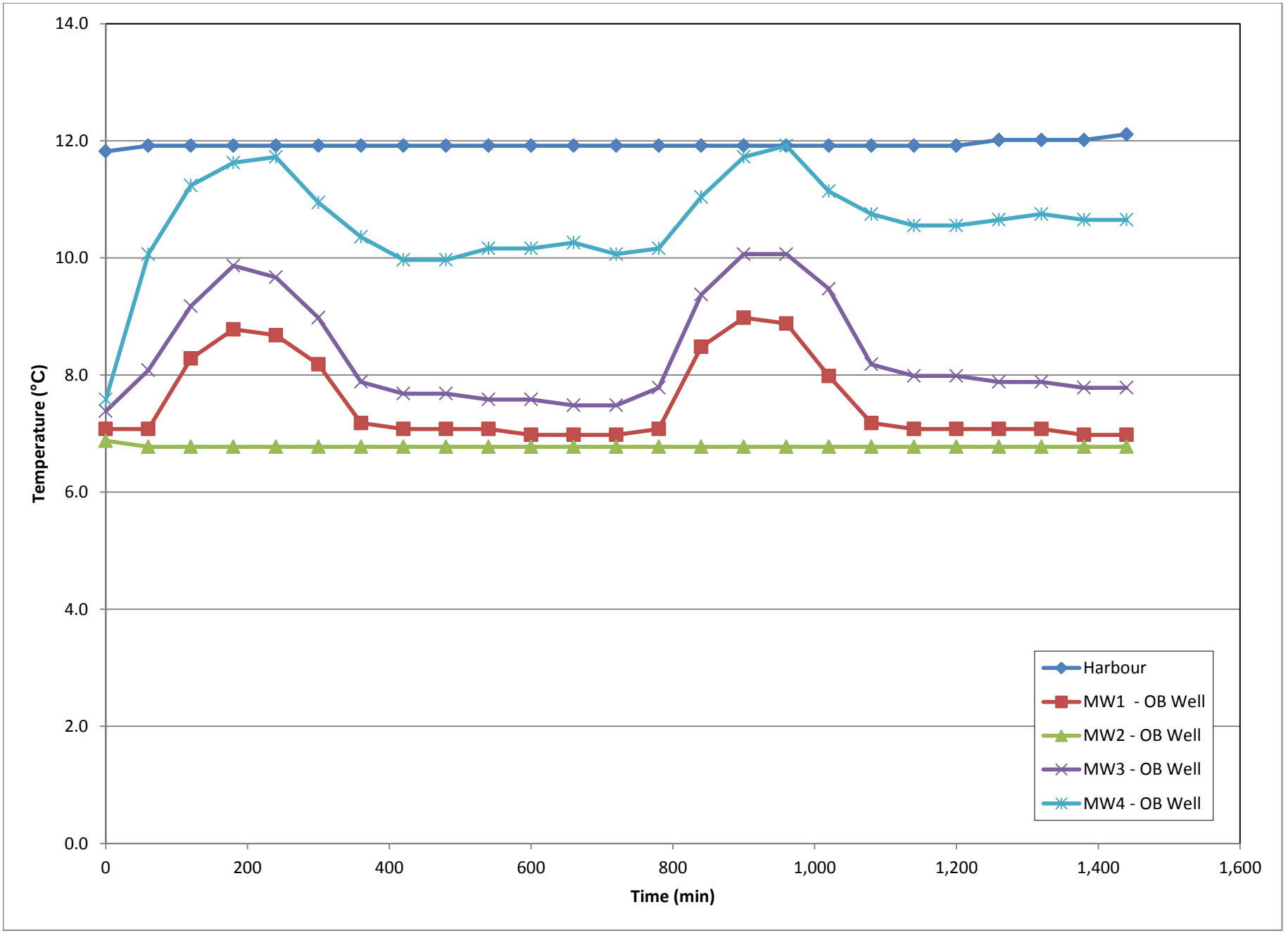


Figure F-2 Groundwater Temperature versus Time during the Constant Rate Test

Table F.1 Field Measurements of Groundwater Conductivity
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Time (min)	Conductivity (µS/cm)
	Well 1
	18-Sep-13
50	44,150
120	44,750
240	44,697
300	44,986
420	45,252
540	44,578
720	46,082
960	48,455
1,080	51,150
1,380	51,276

Table F.2 Field Measurements of Groundwater Temperature
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Time (min)	Temperature (°C)				
	Harbour	MW1	MW2	MW3	MW4
	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13
0	11.8	7.1	6.9	7.4	7.6
60	11.9	7.1	6.8	8.1	10.1
120	11.9	8.3	6.8	9.2	11.2
180	11.9	8.8	6.8	9.9	11.6
240	11.9	8.7	6.8	9.7	11.7
300	11.9	8.2	6.8	9.0	10.9
360	11.9	7.2	6.8	7.9	10.4
420	11.9	7.1	6.8	7.7	10.0
480	11.9	7.1	6.8	7.7	10.0
540	11.9	7.1	6.8	7.6	10.2
600	11.9	7.0	6.8	7.6	10.2
660	11.9	7.0	6.8	7.5	10.3
720	11.9	7.0	6.8	7.5	10.1
780	11.9	7.1	6.8	7.8	10.2
840	11.9	8.5	6.8	9.4	11.0
900	11.9	9.0	6.8	10.1	11.7
960	11.9	8.9	6.8	10.1	11.9
1,020	11.9	8.0	6.8	9.5	11.1
1,080	11.9	7.2	6.8	8.2	10.7
1,140	11.9	7.1	6.8	8.0	10.6
1,200	11.9	7.1	6.8	8.0	10.6
1,260	12.0	7.1	6.8	7.9	10.7
1,320	12.0	7.1	6.8	7.9	10.7
1,380	12.0	7.0	6.8	7.8	10.7
1,440	12.1	7.0	6.8	7.8	10.7

APPENDIX G

Laboratory Analytical Results & Laboratory Certificates of Analysis

Table G.1 Results of Laboratory Analysis of General Chemistry in Groundwater
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Parameters	RDL	Units	Guidelines[1]	Well 1 - WS1	Well 1 - WS1 Lab-Dup	Well 1 - WS2
				18-Sep-13	18-Sep-13	19-Sep-13
Alkalinity	1.0	mg/L $CaC0_3$	-	80	80	87
Sulphate	2.0	mg/L	-	1,300	1,400	1,700
Chloride	50	mg/L	-	11,000	10,000	12,000
Reactive Silica	0.5	mg/L SiO2	-	4.3	4.3	4.0
Orthophosphate	0.010	mg/L P	-	nd	nd	nd
Nitrate + Nitrite	0.050	mg/L N	-	0.079	0.081	0.056
Nitrate	0.050	mg/L N	16	0.079	-	0.056
Nitrite	0.010	mg/L	-	nd	nd	nd
True Color	5.0	TCU	-	12	11	30
Total Organic Carbon	5.0	mg/L	-	nd	-	nd
Turbidity	1.0	NTU	-	4.9	-	8.8
Conductivity	1.0	uS/cm		30,000	-	35,000
pH	-	Units	7.0 - 8.7	7.01	-	**6.90**
Hardness	1.0	mg/L $CaC0_3$	-	4,000	-	4,300
Bicarbonate	1.0	mg/L $CaC0_3$	-	80	-	87
Total Dissolved Solids	1.0	mg/L	-	20,000	-	22,000

Notes:
1 = Federal Interim Groundwater Quality Guidelines (FIGQGs), Generic Guidelines for Commercial and Industrial Land Uses (November 2012), Tier 2 for Marine Life Water Use
RDL = Reportable Detection Limit
nd = Not detected above standard RDL
"-" = indicates value is not available or does not apply
Lab-Dup = Laboratory QA/QC duplicate sample
Bold/shaded = exceeds FIGQG criteria

Table G.2 Results of Laboratory Analysis of Dissolved Metals in Groundwater
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Parameters	RDL	Units	FIGQGs[1]	ON MOE[2]	Well 1 - WS1	Well 1 - WS2
					18-Sep-13	19-Sep-13
Aluminum	5.0	ug/L	-	-	nd	nd
Antimony	1.0	ug/L	-	16,000	nd	nd
Arsenic	1.0	ug/L	12.5	1,500	nd	nd
Barium	1.0	ug/L	500	23,000	170	210
Beryllium	1.0	ug/L	100	53	nd	nd
Bismuth	2.0	ug/L	-	-	nd	nd
Boron	50	ug/L	5,000	36,000	2,300	2,300
Cadmium	0.017	ug/L	0.12	2.1	**0.60**	**0.33**
Calcium	100	ug/L	-	-	360,000	360,000
Chromium	1.0	ug/L	56	640	nd	nd
Cobalt	0.40	ug/L	-	52	4.8	9.3
Copper	2.0	ug/L	2.0	69	nd	nd
Iron	50	ug/L	-	-	150	1,000
Lead	0.50	ug/L	2.0	20	nd	nd
Magnesium	100	ug/L	-	-	750,000	830,000
Manganese	2.0	ug/L	-	-	6,800	10,000
Molybdenum	2.0	ug/L	-	7,300	2	nd
Nickel	2.0	ug/L	83	390	nd	nd
Phosphorus	100	ug/L	-	-	nd	nd
Potassium	100	ug/L	-	-	190,000	220,000
Selenium	1.0	ug/L	54	50	nd	nd
Silver	0.10	ug/L	1.5	1.2	nd	nd
Sodium	100	ug/L	-	180,000	**6,000,000**	**6,700,000**
Strontium	2.0	ug/L	-	-	5,700	6,300
Thallium	0.10	ug/L	-	400	0.3	nd
Tin	2.0	ug/L	-	-	nd	nd
Titanium	2.0	ug/L	-	-	nd	nd
Uranium	0.10	ug/L	-	330	11	9.9
Vanadium	2.0	ug/L	-	200	nd	nd
Zinc	5.0	ug/L	10	890	19	nd

Notes:

1 = Federal Interim Groundwater Quality Guidelines (FIGQGs), Generic Guidelines for Commercial and Industrial Land Uses (November 2012), Tier 2 for Marine Life Water Use (Table 3)

2 = Ontario Ministry of the Environment (MOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act*. April 15, 2011. Generic site condition standards for use within 30 m of a water body in a non-potable groundwater condition (Table 9)

RDL = Reportable Detection Limit for routine analysis

nd = Not detected above standard RDL

"-" = No applicable guideline

Bold/shaded = exceeds FIGQG criteria

Bold/shaded/underlined = exceeds ON MOE criteria

Table G.3 Results of Laboratory Analysis of Petroleum Hydrocarbons in Groundwater
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Parameters	RDL	Units	FIGQGs[1]	ON MOE[2]	Well 1 - WS1	Well 1 - WS1 Lab-Dup	Well 1 - WS2
					18-Sep-13	18-Sep-13	19-Sep-13
Benzene	0.001	mg/L	0.2	0.044	nd	nd	nd
Toluene	0.001	mg/L	8.9	14	nd	nd	nd
Ethylbenzene	0.001	mg/L	11	1.8	nd	nd	nd
Xylenes	0.002	mg/L	-	3.3	nd	nd	nd
C_6-C_{10} - F1	0.01	mg/L	-	0.42	nd	nd	nd
C_{10}-C_{16} - F2	0.05	mg/L	-	0.15	nd	-	nd
C_{16}-C_{32}[4] - F3	0.15	mg/L	-	0.5	nd	-	0.33
>C_{32}[4] - F4	-	mg/L	-	0.5	-	-	-
Modified TPH - Tier I[3]	0.1	mg/L	-	-	nd	-	0.33
Resemblance	-	-	-	-	-	-	WFO/LO

Notes:

1 = Federal Interim Groundwater Quality Guidelines (FIGQGs), Generic Guidelines for Commercial and Industrial Land Uses (November 2012), Tier 2 for Marine Life Water Use (Table 3)

2 = Ontario Ministry of the Environment (MOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act*. April 15, 2011. Generic site condition standards for use within 30 m of a water body in a non-potable groundwater condition (Table 9)

3 = Modified TPH - Tier I does not include BTEX

4 = Atlantic PIRI analytical method does not analyse for >C32. Laboratory certificate indicates (Yes or No) whether chromatogram for each sample returns to baseline after C32. Samples are considered to have returned to baseline if the area from C32-C36 is less than 10% of the area from C10-C32.

* = Baseline not reached at C32; sample may contain carbon fractions >C32

RDL = Reportable Detection Limit

nd = Not detected above standard RDL

WFO = Weathered Fuel Oil; LO = Lube oil

Table G.4 Results of Laboratory Analysis of Polycyclic Aromatic Hydrocarbons in Groundwater
Hydrogeological Assessment, Potential Geothermal Well (Phase II)
Canadian Coast Guard Southside Base, St. John's, NL
Stantec Project No. 121412783

Parameters	RDL	Units	FIGQGs[1]	ON MOE[2]	Well 1 - WS1	Well 1 - WS1 Lab-Dup	Well 1 - WS2
					18-Sep-13	18-Sep-13	19-Sep-13
1-Methylnaphthalene	0.05	ug/L	-	1,500	nd	nd	nd
2-Methylnaphthalene	0.05	ug/L	-	1,500	nd	nd	nd
Acenaphthene	0.01	ug/L	-	600	nd	nd	nd
Acenaphthylene	0.01	ug/L	-	1.4	nd	nd	nd
Anthracene	0.01	ug/L	-	1.0	nd	nd	nd
Benzo(a)anthracene	0.01	ug/L	-	1.8	nd	nd	nd
Benzo(a)pyrene	0.01	ug/L	-	0.81	nd	nd	nd
Benzo(b)fluoranthene	0.01	ug/L	-	0.75	nd	nd	nd
Benzo(g,h,i)perylene	0.01	ug/L	-	0.2	nd	nd	nd
Benzo(j)fluoranthene	0.01	ug/L	-	na	nd	nd	nd
Benzo(k)fluoranthene	0.01	ug/L	-	0.4	nd	nd	nd
Chrysene	0.01	ug/L	-	0.7	nd	nd	nd
Dibenzo(a,h,)anthracene	0.01	ug/L	-	0.4	nd	nd	nd
Fluoranthene	0.01	ug/L	-	73	nd	nd	nd
Fluorene	0.01	ug/L	-	290	nd	nd	nd
Indeno(1,2,3-c,d) pyrene	0.01	ug/L	-	0.2	nd	nd	nd
Naphthalene	0.20	ug/L	1.4	1,400	nd	nd	nd
Perylene	0.01	ug/L	-	na	nd	nd	nd
Phenanthrene	0.01	ug/L	-	380	nd	nd	nd
Pyrene	0.01	ug/L	-	5.7	nd	nd	nd

Notes:
1 = Federal Interim Groundwater Quality Guidelines (FIGQGs), Generic Guidelines for Commercial and Industrial Land Uses (November 2012), Tier 2 for Marine Life Water Use (Table 3)
2 = Ontario Ministry of the Environment (MOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act*. April 15, 2011. Generic site condition standards for use within 30 m of a water body in a non-potable groundwater condition (Table 9)
RDL = Reportable Detection Limit
nd = Not detected above standard RDL
Lab report noted that the samples contained sediment.

Your P.O. #: 16300R-20
Your Project #: 121412783
Site Location: CCG TEST WELL
Your C.O.C. #: ES739813

Attention: Bob MacLeod
Stantec Consulting Ltd
St. John's - Standing Offer
607 Torbay Rd
St. John's, NL
A1A 4Y6

Report Date: 2013/09/26

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B3F7742
Received: 2013/09/19, 8:40

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
TEH in Water (PIRI)	1	2013/09/20	2013/09/24	ATL SOP 00198	Based on Atl. PIRI
VPH in Water (PIRI) (1)	1	2013/09/23	2013/09/24	ATL SOP 00118	Based on Atl. PIRI
ModTPH (T1) Calc. for Water	1	N/A	2013/09/25	N/A	Based on Atl. PIRI

Remarks:

Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

(1) This test was performed by Bedford

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Rob Whelan, Laboratory Manager
Email: RWhelan@maxxam.ca
Phone# (709) 754-0203

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B3F7742
Report Date: 2013/09/26

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJH

ATLANTIC RBCA HYDROCARBONS (WATER)

Maxxam ID				TC7890	TC7890		
Sampling Date				2013/09/18 18:00	2013/09/18 18:00		
Received Temperature (°C)				6.2C	6.2C		
	Units	**Criteria A**	**Criteria C**	**Well1-WS1**	**Well1-WS1 Lab-Dup**	**RDL**	**QC Batch**
Petroleum Hydrocarbons							
Benzene	mg/L	**0.005**		ND	ND	0.0010	3359168
Toluene	mg/L		0.024	ND	ND	0.0010	3359168
Ethylbenzene	mg/L		0.0024	ND	ND	0.0010	3359168
Xylene (Total)	mg/L		0.3	ND	ND	0.0020	3359168
C6 - C10 (less BTEX)	mg/L			ND	ND	0.010	3359168
>C10-C16 Hydrocarbons	mg/L			ND		0.050	3356906
>C16-C21 Hydrocarbons	mg/L			ND		0.050	3356906
>C21-<C32 Hydrocarbons	mg/L			ND		0.10	3356906
Modified TPH (Tier1)	mg/L			ND		0.10	3354880
Reached Baseline at C32	mg/L			YES		N/A	3356906
Surrogate Recovery (%)							
Isobutylbenzene - Extractable	%			103			3356906
Isobutylbenzene - Volatile	%			102	101		3359168
n-Dotriacontane - Extractable	%			116			3356906

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F7742
Report Date: 2013/09/26

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJH

GENERAL COMMENTS

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F7742
Report Date: 2013/09/26

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJH

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3356906	Isobutylbenzene - Extractable	2013/09/24	101	30 - 130	107	30 - 130	105	%		
3356906	n-Dotriacontane - Extractable	2013/09/24	102	30 - 130	110	30 - 130	100	%		
3356906	>C10-C16 Hydrocarbons	2013/09/24	72	30 - 130	96	30 - 130	ND, RDL=0.050	mg/L	NC	40
3356906	>C16-C21 Hydrocarbons	2013/09/24	82	30 - 130	112	30 - 130	ND, RDL=0.050	mg/L	NC	40
3356906	>C21-<C32 Hydrocarbons	2013/09/24	65	30 - 130	94	30 - 130	ND, RDL=0.10	mg/L	NC	40
3359168	Isobutylbenzene - Volatile	2013/09/24	100	70 - 130	100	70 - 130	102	%		
3359168	Benzene	2013/09/24	81	70 - 130	99	70 - 130	ND, RDL=0.0010	mg/L	NC	40
3359168	Toluene	2013/09/24	84	70 - 130	103	70 - 130	ND, RDL=0.0010	mg/L	NC	40
3359168	Ethylbenzene	2013/09/24	85	70 - 130	104	70 - 130	ND, RDL=0.0010	mg/L	NC	40
3359168	Xylene (Total)	2013/09/24	85	70 - 130	103	70 - 130	ND, RDL=0.0020	mg/L	NC	40
3359168	C6 - C10 (less BTEX)	2013/09/24					ND, RDL=0.010	mg/L	NC	40

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Validation Signature Page

Maxxam Job #: B3F7742

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Paula Chaplin, Project Manager

Rose MacDonald, Scientific Specialist (Organics)

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Your P.O. #: 16300R-20
Your Project #: 121412783
Site Location: CCG TEST WELL
Your C.O.C. #: ES739813

Attention: Bob MacLeod
Stantec Consulting Ltd
St. John's - Standing Offer
607 Torbay Rd
St. John's, NL
A1A 4Y6

Report Date: 2013/09/27

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B3F9048
Received: 2013/09/20, 10:39

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Carbonate, Bicarbonate and Hydroxide (1)	1	N/A	2013/09/27	CAM SOP-00102	APHA 4500-CO2 D
Alkalinity (1)	1	N/A	2013/09/26	ATL SOP 00013	Based on EPA310.2
Chloride (1)	1	N/A	2013/09/27	ATL SOP 00014	Based on SM4500-Cl-
Colour (1)	1	N/A	2013/09/26	ATL SOP 00020	Based on SM2120C
Conductance - water (1)	1	N/A	2013/09/26	ATL SOP-00004	Based on SM2510B
Hardness (calculated as CaCO3) (1)	1	N/A	2013/09/26	ATL SOP 00048	Based on SM2340B
Metals Water Diss. MS (1,2)	1	N/A	2013/09/25	ATL SOP 00058	Based on EPA6020A
Ion Balance (% Difference) (1)	1	N/A	2013/09/27		
Anion and Cation Sum (1)	1	N/A	2013/09/27		
Nitrogen Ammonia - water (1)	1	N/A	2013/09/25	ATL SOP 00015	Based on USEPA 350.1
Nitrogen - Nitrate + Nitrite (1)	1	N/A	2013/09/26	ATL SOP 00016	Based on USGS - Enz.
Nitrogen - Nitrite (1)	1	N/A	2013/09/27	ATL SOP 00017	Based on SM4500-NO2B
Nitrogen - Nitrate (as N) (1)	1	N/A	2013/09/27	ATL SOP 00018	Based on ASTMD3867
PAH in Water by GC/MS (SIM) (1)	1	2013/09/25	2013/09/25	ATL SOP 00103	Based on EPA 8270C
pH (1,3)	1	N/A	2013/09/26	ATL SOP 00003	Based on SM4500H+B
Phosphorus - ortho (1)	1	N/A	2013/09/26	ATL SOP 00021	Based on USEPA 365.2
Sat. pH and Langelier Index (@ 20C) (1)	1	N/A	2013/09/27	ATL SOP-00049	.
Sat. pH and Langelier Index (@ 4C) (1)	1	N/A	2013/09/27	ATL SOP-00049	.
Reactive Silica (1)	1	N/A	2013/09/26	ATL SOP 00022	Based on EPA 366.0
Sulphate (1)	1	N/A	2013/09/26	ATL SOP 00023	Based on EPA 375.4
Total Dissolved Solids (TDS calc) (1)	1	N/A	2013/09/27		
Organic carbon - Total (TOC) (1)	1	N/A	2013/09/27	ATL SOP 00037	Based on SM5310C
Turbidity (1)	1	N/A	2013/09/27	ATL SOP 00011	based on EPA 180.1

Remarks:

Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

(1) This test was performed by Bedford
(2) Sample filtered in laboratory prior to analysis for dissolved metals.
New RDLs in effect due to release of NS Contaminated Sites Regulations. Reduced RDL based on MDL study performance. Low level analytical run checks being implemented.
(3) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Michelle Hill, Project Manager
Email: MHill@maxxam.ca
Phone# (902) 420-0203 Ext:289

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

RESULTS OF ANALYSES OF WATER

Maxxam ID				TD3829	TD3829		
Sampling Date				2013/09/18 18:00	2013/09/18 18:00		
	Units	**Criteria A**	**Criteria C**	**WELL-WS1**	**WELL-WS1 Lab-Dup**	**RDL**	**QC Batch**
Calculated Parameters							
Anion Sum	me/L			348		N/A	3357151
Bicarb. Alkalinity (calc. as CaCO3)	mg/L			80		1.0	3357147
Calculated TDS	mg/L		500	20000		1.0	3357155
Carb. Alkalinity (calc. as CaCO3)	mg/L			ND		1.0	3357147
Cation Sum	me/L			344		N/A	3357151
Hardness (CaCO3)	mg/L			4000		1.0	3357149
Ion Balance (% Difference)	%			0.570		N/A	3357150
Langelier Index (@ 20C)	N/A			-0.428			3357153
Langelier Index (@ 4C)	N/A			-0.665			3357154
Nitrate (N)	mg/L	**10**		0.079		0.050	3357152
Saturation pH (@ 20C)	N/A			7.44			3357153
Saturation pH (@ 4C)	N/A			7.68			3357154

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

RESULTS OF ANALYSES OF WATER

Maxxam ID				TD3829	TD3829		
Sampling Date				2013/09/18 18:00	2013/09/18 18:00		
	Units	**Criteria A**	**Criteria C**	**WELL-WS1**	**WELL-WS1 Lab-Dup**	**RDL**	**QC Batch**
Inorganics							
Total Alkalinity (Total as CaCO3)	mg/L			80	80	5.0	3363601
Dissolved Chloride (Cl)	mg/L		250	11000	10000	120	3363605
Colour	TCU		15	12	11	5.0	3363609
Nitrate + Nitrite	mg/L			0.079	0.081	0.050	3363611
Nitrite (N)	mg/L	**1**		ND	ND	0.010	3363613
Nitrogen (Ammonia Nitrogen)	mg/L			1.5		0.050	3362342
Total Organic Carbon (C)	mg/L			ND		5.0	3364529
Orthophosphate (P)	mg/L			ND	ND	0.010	3363610
pH	pH		6.5 : 8.5	7.01		N/A	3363645
Reactive Silica (SiO2)	mg/L			4.3	4.3	0.50	3363608
Dissolved Sulphate (SO4)	mg/L		500	1300	1400	100	3363606
Turbidity	NTU	**0.3**		**4.9**		0.10	3364575
Conductivity	uS/cm			30000		1.0	3363649

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

ELEMENTS BY ICP/MS (WATER)

Maxxam ID				TD3829		
Sampling Date				2013/09/18 18:00		
	Units	**Criteria A**	**Criteria C**	**WELL-WS1**	**RDL**	**QC Batch**
Metals						
Dissolved Aluminum (Al)	ug/L		100	ND	5.0	3360191
Dissolved Antimony (Sb)	ug/L	**6**		ND	1.0	3360191
Dissolved Arsenic (As)	ug/L	**10**		ND	1.0	3360191
Dissolved Barium (Ba)	ug/L	**1000**		170	1.0	3360191
Dissolved Beryllium (Be)	ug/L			ND	1.0	3360191
Dissolved Bismuth (Bi)	ug/L			ND	2.0	3360191
Dissolved Boron (B)	ug/L	**5000**		2300	50	3360191
Dissolved Cadmium (Cd)	ug/L	**5**		0.60	0.010	3360191
Dissolved Calcium (Ca)	ug/L			360000	100	3360191
Dissolved Chromium (Cr)	ug/L	**50**		ND	1.0	3360191
Dissolved Cobalt (Co)	ug/L			4.8	0.40	3360191
Dissolved Copper (Cu)	ug/L		1000	ND	2.0	3360191
Dissolved Iron (Fe)	ug/L		300	150	50	3360191
Dissolved Lead (Pb)	ug/L	**10**		ND	0.50	3360191
Dissolved Magnesium (Mg)	ug/L			750000	1000	3360191
Dissolved Manganese (Mn)	ug/L		50	6800	2.0	3360191
Dissolved Molybdenum (Mo)	ug/L			2.0	2.0	3360191
Dissolved Nickel (Ni)	ug/L			ND	2.0	3360191
Dissolved Phosphorus (P)	ug/L			ND	100	3360191
Dissolved Potassium (K)	ug/L			190000	1000	3360191
Dissolved Selenium (Se)	ug/L	**10**		ND	1.0	3360191

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

ELEMENTS BY ICP/MS (WATER)

Maxxam ID				TD3829		
Sampling Date				2013/09/18 18:00		
	Units	**Criteria A**	**Criteria C**	**WELL-WS1**	**RDL**	**QC Batch**
Dissolved Silver (Ag)	ug/L			ND	0.10	3360191
Dissolved Sodium (Na)	ug/L		200000	6000000	1000	3360191
Dissolved Strontium (Sr)	ug/L			5700	20	3360191
Dissolved Thallium (Tl)	ug/L			0.30	0.10	3360191
Dissolved Tin (Sn)	ug/L			ND	2.0	3360191
Dissolved Titanium (Ti)	ug/L			ND	2.0	3360191
Dissolved Uranium (U)	ug/L	**20**		11	0.10	3360191
Dissolved Vanadium (V)	ug/L			ND	2.0	3360191
Dissolved Zinc (Zn)	ug/L		5000	19	5.0	3360191

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID			TD3829	TD3829		
Sampling Date			2013/09/18 18:00	2013/09/18 18:00		
	Units	**Criteria A**	**WELL-WS1**	**WELL-WS1 Lab-Dup**	**RDL**	**QC Batch**
Polyaromatic Hydrocarbons						
1-Methylnaphthalene	ug/L		ND	ND	0.050	3361938
2-Methylnaphthalene	ug/L		ND	ND	0.050	3361938
Acenaphthene	ug/L		ND	ND	0.010	3361938
Acenaphthylene	ug/L		ND	ND	0.010	3361938
Anthracene	ug/L		ND	ND	0.010	3361938
Benzo(a)anthracene	ug/L		ND	ND	0.010	3361938
Benzo(a)pyrene	ug/L	**0.01**	ND	ND	0.010	3361938
Benzo(b)fluoranthene	ug/L		ND	ND	0.010	3361938
Benzo(g,h,i)perylene	ug/L		ND	ND	0.010	3361938
Benzo(j)fluoranthene	ug/L		ND	ND	0.010	3361938
Benzo(k)fluoranthene	ug/L		ND	ND	0.010	3361938
Chrysene	ug/L		ND	ND	0.010	3361938
Dibenz(a,h)anthracene	ug/L		ND	ND	0.010	3361938
Fluoranthene	ug/L		ND	ND	0.010	3361938
Fluorene	ug/L		ND	ND	0.010	3361938
Indeno(1,2,3-cd)pyrene	ug/L		ND	ND	0.010	3361938
Naphthalene	ug/L		ND	ND	0.20	3361938
Perylene	ug/L		ND	ND	0.010	3361938
Phenanthrene	ug/L		ND	ND	0.010	3361938
Pyrene	ug/L		ND	ND	0.010	3361938

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID			TD3829	TD3829		
Sampling Date			2013/09/18 18:00	2013/09/18 18:00		
	Units	**Criteria A**	**WELL-WS1**	**WELL-WS1 Lab-Dup**	**RDL**	**QC Batch**
Surrogate Recovery (%)						
D10-Anthracene	%		101	100		3361938
D14-Terphenyl	%		101(1)	98(1)		3361938
D8-Acenaphthylene	%		100	97		3361938

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.
(1) - PAH sample contained sediment.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

Package 1	6.2°C

Each temperature is the average of up to three cooler temperatures taken at receipt

GENERAL COMMENTS

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3360191	Dissolved Aluminum (Al)	2013/09/24	102	80 - 120	102	80 - 120	ND, RDL=5.0	ug/L				
3360191	Dissolved Antimony (Sb)	2013/09/24	105	80 - 120	105	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Arsenic (As)	2013/09/24	99	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Barium (Ba)	2013/09/24	101	80 - 120	100	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Beryllium (Be)	2013/09/24	100	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Bismuth (Bi)	2013/09/24	101	80 - 120	105	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Boron (B)	2013/09/24	100	80 - 120	98	80 - 120	ND, RDL=50	ug/L				
3360191	Dissolved Cadmium (Cd)	2013/09/24	101	80 - 120	100	80 - 120	ND, RDL=0.010	ug/L				
3360191	Dissolved Calcium (Ca)	2013/09/24	99	80 - 120	100	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Chromium (Cr)	2013/09/24	98	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Cobalt (Co)	2013/09/24	98	80 - 120	98	80 - 120	ND, RDL=0.40	ug/L				
3360191	Dissolved Copper (Cu)	2013/09/24	97	80 - 120	97	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Iron (Fe)	2013/09/24	104	80 - 120	104	80 - 120	ND, RDL=50	ug/L	NC	20		
3360191	Dissolved Lead (Pb)	2013/09/24	98	80 - 120	99	80 - 120	ND, RDL=0.50	ug/L				
3360191	Dissolved Magnesium (Mg)	2013/09/24	105	80 - 120	106	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Manganese (Mn)	2013/09/24	101	80 - 120	104	80 - 120	ND, RDL=2.0	ug/L	0.4	20		
3360191	Dissolved Molybdenum (Mo)	2013/09/24	101	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Nickel (Ni)	2013/09/24	100	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Phosphorus (P)	2013/09/24	105	80 - 120	104	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Potassium (K)	2013/09/24	106	80 - 120	105	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Selenium (Se)	2013/09/24	99	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Silver (Ag)	2013/09/24	97	80 - 120	97	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Sodium (Na)	2013/09/24	103	80 - 120	104	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Strontium (Sr)	2013/09/24	102	80 - 120	102	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Thallium (Tl)	2013/09/24	104	80 - 120	104	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Tin (Sn)	2013/09/24	106	80 - 120	105	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Titanium (Ti)	2013/09/24	102	80 - 120	106	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Uranium (U)	2013/09/24	106	80 - 120	109	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Vanadium (V)	2013/09/24	101	80 - 120	104	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Zinc (Zn)	2013/09/24	101	80 - 120	102	80 - 120	ND, RDL=5.0	ug/L				
3361938	D10-Anthracene	2013/09/25	90	30 - 130	97	30 - 130	101	%				
3361938	D14-Terphenyl	2013/09/25	92(1)	30 - 130	99	30 - 130	100	%				
3361938	D8-Acenaphthylene	2013/09/25	92	30 - 130	99	30 - 130	99	%				
3361938	1-Methylnaphthalene	2013/09/25	87	30 - 130	96	30 - 130	ND, RDL=0.050	ug/L	NC	40		
3361938	2-Methylnaphthalene	2013/09/25	91	30 - 130	101	30 - 130	ND, RDL=0.050	ug/L	NC	40		
3361938	Acenaphthene	2013/09/25	93	30 - 130	103	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Acenaphthylene	2013/09/25	88	30 - 130	95	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Anthracene	2013/09/25	89	30 - 130	97	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(a)anthracene	2013/09/25	95	30 - 130	99	30 - 130	ND, RDL=0.010	ug/L	NC	40		

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3361938	Benzo(a)pyrene	2013/09/25	83	30 - 130	91	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(b)fluoranthene	2013/09/25	81	30 - 130	90	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(g,h,i)perylene	2013/09/25	97	30 - 130	100	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(j)fluoranthene	2013/09/25	82	30 - 130	93	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(k)fluoranthene	2013/09/25	90	30 - 130	98	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Chrysene	2013/09/25	96	30 - 130	104	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Dibenz(a,h)anthracene	2013/09/25	79	30 - 130	81	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Fluoranthene	2013/09/25	92	30 - 130	98	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Fluorene	2013/09/25	96	30 - 130	105	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Indeno(1,2,3-cd)pyrene	2013/09/25	82	30 - 130	90	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Naphthalene	2013/09/25	90	30 - 130	98	30 - 130	ND, RDL=0.20	ug/L	NC	40		
3361938	Perylene	2013/09/25	84	30 - 130	95	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Phenanthrene	2013/09/25	100	30 - 130	110	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Pyrene	2013/09/25	93	30 - 130	100	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3362342	Nitrogen (Ammonia Nitrogen)	2013/09/25	93	80 - 120	100	80 - 120	ND, RDL=0.050	mg/L	NC	25		
3363601	Total Alkalinity (Total as CaCO3)	2013/09/26	NC	80 - 120	94	80 - 120	ND, RDL=5.0	mg/L	0.2	25		
3363605	Dissolved Chloride (Cl)	2013/09/27	NC	80 - 120	101	80 - 120	ND, RDL=1.0	mg/L	7.6	25	109	80 - 120
3363606	Dissolved Sulphate (SO4)	2013/09/26	NC	80 - 120	101	80 - 120	ND, RDL=2.0	mg/L	4.4	25		
3363608	Reactive Silica (SiO2)	2013/09/26	92	80 - 120	99	80 - 120	ND, RDL=0.50	mg/L	0.3	25		
3363609	Colour	2013/09/26					ND, RDL=5.0	TCU	NC	25	104	80 - 120
3363610	Orthophosphate (P)	2013/09/26	94	80 - 120	96	80 - 120	ND, RDL=0.010	mg/L	NC	25		
3363611	Nitrate + Nitrite	2013/09/26	92	80 - 120	92	80 - 120	ND, RDL=0.050	mg/L	NC	25		
3363613	Nitrite (N)	2013/09/27	100	80 - 120	96	80 - 120	ND, RDL=0.010	mg/L	NC	25		
3363645	pH	2013/09/26							0.2	25	100	80 - 120
3363649	Conductivity	2013/09/26			99	80 - 120	ND, RDL=1.0	uS/cm	0.4	25		
3364529	Total Organic Carbon (C)	2013/09/27	81	80 - 120	88	80 - 120	ND, RDL=0.50	mg/L	22.1	25		
3364575	Turbidity	2013/09/27					ND, RDL=0.10	NTU	1	25	98	80 - 120

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9048
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

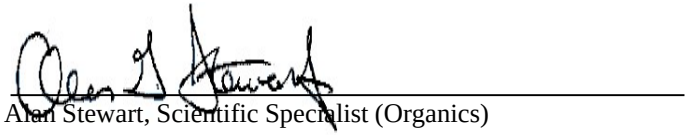
to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - PAH sample contained sediment.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Validation Signature Page

Maxxam Job #: B3F9048

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Alan Stewart, Scientific Specialist (Organics)

Kevin MacDonald, Inorganics Supervisor

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Your P.O. #: 16300R-20
Your Project #: 121412783
Site Location: CCG TEST WELL
Your C.O.C. #: ES741813

Attention: Michael Haverstock
Stantec Consulting Ltd
St. John's - Standing Offer
607 Torbay Rd
St. John's, NL
A1A 4Y6

Report Date: 2013/09/27
This report supersedes all previous reports with the same Maxxam job number

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B3F9115
Received: 2013/09/20, 13:20

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
TEH in Water (PIRI)	1	2013/09/25	2013/09/26	ATL SOP 00198	Based on Atl. PIRI
VPH in Water (PIRI) (1)	1	2013/09/24	2013/09/27	ATL SOP 00118	Based on Atl. PIRI
ModTPH (T1) Calc. for Water	1	N/A	2013/09/27	N/A	Based on Atl. PIRI

Remarks:

Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

(1) This test was performed by Bedford

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Rob Whelan, Laboratory Manager
Email: RWhelan@maxxam.ca
Phone# (709) 754-0203

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B3F9115
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

ATLANTIC RBCA HYDROCARBONS (WATER)

Maxxam ID				TD4338		
Sampling Date				2013/09/19		
Received Temperature (°C)				8.7C		
	Units	**Criteria A**	**Criteria C**	**WELL 1 - WS2**	**RDL**	**QC Batch**
Petroleum Hydrocarbons						
Benzene	mg/L	**0.005**		ND	0.0010	3362323
Toluene	mg/L		0.024	ND	0.0010	3362323
Ethylbenzene	mg/L		0.0024	ND	0.0010	3362323
Xylene (Total)	mg/L		0.3	ND	0.0020	3362323
C6 - C10 (less BTEX)	mg/L			ND	0.010	3362323
>C10-C16 Hydrocarbons	mg/L			ND	0.050	3361948
>C16-C21 Hydrocarbons	mg/L			0.15	0.050	3361948
>C21-<C32 Hydrocarbons	mg/L			0.18	0.10	3361948
Modified TPH (Tier1)	mg/L			0.33	0.10	3356632
Reached Baseline at C32	mg/L			YES	N/A	3361948
Hydrocarbon Resemblance	mg/L			SEECOMMENT(1)	N/A	3361948
Surrogate Recovery (%)						
Isobutylbenzene - Extractable	%			102		3361948
Isobutylbenzene - Volatile	%			97		3362323
n-Dotriacontane - Extractable	%			112		3361948

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.
(1) - Weathered fuel oil fraction. Lube oil range.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9115
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

GENERAL COMMENTS

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3F9115
Report Date: 2013/09/27

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3361948	Isobutylbenzene - Extractable	2013/09/26	87	30 - 130	102	30 - 130	102	%		
3361948	n-Dotriacontane - Extractable	2013/09/26	106	30 - 130	112	30 - 130	101	%		
3361948	>C10-C16 Hydrocarbons	2013/09/26	NC	30 - 130	91	30 - 130	ND, RDL=0.050	mg/L	NC	40
3361948	>C16-C21 Hydrocarbons	2013/09/26	94	30 - 130	86	30 - 130	ND, RDL=0.050	mg/L	NC	40
3361948	>C21-<C32 Hydrocarbons	2013/09/26	84	30 - 130	102	30 - 130	ND, RDL=0.10	mg/L	NC	40
3362323	Isobutylbenzene - Volatile	2013/09/27	98	70 - 130	99	70 - 130	97	%		
3362323	Benzene	2013/09/27	100	70 - 130	99	70 - 130	ND, RDL=0.0010	mg/L	1.4	40
3362323	Toluene	2013/09/27	101	70 - 130	101	70 - 130	ND, RDL=0.0010	mg/L	0.2	40
3362323	Ethylbenzene	2013/09/27	101	70 - 130	102	70 - 130	ND, RDL=0.0010	mg/L	1.2	40
3362323	Xylene (Total)	2013/09/27	103	70 - 130	102	70 - 130	ND, RDL=0.0020	mg/L	1.7	40
3362323	C6 - C10 (less BTEX)	2013/09/27					ND, RDL=0.010	mg/L	2.4	40

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Validation Signature Page

Maxxam Job #: B3F9115

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Paula Chaplin, Project Manager

Rose MacDonald, Scientific Specialist (Organics)

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Your P.O. #: 16300R-20
Your Project #: 121412783
Site Location: CCG TEST WELL
Your C.O.C. #: ES741813

Attention: Bob MacLeod
Stantec Consulting Ltd
St. John's - Standing Offer
607 Torbay Rd
St. John's, NL
A1A 4Y6

Report Date: 2013/10/01

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B3G0030
Received: 2013/09/21, 09:30

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Carbonate, Bicarbonate and Hydroxide (1)	1	N/A	2013/09/30	CAM SOP-00102	APHA 4500-CO2 D
Alkalinity (1)	1	N/A	2013/09/27	ATL SOP 00013	Based on EPA310.2
Chloride (1)	1	N/A	2013/09/30	ATL SOP 00014	Based on SM4500-Cl-
Colour (1)	1	N/A	2013/09/27	ATL SOP 00020	Based on SM2120C
Conductance - water (1)	1	N/A	2013/09/30	ATL SOP-00004	Based on SM2510B
Hardness (calculated as CaCO3) (1)	1	N/A	2013/09/25	ATL SOP 00048	Based on SM2340B
Metals Water Diss. MS (1,2)	1	N/A	2013/09/24	ATL SOP 00058	Based on EPA6020A
Ion Balance (% Difference) (1)	1	N/A	2013/09/30		
Anion and Cation Sum (1)	1	N/A	2013/09/30		
Nitrogen Ammonia - water (1)	1	N/A	2013/09/26	ATL SOP 00015	Based on USEPA 350.1
Nitrogen - Nitrate + Nitrite (1)	1	N/A	2013/09/27	ATL SOP 00016	Based on USGS - Enz.
Nitrogen - Nitrite (1)	1	N/A	2013/09/28	ATL SOP 00017	Based on SM4500-NO2B
Nitrogen - Nitrate (as N) (1)	1	N/A	2013/09/30	ATL SOP 00018	Based on ASTMD3867
PAH in Water by GC/MS (SIM) (1)	1	2013/09/25	2013/09/25	ATL SOP 00103	Based on EPA 8270C
pH (1,3)	1	N/A	2013/09/27	ATL SOP 00003	Based on SM4500H+B
Phosphorus - ortho (1)	1	N/A	2013/09/27	ATL SOP 00021	Based on USEPA 365.2
Sat. pH and Langelier Index (@ 20C) (1)	1	N/A	2013/09/30	ATL SOP-00049	.
Sat. pH and Langelier Index (@ 4C) (1)	1	N/A	2013/09/30	ATL SOP-00049	.
Reactive Silica (1)	1	N/A	2013/09/27	ATL SOP 00022	Based on EPA 366.0
Sulphate (1)	1	N/A	2013/09/27	ATL SOP 00023	Based on EPA 375.4
Total Dissolved Solids (TDS calc) (1)	1	N/A	2013/09/30		
Organic carbon - Total (TOC) (1)	1	N/A	2013/09/30	ATL SOP 00037	Based on SM5310C
Turbidity (1)	1	N/A	2013/09/27	ATL SOP 00011	based on EPA 180.1

Remarks:

Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

(1) This test was performed by Bedford
(2) Sample filtered in laboratory prior to analysis for dissolved metals.
New RDLs in effect due to release of NS Contaminated Sites Regulations. Reduced RDL based on MDL study performance. Low level analytical run checks being implemented.
(3) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Michelle Hill, Project Manager
Email: MHill@maxxam.ca
Phone# (902) 420-0203 Ext:289

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

RESULTS OF ANALYSES OF WATER

Maxxam ID				TD9035		
Sampling Date				2013/09/19 16:30		
	Units	**Criteria A**	**Criteria C**	**WELL1-WS2**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L			388	N/A	3358805
Bicarb. Alkalinity (calc. as CaCO3)	mg/L			87	1.0	3358801
Calculated TDS	mg/L		500	22000	1.0	3358810
Carb. Alkalinity (calc. as CaCO3)	mg/L			ND	1.0	3358801
Cation Sum	me/L			382	N/A	3358805
Hardness (CaCO3)	mg/L			4300	1.0	3358803
Ion Balance (% Difference)	%			0.820	N/A	3358804
Langelier Index (@ 20C)	N/A			-0.483		3358808
Langelier Index (@ 4C)	N/A			-0.721		3358809
Nitrate (N)	mg/L	**10**		0.056	0.050	3358806
Saturation pH (@ 20C)	N/A			7.38		3358808
Saturation pH (@ 4C)	N/A			7.62		3358809

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

RESULTS OF ANALYSES OF WATER

Maxxam ID				TD9035		
Sampling Date				2013/09/19 16:30		
	Units	**Criteria A**	**Criteria C**	**WELL1-WS2**	**RDL**	**QC Batch**
Inorganics						
Total Alkalinity (Total as CaCO3)	mg/L			87	5.0	3365348
Dissolved Chloride (Cl)	mg/L		250	12000	120	3365350
Colour	TCU		15	30	5.0	3365353
Nitrate + Nitrite	mg/L			0.056	0.050	3365356
Nitrite (N)	mg/L	**1**		ND	0.010	3365357
Nitrogen (Ammonia Nitrogen)	mg/L			1.6	0.050	3363886
Total Organic Carbon (C)	mg/L			ND(1)	5.0	3366048
Orthophosphate (P)	mg/L			ND	0.010	3365354
pH	pH		6.5 : 8.5	6.90	N/A	3365453
Reactive Silica (SiO2)	mg/L			4.0	0.50	3365352
Dissolved Sulphate (SO4)	mg/L		500	1700	200	3365351
Turbidity	NTU	**0.3**		**8.8**	0.10	3364577
Conductivity	uS/cm			35000	1.0	3365456

N/A = Not Applicable
ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.
(1) - Elevated reporting limit due to sample matrix.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

ELEMENTS BY ICP/MS (WATER)

Maxxam ID				TD9035		
Sampling Date				2013/09/19 16:30		
	Units	**Criteria A**	**Criteria C**	**WELL1-WS2**	**RDL**	**QC Batch**
Metals						
Dissolved Aluminum (Al)	ug/L		100	ND	50	3360191
Dissolved Antimony (Sb)	ug/L	**6**		ND	10	3360191
Dissolved Arsenic (As)	ug/L	**10**		ND	10	3360191
Dissolved Barium (Ba)	ug/L	**1000**		210	10	3360191
Dissolved Beryllium (Be)	ug/L			ND	10	3360191
Dissolved Bismuth (Bi)	ug/L			ND	20	3360191
Dissolved Boron (B)	ug/L	**5000**		2300	500	3360191
Dissolved Cadmium (Cd)	ug/L	**5**		0.33	0.10	3360191
Dissolved Calcium (Ca)	ug/L			360000	1000	3360191
Dissolved Chromium (Cr)	ug/L	**50**		ND	10	3360191
Dissolved Cobalt (Co)	ug/L			9.3	4.0	3360191
Dissolved Copper (Cu)	ug/L		1000	ND	20	3360191
Dissolved Iron (Fe)	ug/L		300	1000	500	3360191
Dissolved Lead (Pb)	ug/L	**10**		ND	5.0	3360191
Dissolved Magnesium (Mg)	ug/L			830000	1000	3360191
Dissolved Manganese (Mn)	ug/L		50	10000	20	3360191
Dissolved Molybdenum (Mo)	ug/L			ND	20	3360191
Dissolved Nickel (Ni)	ug/L			ND	20	3360191
Dissolved Phosphorus (P)	ug/L			ND	1000	3360191
Dissolved Potassium (K)	ug/L			220000	1000	3360191
Dissolved Selenium (Se)	ug/L	**10**		ND	10	3360191

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

ELEMENTS BY ICP/MS (WATER)

Maxxam ID				TD9035		
Sampling Date				2013/09/19 16:30		
	Units	**Criteria A**	**Criteria C**	**WELL1-WS2**	**RDL**	**QC Batch**
Dissolved Silver (Ag)	ug/L			ND	1.0	3360191
Dissolved Sodium (Na)	ug/L		200000	6700000	1000	3360191
Dissolved Strontium (Sr)	ug/L			6300	20	3360191
Dissolved Thallium (Tl)	ug/L			ND	1.0	3360191
Dissolved Tin (Sn)	ug/L			ND	20	3360191
Dissolved Titanium (Ti)	ug/L			ND	20	3360191
Dissolved Uranium (U)	ug/L	**20**		9.9	1.0	3360191
Dissolved Vanadium (V)	ug/L			ND	20	3360191
Dissolved Zinc (Zn)	ug/L		5000	ND	50	3360191

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID			TD9035		
Sampling Date			2013/09/19 16:30		
	Units	**Criteria A**	**WELL1-WS2**	**RDL**	**QC Batch**
Polyaromatic Hydrocarbons					
1-Methylnaphthalene	ug/L		ND	0.050	3361938
2-Methylnaphthalene	ug/L		ND	0.050	3361938
Acenaphthene	ug/L		ND	0.010	3361938
Acenaphthylene	ug/L		ND	0.010	3361938
Anthracene	ug/L		ND	0.010	3361938
Benzo(a)anthracene	ug/L		ND	0.010	3361938
Benzo(a)pyrene	ug/L	**0.01**	ND	0.010	3361938
Benzo(b)fluoranthene	ug/L		ND	0.010	3361938
Benzo(g,h,i)perylene	ug/L		ND	0.010	3361938
Benzo(j)fluoranthene	ug/L		ND	0.010	3361938
Benzo(k)fluoranthene	ug/L		ND	0.010	3361938
Chrysene	ug/L		ND	0.010	3361938
Dibenz(a,h)anthracene	ug/L		ND	0.010	3361938
Fluoranthene	ug/L		ND	0.010	3361938
Fluorene	ug/L		ND	0.010	3361938
Indeno(1,2,3-cd)pyrene	ug/L		ND	0.010	3361938
Naphthalene	ug/L		ND	0.20	3361938
Perylene	ug/L		ND	0.010	3361938
Phenanthrene	ug/L		ND	0.010	3361938
Pyrene	ug/L		ND	0.010	3361938

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID			TD9035		
Sampling Date			2013/09/19 16:30		
	Units	**Criteria A**	**WELL1-WS2**	**RDL**	**QC Batch**
Surrogate Recovery (%)					
D10-Anthracene	%		99		3361938
D14-Terphenyl	%		99(1)		3361938
D8-Acenaphthylene	%		97		3361938

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A, Criteria C: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, Dec. 2010.

A= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health. When exceeded, minimum action required is immediate resampling. If continuous exceedance occurs, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action.

C= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water. If a concentration is well above an AO, then there is a possibility of a health hazard.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.
Note 2 Aluminium guideline value of 0.1 mg/L is for treatment plants using aluminium-based coagulants, 0.2mg/L applies to other types of treatment systems.
(1) - PAH sample contained sediment.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

Package 1	8.7°C

Each temperature is the average of up to three cooler temperatures taken at receipt

GENERAL COMMENTS

Sample TD9035-01: Elevated reporting limits for trace metals due to sample matrix.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3360191	Dissolved Aluminum (Al)	2013/09/24	102	80 - 120	102	80 - 120	ND, RDL=5.0	ug/L				
3360191	Dissolved Antimony (Sb)	2013/09/24	105	80 - 120	105	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Arsenic (As)	2013/09/24	99	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Barium (Ba)	2013/09/24	101	80 - 120	100	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Beryllium (Be)	2013/09/24	100	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Bismuth (Bi)	2013/09/24	101	80 - 120	105	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Boron (B)	2013/09/24	100	80 - 120	98	80 - 120	ND, RDL=50	ug/L				
3360191	Dissolved Cadmium (Cd)	2013/09/24	101	80 - 120	100	80 - 120	ND, RDL=0.010	ug/L				
3360191	Dissolved Calcium (Ca)	2013/09/24	99	80 - 120	100	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Chromium (Cr)	2013/09/24	98	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Cobalt (Co)	2013/09/24	98	80 - 120	98	80 - 120	ND, RDL=0.40	ug/L				
3360191	Dissolved Copper (Cu)	2013/09/24	97	80 - 120	97	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Iron (Fe)	2013/09/24	104	80 - 120	104	80 - 120	ND, RDL=50	ug/L	NC	20		
3360191	Dissolved Lead (Pb)	2013/09/24	98	80 - 120	99	80 - 120	ND, RDL=0.50	ug/L				
3360191	Dissolved Magnesium (Mg)	2013/09/24	105	80 - 120	106	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Manganese (Mn)	2013/09/24	101	80 - 120	104	80 - 120	ND, RDL=2.0	ug/L	0.4	20		
3360191	Dissolved Molybdenum (Mo)	2013/09/24	101	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Nickel (Ni)	2013/09/24	100	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Phosphorus (P)	2013/09/24	105	80 - 120	104	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Potassium (K)	2013/09/24	106	80 - 120	105	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Selenium (Se)	2013/09/24	99	80 - 120	99	80 - 120	ND, RDL=1.0	ug/L				
3360191	Dissolved Silver (Ag)	2013/09/24	97	80 - 120	97	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Sodium (Na)	2013/09/24	103	80 - 120	104	80 - 120	ND, RDL=100	ug/L				
3360191	Dissolved Strontium (Sr)	2013/09/24	102	80 - 120	102	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Thallium (Tl)	2013/09/24	104	80 - 120	104	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Tin (Sn)	2013/09/24	106	80 - 120	105	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Titanium (Ti)	2013/09/24	102	80 - 120	106	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Uranium (U)	2013/09/24	106	80 - 120	109	80 - 120	ND, RDL=0.10	ug/L				
3360191	Dissolved Vanadium (V)	2013/09/24	101	80 - 120	104	80 - 120	ND, RDL=2.0	ug/L				
3360191	Dissolved Zinc (Zn)	2013/09/24	101	80 - 120	102	80 - 120	ND, RDL=5.0	ug/L				
3361938	D10-Anthracene	2013/09/25	90	30 - 130	97	30 - 130	101	%				
3361938	D14-Terphenyl	2013/09/25	92(1)	30 - 130	99	30 - 130	100	%				
3361938	D8-Acenaphthylene	2013/09/25	92	30 - 130	99	30 - 130	99	%				
3361938	1-Methylnaphthalene	2013/09/25	87	30 - 130	96	30 - 130	ND, RDL=0.050	ug/L	NC	40		
3361938	2-Methylnaphthalene	2013/09/25	91	30 - 130	101	30 - 130	ND, RDL=0.050	ug/L	NC	40		
3361938	Acenaphthene	2013/09/25	93	30 - 130	103	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Acenaphthylene	2013/09/25	88	30 - 130	95	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Anthracene	2013/09/25	89	30 - 130	97	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(a)anthracene	2013/09/25	95	30 - 130	99	30 - 130	ND, RDL=0.010	ug/L	NC	40		

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3361938	Benzo(a)pyrene	2013/09/25	83	30 - 130	91	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(b)fluoranthene	2013/09/25	81	30 - 130	90	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(g,h,i)perylene	2013/09/25	97	30 - 130	100	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(j)fluoranthene	2013/09/25	82	30 - 130	93	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Benzo(k)fluoranthene	2013/09/25	90	30 - 130	98	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Chrysene	2013/09/25	96	30 - 130	104	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Dibenz(a,h)anthracene	2013/09/25	79	30 - 130	81	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Fluoranthene	2013/09/25	92	30 - 130	98	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Fluorene	2013/09/25	96	30 - 130	105	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Indeno(1,2,3-cd)pyrene	2013/09/25	82	30 - 130	90	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Naphthalene	2013/09/25	90	30 - 130	98	30 - 130	ND, RDL=0.20	ug/L	NC	40		
3361938	Perylene	2013/09/25	84	30 - 130	95	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Phenanthrene	2013/09/25	100	30 - 130	110	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3361938	Pyrene	2013/09/25	93	30 - 130	100	30 - 130	ND, RDL=0.010	ug/L	NC	40		
3363886	Nitrogen (Ammonia Nitrogen)	2013/09/26	97	80 - 120	101	80 - 120	ND, RDL=0.050	mg/L	NC	25		
3364577	Turbidity	2013/09/27					ND, RDL=0.10	NTU	4.6	25	99	80 - 120
3365348	Total Alkalinity (Total as CaCO3)	2013/09/27	NC	80 - 120	98	80 - 120	ND, RDL=5.0	mg/L	0.9	25		
3365350	Dissolved Chloride (Cl)	2013/09/30	103	80 - 120	97	80 - 120	ND, RDL=1.0	mg/L	NC	25	103	80 - 120
3365351	Dissolved Sulphate (SO4)	2013/09/27	NC	80 - 120	99	80 - 120	ND, RDL=2.0	mg/L	5.6	25		
3365352	Reactive Silica (SiO2)	2013/09/27	NC	80 - 120	96	80 - 120	ND, RDL=0.50	mg/L	1.3	25		
3365353	Colour	2013/09/27					ND, RDL=5.0	TCU	NC	25	105	80 - 120
3365354	Orthophosphate (P)	2013/09/27	94	80 - 120	96	80 - 120	ND, RDL=0.010	mg/L	NC	25		
3365356	Nitrate + Nitrite	2013/09/27	93	80 - 120	96	80 - 120	ND, RDL=0.050	mg/L	NC	25		
3365357	Nitrite (N)	2013/09/28	96	80 - 120	96	80 - 120	ND, RDL=0.010	mg/L	NC	25		
3365453	pH	2013/09/27							0.1	25	101	80 - 120
3365456	Conductivity	2013/09/27			99	80 - 120	ND, RDL=1.0	uS/cm	0.6	25		
3366048	Total Organic Carbon (C)	2013/09/30	NC	80 - 120	88	80 - 120	ND, RDL=0.50	mg/L	2.4	25		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Maxxam Job #: B3G0030
Report Date: 2013/10/01

Stantec Consulting Ltd
Client Project #: 121412783
Site Location: CCG TEST WELL
Your P.O. #: 16300R-20
Sampler Initials: MJM

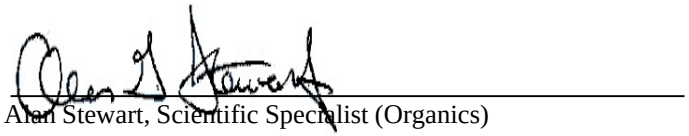
to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - PAH sample contained sediment.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca

Validation Signature Page

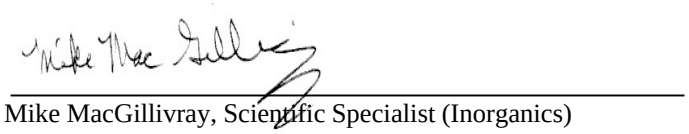
Maxxam Job #: B3G0030

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Alan Stewart, Scientific Specialist (Organics)

Eric Dearman, Scientific Specialist



Mike MacGillivray, Scientific Specialist (Inorganics)

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax:709-754-8612 www.maxxam.ca