Government of Yukon – Community Services

COMPLETION REPORT FOR WARM WATER WELL KFN-L BURWASH LANDING, YUKON

REPORT

DECEMBER 2012
ISSUED FOR USE
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EXECUTIVE SUMMARY

EBA Engineering Consultants Ltd., operating as EBA, A Tetra Tech Company (EBA), coordinated the drilling, construction, and testing of the deep test water well KFN-L for Government of Yukon, Community Services (YG) and Kluane First Nation (KFN). The scope of work for this project included a review of available lithological and hydrogeological information, preparing specifications for drilling, well construction and testing, overseeing well drilling, construction and testing, data analysis, and reporting.

The purpose of this project was to drill an exploration well to a maximum depth of 460 m (1,500 ft) to determine the presence and quality of warm water from a deep aquifer for potential future use as a water supply well or for district heating applications.

The test well was successfully completed at a depth of 387.4 m (1,271 ft) below ground surface (bgs) in a sand aquifer producing water at a temperature of about 16°C. The well was terminated at a depth shallower than the anticipated maximum depth of 460 m because of the encounter of a warm water aquifer and because the borehole could not be further advanced using the drilling method applied. Hydraulic test results from an 8-hour step drawdown and a 72-hour constant rate pumping test completed on the new well show that it is completed within a highly productive aquifer (compared with typical aquifers in Yukon). The theoretical long-term sustainable yield for the well based on projection of the water level drawdown to 100 days is 16 L/s (254 USgpm). However, the maximum recommended pumping rate is 6.3 L/s (100 USgpm) as limited by the well screen transmitting capacity. This recommended pumping rate may somewhat limit the operational utility of this test well for geoexchange use. Future production wells could be designed for higher flows if needed.

Laboratory results indicate that the raw water quality from samples obtained from KFN-L met the Guidelines for Canadian Drinking Water Quality (GCDWQ) for health based parameters and aesthetic objectives on the date sampled, except for arsenic which exceeded the maximum allowable concentration of 0.010 mg/L. If the well will be used for potable water supply, the well water should be re-tested prior to commissioning and if the exceedance of the arsenic guideline value is confirmed, we recommend that appropriate treatment of the water be carried out to ensure the water meets all health-based Canadian drinking water guidelines before it is used for human consumption.

The recommended pump configuration will depend on the intended use and pumping rate for this well. The pump should be installed at a depth suitable for the available drawdown and to enhance well performance. However, the pump should be installed no deeper than about 5 m above the top of the well screen.

Information for this well is summarized below.

Well Information Summary

Well ID	**KFN-L**
Date of Completion	August 20, 2012
Static Water Level (August 24, 2012)	Artesian flowing: <1 psi (at the well head)
Recommended Long Term Safe Yield	6.3 L/s
Depth to Top of Screen	384.0 m bgs
Well Casing Diameter (ID)	155.6 mm
Screen Length	3.35 m
Name of Drilling Contractor	Fyfe Well and Water

m bgs – metres below ground surface

A detailed feasibility assessment of the potential use of well KFN-L for geoexchange heating applications was beyond the scope of services for this project. However, EBA recommends that a Geoexchange Suitability Assessment be completed based on the results of the successful completion of KFN-L. This assessment should include, but not necessarily be limited to, a review of the heating demands of buildings to be potentially included in a future geoexchange district heating system, a geoexchange and geochemical assessment of the well water from KFN-L, a review of the well capacity, and the assessment and discussion of different geoexchange district heating options for Burwash Landing.

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1.0 INTRODUCTION AND SCOPE

EBA Engineering Consultants Ltd., operating as EBA, A Tetra Tech Company (EBA), was retained by Government of Yukon – Community Services (YG) to provide hydrogeological consulting and project management services for the installation of a deep test water well for Kluane First Nation (KFN) in Burwash Landing, Yukon. A site location map is provided as Figure 1 and a detailed site plan is included as Figure 2.

The purpose of this project was (i) to investigate the potential for accessing geoexchange resources for heating purposes and (ii) to drill a test well that can potentially be used as a backup water supply well for the community of Burwash Landing. A deep well drilled to a maximum depth of 460 m (1,500 ft) was intended to explore the presence and quality of a warm water aquifer below Burwash Landing potentially suitable for development of geoexchange heating uses or backup community water supply.

The scope of work for this project included the following tasks which are documented in this report:

- Provide recommendations on well location (see memo in Appendix B dated December 13, 2010);
- Prepare well drilling, construction, and testing specifications (see memo in Appendix B dated October 2010)
- Prepare YESAA project proposal (see YESAA project proposal, information request response, and decision document in Appendix B)
- Assist with selecting a drilling and pumping test contractor;
- Prepare contingency plans for the case of onsite spills or artesian aquifers (see memos in Appendix B dated July 13, 2012);
- Coordinate and oversee well drilling, construction and hydraulic testing;
- Provide a summary of work completed (see memo in Appendix B dated, August 29, 2012);
- Analyse and interpret project data ; and,
- Prepare this well completion report.

2.0 FIELD PROGRAM

2.1 Well Location Selection

EBA staff in consultation with YG and KFN representatives carefully choose the drill location for this project. Factors considered included proximity to community buildings, potential for contamination of existing drinking water wells, land ownership, and potential for damage to the area surrounding the well in the case of flowing well conditions. EBA memo TM-1-REV1 (included in Appendix B) describes three drill site options. Option number three was chosen at EBA's recommendation in consultation with KFN and YG. The decision was based upon land ownership by KFN, location at a sufficient distance from community wells to minimize risk of affecting them, and location at a sufficient distance from community

infrastructure that any artesian flow should not cause damage. The well site before drilling and during the final pumping testing are shown in Photos 1 and 2.

2.2 Well Drilling and Construction

KFN-L was drilled from July 24 to August 15, 2012 by Fyfe Well and Water Services (Fyfe) of Qualicum Beach, British Columbia using a combination of dual air rotary and mud rotary drilling methods. During drilling EBA representative, Sarah Sternbergh, EIT was onsite to observe work completed and record drilling performance and subsurface conditions encountered.

Figure 3 summarizes the subsurface conditions encountered at KFN-L. Representative soil samples were collected at lithological contacts and about every 6 m (20 ft) during mud rotary drilling, and every 0.9-1.5 m (3-5 ft) while air rotary drilling.

Permafrost was not identifiable in this borehole due to the mud rotary drilling method. . It is likely that permafrost exists from about 2 to 55 m depth bgs, based on the well record for a cold water supply well (KFN-K)_drilled nearby (reported separately to YG). Several aquifer and possible aquifer zones were encountered in KFN-L. Figure 3 shows a summary of aquifers and lithology encountered.

A 305 mm hole (12 inch) was drilled to 85.3 m bgs. A 219 mm OD/206 mm ID (8.6 inch OD/8.1 inch ID) casing was installed to 84.1 m bgs inside the 12-inch hole, and a cement seal was installed in the open annulus between the 12-inch hole and the 8-inch casing. An 8-inch borehole was then advanced using mud rotary drilling to 384.0 m bgs (1,260 ft). Inside the 8 inch borehole, a 168 mm OD/155.6 mm ID casing (6.6 inch OD/6.1 inch ID) was installed to 384.0 m bgs (1,260 ft). A 6-inch borehole was advanced to 387.4 m bgs (1,271 ft) using air rotary drilling. At 384.0 m (1,260 ft), an artesian aquifer was encountered in an unit consisting of sand with trace silt. Fyfe attempted to advance the casing using an eccentric 8-inch bit; however the 6-inch casing was found to be jammed and could not be advanced any further. A decision was made by EBA after consultation with Fyfe and YG to terminate the hole at 387.4 m bgs (1,271 ft).

From about 89.3 to 90.5 m (293 to 297 ft) an artesian aquifer was encountered, and upon cementing in the 12 inch surface seal, this aquifer was allowed to flow through the 8 inch casing. The aquifer was controlled by a valve at the surface casing and equipped with a pressure gauge. Pressure changes in this zone during pump testing at KFN-K and pressure changes observed in KFN-K when this zone was allowed to flow, indicate that this aquifer is hydraulically connected to a shallow aquifer encountered in KFN-K.

EBA conducted a field particle size analysis on samples obtained at 385 and 387.4 m bgs (1,263 and 1,272 ft). Particle size distribution results from these samples are included in Appendix C and indicate that the aquifer material is sand with trace silt. Based on these results, a well screen consisting of 3.35 m (11 ft) of 0.010 in (10 slot) Variperm telescopic V-wire well screen was installed from 384.0 to 387.4 m bgs (1,260 to 1,271 ft). The well screen prior to installation is shown in Photo 3.

The well was developed for approximately 8 hours by air lifting and 8 hours by water jetting. The well development was stopped after 16 hours when the visual clarity of the water and measured turbidity <1 NTU had dropped to acceptable levels. Turbidity measured in this well after the 72 hour pumping test was found to be 0.25 NTU.

The final wellhead construction consists of an 8-inch casing extending to 0.34 m (1.1 ft) above ground surface (ags) with a valve and pressure gauge assembly, and a 6 inch casing extending to 0.68 m (2.2 ft) ags also with a valve and pressure gauge assembly. The 8 inch casing is fed by the shallow cold artesian aquifer and the 6 inch casing is fed by the deep warm artesian aquifer. The wellhead is shown in Photo 4. Construction details for KFN-L are included in Figure 3, and a drillers log is attached in Appendix D.

A summary of the relevant well construction details is presented below in Table 1.

Table 1: Summary of Well Information and Construction Details for KFN-L

Date of construction:	July 16-24, 2012
Owner of the well:	Kluane First Nation
Description of the property:	Burwash Landing, Fire Break line
UTM Coordinates (Nad 83):	UTM Zone 07 V E 0608123 N 6803843
Location of well on the property:	See Figure 2
Drilling contractor:	Fyfe Well and Water Services, Qualicum Beach, British Columbia
Method of construction:	Dual Air/Mud Rotary
Description, depth, and thickness of geologic materials encountered during construction:	See well log in Figure 3 and drillers well log in Appendix D.
Depth and diameter of the well:	Total depth of well completion is 387.4 m (1,271 ft) bgs and diameter of well is 168 mm OD/155.6 ID (6.6 inch OD/6.1 inch ID). Construction details are included on Figure 3.
Type of casing materials and thickness:	Steel casing – 6.35 mm (0.250 in.) wall thickness
Static water level:	Artesian, <1 psi (August 23, 2012)
Type, size, length and location of the screen:	Variperm telescopic V-wire screen 10-slot (0.305 mm/0.010 inches) from 384.0 to 387.4 m (1,260 to 1,271 ft) bgs; Total screen length is 3.35 m (11 ft).
Location of major water-bearing zones:	Water-bearing sand and gravel aquifer from about 384.0-387.4 m (1,260 to 1,271 ft) bgs.
Location, type and thickness of grout sealant placed around the well:	A cement surface seal with a radial thickness of 2 inch was installed around the 8-inch casing from grade to 84.1 m (276 ft) bgs.
Details of shallow sampling port	Casing - 219 mm (8.6 in) OD/206 mm (8.1 in) ID, 6.35 mm (0.25 in) thickness to 84.1 m (276 ft) bgs; Shallow aquifer from 89.3 to 90.5 m (293 to 297 ft) bgs.

3.0 WELL AND AQUIFER TESTING

3.1.1 Hydraulic Testing Method

Step drawdown and constant rate hydraulic tests were conducted from August 19-23, 2012 by Fyfe and overseen by EBA. A temporary submersible pump was installed in the well with the intake positioned about 70 m (230 ft) bgs. A pressure transducer was deployed in this well, and in KFN-K for the duration of the 72-hour constant rate pumping test. A barologger was used to record barometric pressure at the wellhead for the duration of the test. This data was recorded to allow barometric correction of the water level data.

Fyfe collected manual groundwater level measurements at specific intervals for both step and constant rate tests. As well, pumping rates were recorded by a digital flow meter installed at the wellhead.

Field water quality parameters and temperature measurements were recorded by EBA at several times during the 72-hour constant rate pumping test. Manual data collected during the pumping tests are included in Appendix E.

Water from the test was conveyed to a sump atthe drill site, where it then flowed into the drainage ditch just south of the drill pad and away from the site. Given the inferred thick permafrost and the low-permability of strata overlying the aquifer tested, it is very unlikely that the sump or drainage ditches had any hydraulic effect on the well response during hydraulic testing.

3.1.2 Step Rate Pumping Test

A step rate pumping test consisting of four 2-hour steps of nominally 25, 50, 75 and 100 USgpm was completed on August 19, 2012. The drawdown data from the step rate pumping test is shown in Figure 4a. The maximum drawdown observed at the end of the 100 USgpm was 28.1 m.

A pumping rate of 55 USgpm from any water well is the maximum allowed in Yukon without a regulatory approval through a Type B Water Licence. After completing the step rate test, EBA determined that the well could be pumped at this 55 USgpm for the 72 hour constant rate test without the risk of drawing the groundwater level to the depth of the pump intake. Even though the well could have been pumped at a higher rate, for expediency EBA in consultation with YG decided to set the constant rate pumping rate at 55 USgpm. A higher pump rate would have required regulatory approval through a Water Licence.

3.1.3 Constant Rate Pumping Test

A constant rate pumping test was conducted from August 20-23, 2012 after the well had recovered to a stable flowing condition following the step rate pumping test. The drawdown observed during the constant rate pumping test is shown in Figure 4b. The well was pumped at 55 USgpm for 72 hours, and the maximum drawdown observed during the test was 14.5 m. The groundwater level recovered to a stable flowing condition after 12.5 minutes. The fast recovery suggests a transmissive aquifer was feeding water to the well.

3.2 Water Sample Collection

EBA collected water samples for chemical and radiological analysis from KFN-L on August 24, 2012 after 71.5 hours of pumping. Samples were only collected for routine water potability analysis. A more detailed hydrogeochemical and microbiological characterization of the well water with respect to the potential use in a geoexchange system was beyond the scope of this project but is recommended to be included in a future geoexchange suitability assessment.

The samples were collected in laboratory supplied sample bottles in accordance with laboratory sampling procedures. Samples were transported to Whitehorse by EBA personnel.

Chemistry samples were then shipped on ice by air cargo to Exova in Surrey, B.C., for chemical analysis. The Exova laboratory in Surrey is an accredited ISO/IEC 17025 testing laboratory.

Samples collected for radiological analysis (gross alpha/beta radiation) were shipped on ice by air cargo to SRC Laboratories for analysis.

A bacteriological sample was collected from KFN-L on August 22, 2012 during the constant rate pumping test and analyzed by Yukon Environmental Health in Whitehorse, Yukon. The sample was collected on a different day than the other samples to ensure submission of the sample to the laboratory within the 24 hour holding time for bacteriological samples.

4.0 HYDRAULIC TESTING RESULTS AND ANALYSIS

4.1 Pumping Test Results

Water levels recorded during the step and constant rate pumping tests completed on KFN-L are shown in Figures 4a and 4b. The maximum drawdown observed during the constant rate pumping test was 14.5 m (47.6 ft) and remained fairly constant throughout the duration of the test. Recovery of the groundwater level to stable pre-test flowing conditions occurred within 12.5 minutes.

A datalogger was installed in KFN-K during this pumping test to record any water level changes associated with pumping of this aquifer. The data shows no drawdown in KFN-K during the pumping of KFN-L. The results therefore indicate that there is no signififcant hydraulic connection between the deep warm water aquifer intersected in KFN-L and the shallow cold water aquifer that KFN-K is completed in. The data further suggest that there is also a proper seal between the same two aquifer that were both intersected in KFN-L and that there is no preferential pathway with measureable hydraulic connection between the aquifers along the 6-inch casing.

The pumping test data were analyzed using the Theis recovery and Cooper-Jacob Straight-Line Time-Drawdown Methods (e.g., Fetter 2001) which are considered appropriate for the aquifer conditions encountered in this well. Both interpretation methods were applied using the software AquiferTest (by WHI, v3.5), which was used to analyze the pumping test data (see Appendix F).

The results of the pumping test are presented in Table 2. The calculated hydraulic conductivity of about 3×10^{-4} m/s is typical for sand deposits such as those encountered in the KFN-L well.

Table 2: Pumping Test Results

Well	Method	T [m^2/s]	K [m/s]
KFN-L	Theis Recovery	6.35E-04	1.89E-04
	Copper- Jacob Time Drawdown	1.12E-03	3.35E-04
	Mean	**9E-04**	**3E-04**

4.2 Well Capacity

The safe yield of a well is determined by the available drawdown above the pump intake, the capacity of the screen installed in the well, and the transmissivity of the aquifer around the well screen.

To calculate the safe yield of the wells, the 100-day specific capacity was multiplied by the safe available drawdown. The 100-day specific capacity of the well (at a given pumping rate) is based on the projection of the observed drawdown at the end of the constant rate pumping test extrapolated to 100 days as shown on Figure 5. This conservatively assumes that the well would be continuously pumped at the same rate for 100 days with no recharge to the aquifer. The safe available drawdown of a well is determined by applying a safety factor of 70% to the physical available drawdown after an allowance has been made for seasonal fluctuations in static water level.

The safe yield of a well screen is based on the maximum recommended screen entrance velocity of 0.03 m/s (0.1 ft/s). Table 3 details the safe yield calculations for KFN-L.

Based on the graphical analysis shown in Figure 5, the long-term theoretical sustainable yield of KFN-L would be 16 L/s (254 USgpm) based on an assumed depth of 100 m for the pump installation. However, at this pumping rate, the screen entrance velocity would be greater than the recommended maximum screen entrance velocity of 0.03 m/s; thus the recommended maximum sustainable yield of the well is limited to 6.3 L/s (100 USgpm) as determined by the safe transmitting capacity of the well screen.

As the constant rate pumping test was conducted at 3.5 L/s (55 USgpm), EBA recommends pumping this well at a rate no higher than 3.5 L/s. If higher rates are desired, a long-term pumping test at the desired rate higher than 3.5 L/s (but not exceeding 6.3 L/s) should be conducted. The short-term (hourly) capacity of the well will depend on the exact depth of pump intake installation and the fluctuations in static water level.

Table 3: Summary of Safe Yield Calculations

WELL PARAMETER	VALUE	UNIT	KEY
Constant Rate Pumping Test Discharge Rate	3.47	L/s	a
Projected 100-Day Drawdown	15	m	b
Projected 100-Day Specific Capacity	0.231	L/s/m	c=a/b
Lowest Expected Seasonal Water Table (2 m below static)	1.35	m	d
Depth of Pump Intake[1]	100	m	e
Available Drawdown	98.65	m	f = e-d
Safety Factor	70	%	g
Safe Available Drawdown	69	m	h = f x g
Safe Yield Based on Constant Rate Pumping Test			
Theoretical Sustainable Yield	16	L/s	i = c x h
Theoretical Sustainable Yield	254	USgpm	
Check for Screen Entrance Velocity			
Recommended Maximum Screen Entrance Velocity	0.03	m/s	v
Intake Area (m^2) of 3.35 m of 10 slot screen	0.21	m^2	j
Screen Entrance Velocity at Safe Estimated Sustainable Yield	0.08	m/s	(i/1000/j)
Check: Less than recommended maximum velocity	NO		
Recommended Safe Yield Based on Screen Transmitting Capacity			
Recommended Sustainable Yield	**6.3**	L/s	v x 1000 x j
Recommended Sustainable Yield	**100**	USgpm	

[1] Assumed depth for pump installation

5.0 RESULTS OF LABORATORY ANALYSIS

Groundwater analytical results and a comparison with Guidelines for Canadian Drinking Water Quality (GCDWQ) are presented in Table 4, attached. The laboratory reports and certificates are included as Appendix G. For reference, the laboratory results for water from KFN-K are also included in Table 4 (these results discussed in a separate report). To evaluate the quality of the analysis, EBA calculated the ion balance (i.e., the balance between the sums of anion and cation equivalent charges). Usually, an ion balance of within ±10% is considered satisfactory. The calculated ion balance ranging up to 4.2% suggests that analytical errors are within acceptable limits and all major cations and anions present in the sample water were analyzed.

The water sample from KFN-L is very hard and can be characterized as magnesium-sodium-calcium-bicarbonate (Mg-Na-Ca-HCO_3) type water.

Based on the analytical results for the water samples collected on August 24, 2012, the water from the well exceeded the GCDWQ Maximum Allowable Concentration (MAC) for arsenic and the aesthetic objectives (AO) for temperature, colour, and iron (see Table 4). All other parameters tested met the GCDWQ at the dates of sample collection.

A bacteriological sample taken from the well on August 22, 2012 was submitted to the Environmental Health Services department. Sample results showed no presence of total coliforms or *E.coli* on the date sampled.

Sample results for radiological parameters are still pending and will be incorporated into the Issued for Use verison of the report to be submitted upon receipt of the outstanding laboratory report.

6.0 GROUNDWATER UNDER THE DIRECT INFLUENCE (GUDI) ASSESSMENT

Well water or groundwater under the direct influence of surface water (GUDI) refers to groundwater sources that have a direct hydraulic connection to surface water sources and are therefore vulnerable to contamination by surface water organisms. The implication of a well being classified GUDI means that the well water source requires water treatment equivalent to that required for surface water sources.

EBA conducted a Phase 1 Initial GUDI Screening and determined that the KFN-L can likely be considered non-GUDI according to the guidelines outlined in YG (2006). The following criteria were considered in the Phase 1 Initial GUDI Screening:

- The aquifer is confined and overlain by thick permafrost and more than 200 m of low-permebaility silt and clay units. Furthermore, the aquifer is artesian with a pressure of <1 psi at the well head. Both the artesian pressure, and the thick low-permability units and permafrost provide significant protection of the aquifer against potential contamination from surface sources;
- The well is located more than 60 m away from any permanent surface water bodies. However, water ponding has been observed in the vicinity of the well head and the site drainage should be improved to eliminate any standing water in the vicinity of the well;
- The well was constructed in accordance with the Guidelines for Water Well Construction published by the Canadian Ground Water Association, including a surface seal to a depth of about 84 m bgs;
- The water quality does not indicate any evidence for contamination with surface water.

7.0 SUMMARY AND CONCLUSIONS

The following summary and conclusions are based on the information presented in this well completion report:

- In July and August 2012, the test well KFN-L was drilled for Kluane First Nation in Burwash Landing, Yukon to a depth of 387.4 m (bgs, and a screen was set from 384.0 to 387.4 m bgs within a confined artesian aquifer hosted in a sand aquifer;
- The well was constructed in accordance with the Public Drinking Water Regulations and the Canadian Groundwater Association's Well Construction Guidelines;
- The well produced water at a temperature of 15.9°C during the 72-hour constant rate pumping test;

- Pumping test results from the well indicate an aquifer transmissivity in the order of 9×10^{-4} m^2/s (78 m^2/day);
- The recommended long term safe yield of KFN-L is 6.3 L/s (100 USgpm) based on the transmitting capacity of the well screen. Higher yields might be obtained if needed from larger diameter production wells designed with larger screen capacities;
- The groundwater piezometric head in KFN-K was not affected by the pumping test conducted on KFN-L, suggesting that the shallow cold water and deep warm water aquifers are not hydraulically connected;
- Water from the well exceeded the GCDWQ MAC for arsenic and the AO for temperature, colour, and iron. All other parameters tested met the GCDWQ on the date of sample collection. Bacteriological analysis indicated no total coliforms or *E.Coli* on the data sampled;
- The warm water aquifer encountered in KFN-L is promising as a potential source of warm water for geoexchange heating purposes. Detailed feasibility of geoexchange potential is beyond the scope of this study, but is part of recommendations below.

8.0 RECOMMENDATIONS

EBA makes the following recommendations to further assess the suitability of the well and well water for geoexchange applications, backup water supply, and to protect the well from freezing:

Geoexchange Suitability Assessment

- A Phase 2 Geoexchange Suitability Assessment should be conducted to assess the suitability of the warm water aquifer intersected in KFN-L for geoexchange applications. This study should include, but not necessarily be limited to:
  - Geochemical characterization of the well water from KFN-L with repect to its suitability for geoexchange applications;
  - Demand-side assessment of heating and cooling loads for buildings to be potentially included in a future district heating system;
  - Assessment of different geoexchange heating options.

Well Commissioning for Potable Water Supply

Although KFN-L was completed in a productive aquifer, the chemical composition of the well water is less favourable for the potential use of the well as a backup community water supply when compared to the shallow, cold water well KFN-K. KFN-K is also highly productive but the water is less mineralized and would likely require less treatment than water from KFN-L. However, if KFN-L was going to be used as a drinking water supply well, the following recommendations should be taken into consideration.

- The well should be disinfected ("shock chlorinated") prior to commissioning;
- KFN-K should be re-sampled to verify the concentration of arsenic that previously exceeded the MAC as defined by the GCDWQ;

- If arsenic proves to be elevated above the GCDWQ MAC, we recommend that the well water be treated to lower the arsenic value below the MAC of 0.010 mg/L using appropriate water treatment before the well water is used for human consumption;
- The water quality should be monitored again in one year. If the well is used for a long term water supply, it should be sampled every five years in accordance with the guidelines for Public Drinking Water Regulations to ensure that all health-based parameters meet the drinking water guidelines; and,
- Any alterations to the well should be in compliance with the Public Drinking Water Regulations and the Canadian Groundwater Association's Guidelines for Water Well Construction (CGWA 1995).

Well Maintenance and Wellhead Protection

- To ensure the well does not freeze over winter the well should be equipped with heat trace or allowed to bleed (vent a small amount of flow by opening the valve at the top of the casing and direct the water to an area for safe disposal).
- The wellhead should be protected as detailed in EBA's memo dated August 29, 2012, including:
  - Re-grade site to ensure drainage is away from the wellheads;
  - Backfill sumps;
  - Remove sump pump equipment from the site;
  - Install either fencing around the site or wellhead protection such as bollards to protect wells from damage due to vehicle access to the site;
  - Install heat trace into both wellheads to ensure that wells are maintained in a thawed state through the winter;
  - Complete drainage upgrades in the vicinity of the site to ensure that ponding of water in the wellheadarea is prevented; and,
  - Update wellhead protection planning for Burwash Landing area to include KFN-K and KFN-L.

9.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon and their agents. EBA, A Tetra Tech Company does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Yukon Government or Kluane First Nation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

10.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Respectfully submitted,
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Canadian Groundwater Association (1995) Guidelines for Water Well Construction.

Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment (2012) Guidelines for Canadian Drinking Water Quality – Summary Table.

Fetter, C.W. (2001) Applied Hydrogeology. 4th edition, Prentice-Hall, Upper Saddle River, New Jersey.

Government of Yukon, Health and Social Services (2007) Guidelines for Part I – Large Public Drinking Water Systems.

Government of Yukon, Health and Social Services. (2006) Assessment Guideline for Well Water or Groundwater Under the Direct Influence of Surface Water (GUDI).

TABLES

Table 4 - Water Chemistry Results Summary

Parameter		Unit	Detection Limit	Well ID	KFN-K		KFN-L		Guidelines for Canadian Drinking Water Quality[1]
				Location (07V)	E 608130	N 6803842	E 608123	N 6803843	
				Sample Date	18-Jul-12	24-Aug-12	23-Aug-12		
				Results					
				Water Type	Mg-Na-HCO3	Mg-Na-HCO3	Mg-Na-Ca-HCO3		
				Ion Balance (%)	**0.2**	**-2.6**	**-4.2**		
Field Parameters									
Temperature	T	oC	-		1	1.9	15.9		15^{AO}
Dissolved O_2	DO2	mg/L	-		2.43	0.6	0		-
Electrical Conductivity	EC	uS/cm	-		418	368.9	948		-
Turbidity	TURB	NTU	-		0.19	0.24	0.25		-[2]
pH	pH	pH_Units	-		**8.83**	**8.83**	7.84		$6.5\text{-}8.5^{T}$
Total Dissolved Solids	TDS	mg/L	-		273.6	239.9	671.5		500^{AO}
Physical Parameters									
Colour	Colour	TCU	5		10	6	29		15^{AO}
Electrical Conductivity	EC	uS/cm	1		412	403	1060		-
Turbidity	TURB	NTU	0.1		1.1	<0.1	4.2		-[2]
pH	pH	pH_Units	0.01		8.15	8.1	7.5		$6.5\text{-}8.5^{T}$
Total Dissolved Solids	TDS	mg/L	1		271	264	725		500^{AO}
Total cholifoms/E-coli	BacT	Count	None		None	None	None		$None^{MAC}$
Non-metals/Anions									
Hardness	CaCO3	mg/L	1		158	150	406		-
Hydroxide	OH		5		<5	<5	<5		-
Alkalinity (total)	CaCO3		5		201	198	534		-
Nitrate	N		0.01		<0.01	<0.01	<0.1		10^{MAC}
Nitrite	N		0.01		0.17	0.06	<0.1		-
Sulfate	SO4		0.5		35.3	36.4	110		500^{AO}
Total Organic Carbon	TOC		0.5		1	1.1	1.1		-
Chloride	Cl		0.05		0.94	1.26	8.82		250^{AO}
Fluoride	Fl		0.01		0.32	0.38	<0.1		1.5^{MAC}
Carbonate	CO3		6		<6	<6	<6		-
Bicarbonate	HCO3		5		245	242	651		-
Metals									
Aluminum	Al	mg/L	0.005		<0.005	<0.005	<0.005		0.1^{MAC}
Antimony	Sb		0.0002		<0.0002	<0.0002	<0.0002		0.006^{MAC}
Arsenic	As		0.0002		**0.0121**	**0.0118**	**0.075**		0.01^{MAC}
Barium	Ba		0.001		0.037	0.036	0.047		1.0^{MAC}
Boron	B		0.005		0.501	0.525	0.53		5^{MAC}
Cadmium	Cd		0.00007		<0.00007	<0.00007	<0.00007		0.005^{MAC}
Calcium	Ca		0.1		18.9	17.6	55.5		-
Chromium	Cr		0.0005		0.0015	0.0019	0.007		0.05^{MAC}
Copper	Cu		0.001		<0.001	<0.001	<0.001		1^{MAC}
Iron	Fe		0.005		0.277	0.032	0.557		0.3^{AO}
Lead	Pb		0.0001		<0.0001	<0.0001	<0.0001		0.010^{MAC}
Magnesium	Mg		0.1		27	25.8	64.9		-
Manganese	Mn		0.001		0.032	0.026	0.029		0.05^{AO}
Mercury	Hg		0.00001		<0.00001	<0.00001	<0.00001		-
Potassium	K		0.1		4.3	3.7	3.5		-
Selenium	Se		0.0006		<0.0006	<0.0006	<0.0006		0.010^{MAC}
Silicon	Si		0.05		10.6	10.2	26.2		-
Sodium	Na		0.1		34.7	32.6	90.3		200^{AO}
Uranium	U		0.0005		<0.0005	<0.0005	<0.0005		0.02^{MAC}
Vanadium	V		0.0001		0.0006	0.0006	0.0025		-
Zinc	Zn		0.001		<0.001	0.043	0.393		5^{AO}
Radiological Parameters									
Gross Alpha	α	Bq/L				<0.20	<0.46		0.5^{MAC}
Gross Beta	β					0.15	<0.26		1.0^{MAC}

Bold - indicates parameter above GCDWQ MAC.

Underline - indicates parameter above GCDWQ AO.

[1] GCDWQ criteria are taken from the "Guidelines for Canadian Drinking Water Quality Summary Table, August 2012"

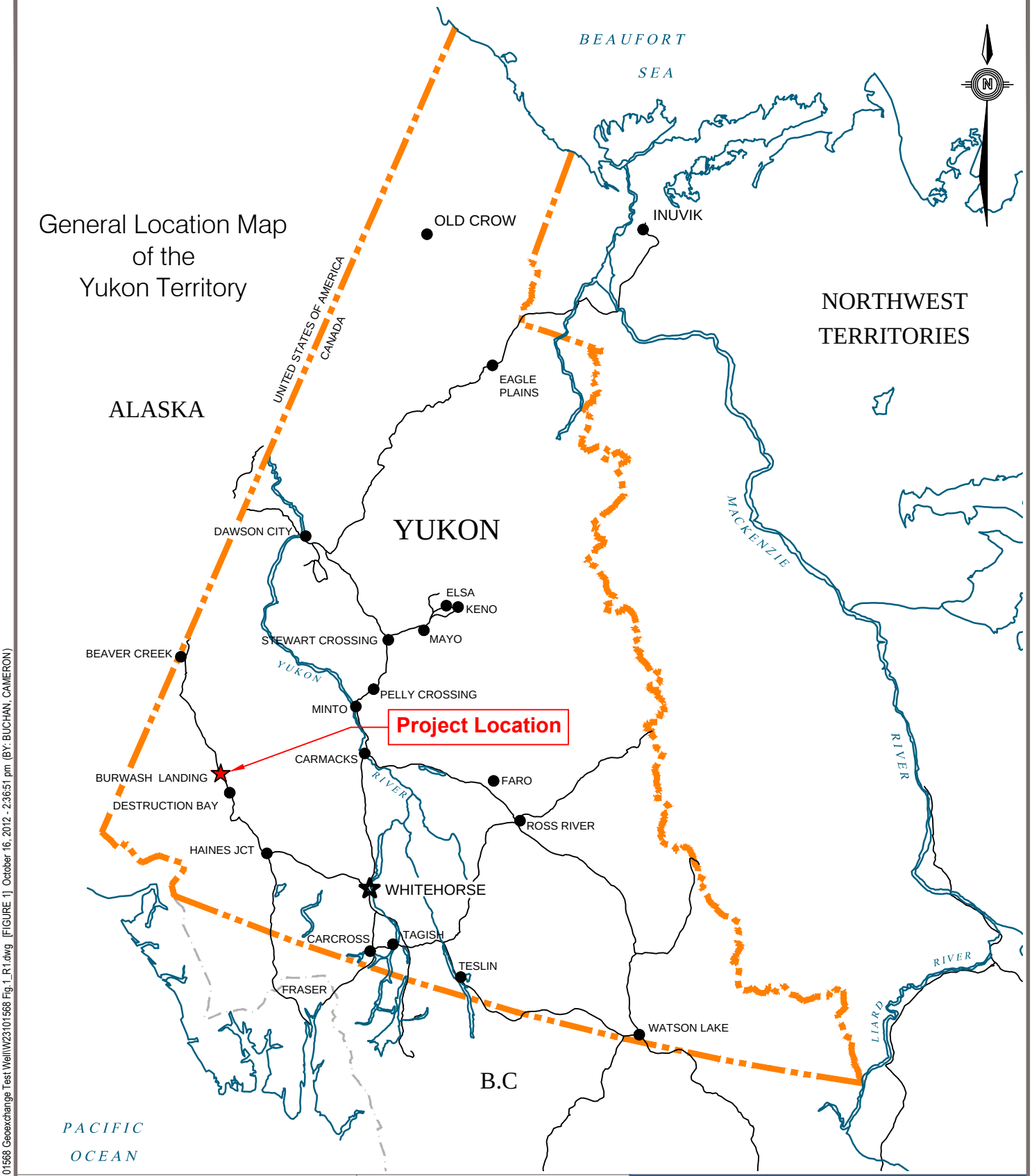
MAC refers to the Maximum Acceptable Concentration according to the GCDWQ criteria.

AO refers to the Aesthetic Objective according to the GCDWQ criteria.

T refers to treatment related parameters

[2] Regulations do not apply to unfiltered water

FIGURES



Q:\Whitehorse\Data\0201drawings\Burwash\W23101568 Geoexchange Test Well\W23101568 Fig.1_R1.dwg [FIGURE 1] October 16, 2012 - 2:36:51 pm (BY: BUCHAN, CAMERON)

CLIENT

Yukon Government

A TETRA TECH COMPANY

GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

SITE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

OFFICE	DATE
EBA-WHSE	October 3, 2012

Figure 1

Q:\Whitehorse\Data\0201drawings\Burwash\W23101568 Geoexchange Test Well\W23101568 Fig.2_R0.dwg [FIGURE 2] October 16, 2012 - 2:35:33 pm (BY: BUCHAN, CAMERON)

NOTE : THE IMAGERY CONTAINED ON THIS PLAN WAS ACQUIRED FROM GOOGLE EARTH PRO VERSION (DATED 2004)

LEGEND:

- WATER WELL LOCATION

0 200

Scale: 1: 4 000 (metres)

CLIENT

Yukon Government

A TETRA TECH COMPANY

GEOEXCHANGE TEST WELL - BURWASH LANDING, YUKON

SITE PLAN SHOWING WATER WELL LOCATIONS

PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

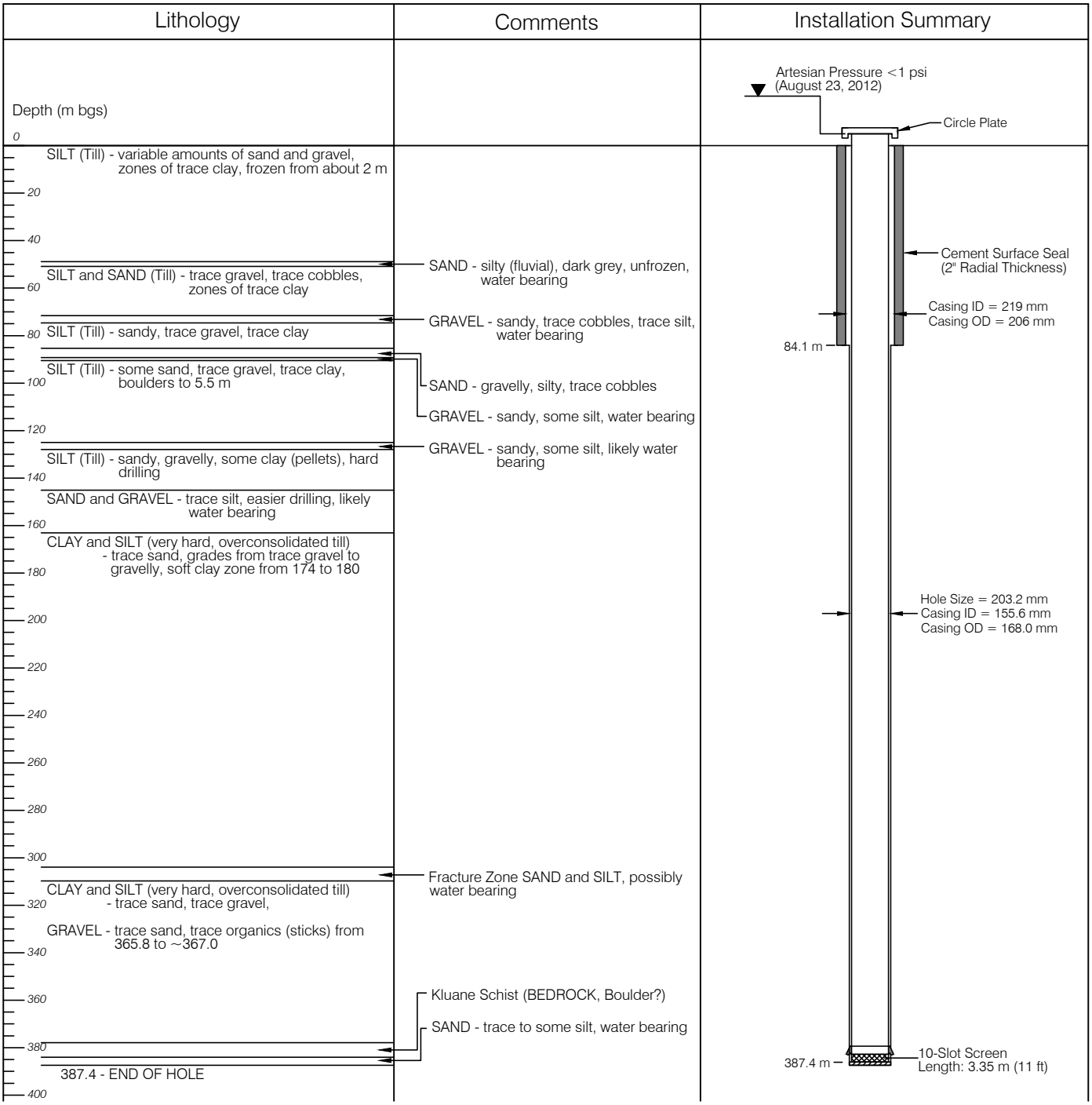
OFFICE	DATE
EBA-WHSE	October 5, 2012

Figure 2

BOREHOLE LOG

PROJECT NAME: Burwash Geoexchange Test Well
LOCATION: Burwash Landing, Yukon
CLIENT: Government of Yukon, Community Services
DRILL TYPE: Mud / Air Rotary
DRILL DATE: July 22, 2012

BOREHOLE NO.: KFN-L
PROJECT NO.: W23101568
UTM (NAD83, Zone 7): 6803843 N; 608123 E



CLIENT: Yukon Government

GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

WELL LOG KFN-L

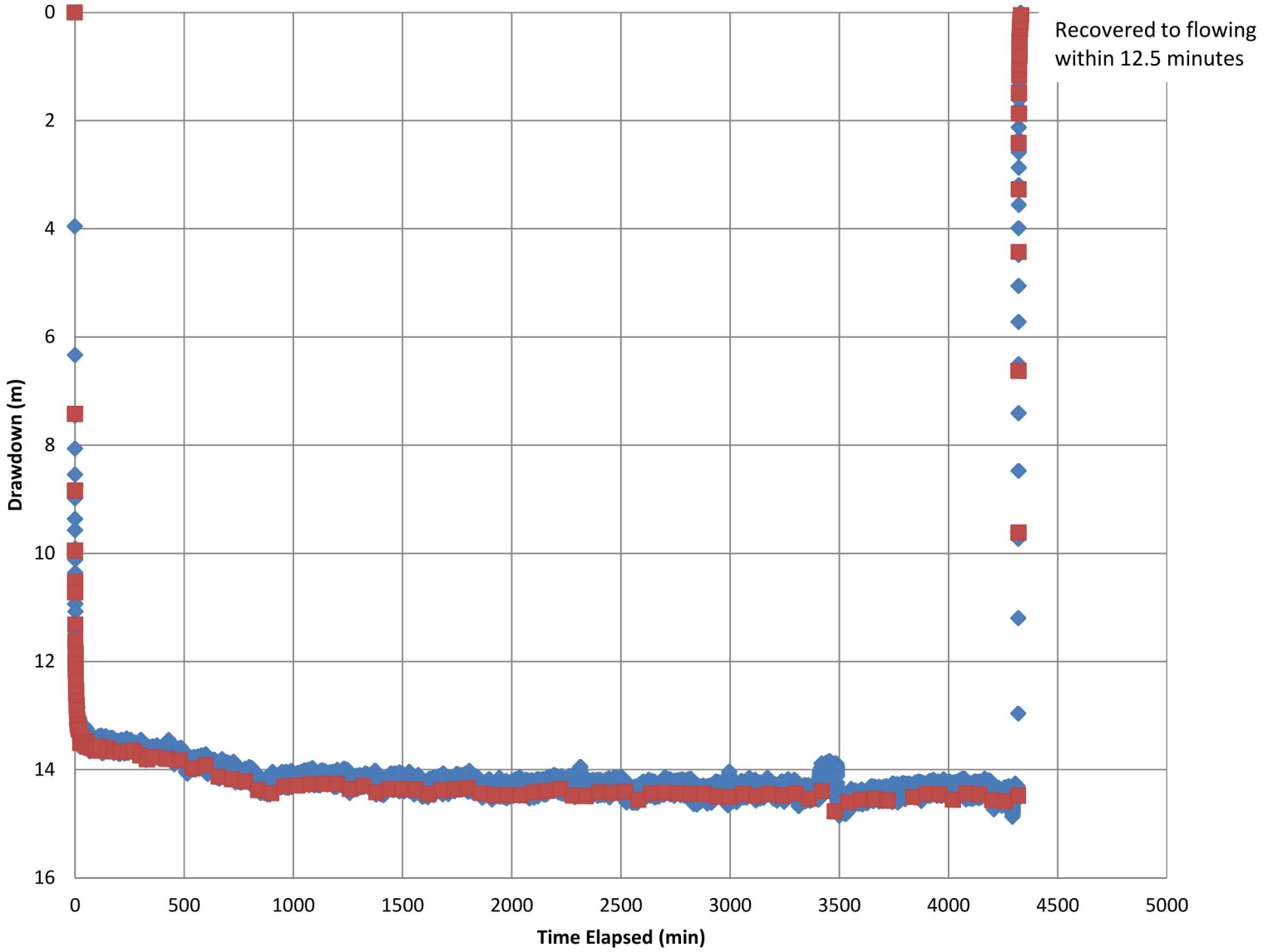
PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

OFFICE	DATE
EBA-WHSE	October 3, 2012

Figure 3

eba A TETRA TECH COMPANY

Q:\Whitehorse\Data\0201drawings\Burwash\W23101568 Geoexchange Test Well\W23101568 KFN-L Figs.3-5_R0.dwg [FIGURE 3] October 24, 2012 - 11:56:16 am (BY: BUCHAN, CAMERON)



LEGEND :

- KFN-L Levelogger (Barometric Pressure Corrected)
- KFN-L Manual Data

CLIENT

Yukon Government

A TETRA TECH COMPANY

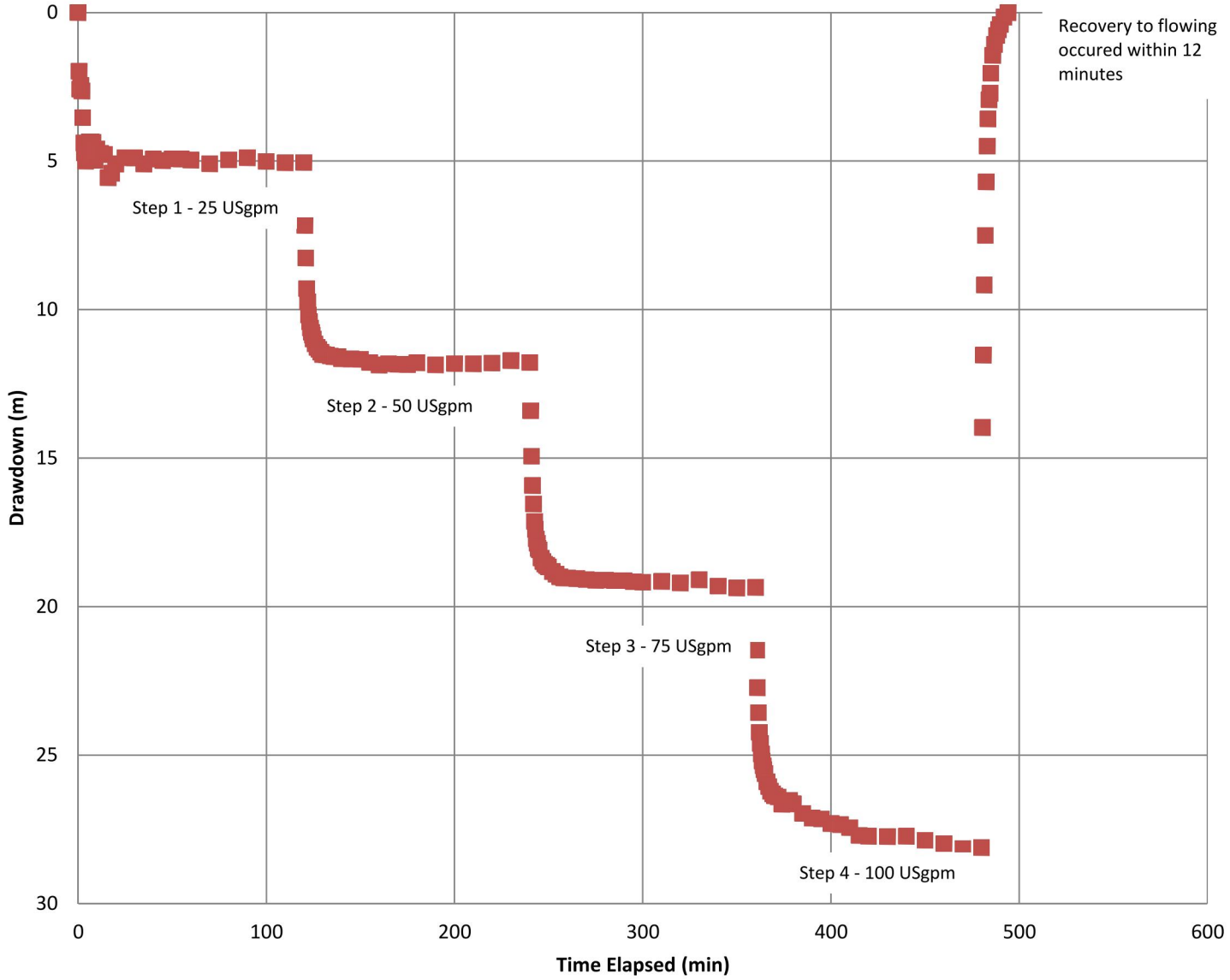
GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

KFN-L 72 HOUR CONSTANT RATE PUMPING TEST AND RECOVERY

PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

OFFICE	DATE
EBA-WHSE	October 3, 2012

Figure 4A



LEGEND :

KFN-L Manual Data

CLIENT

Yukon Government

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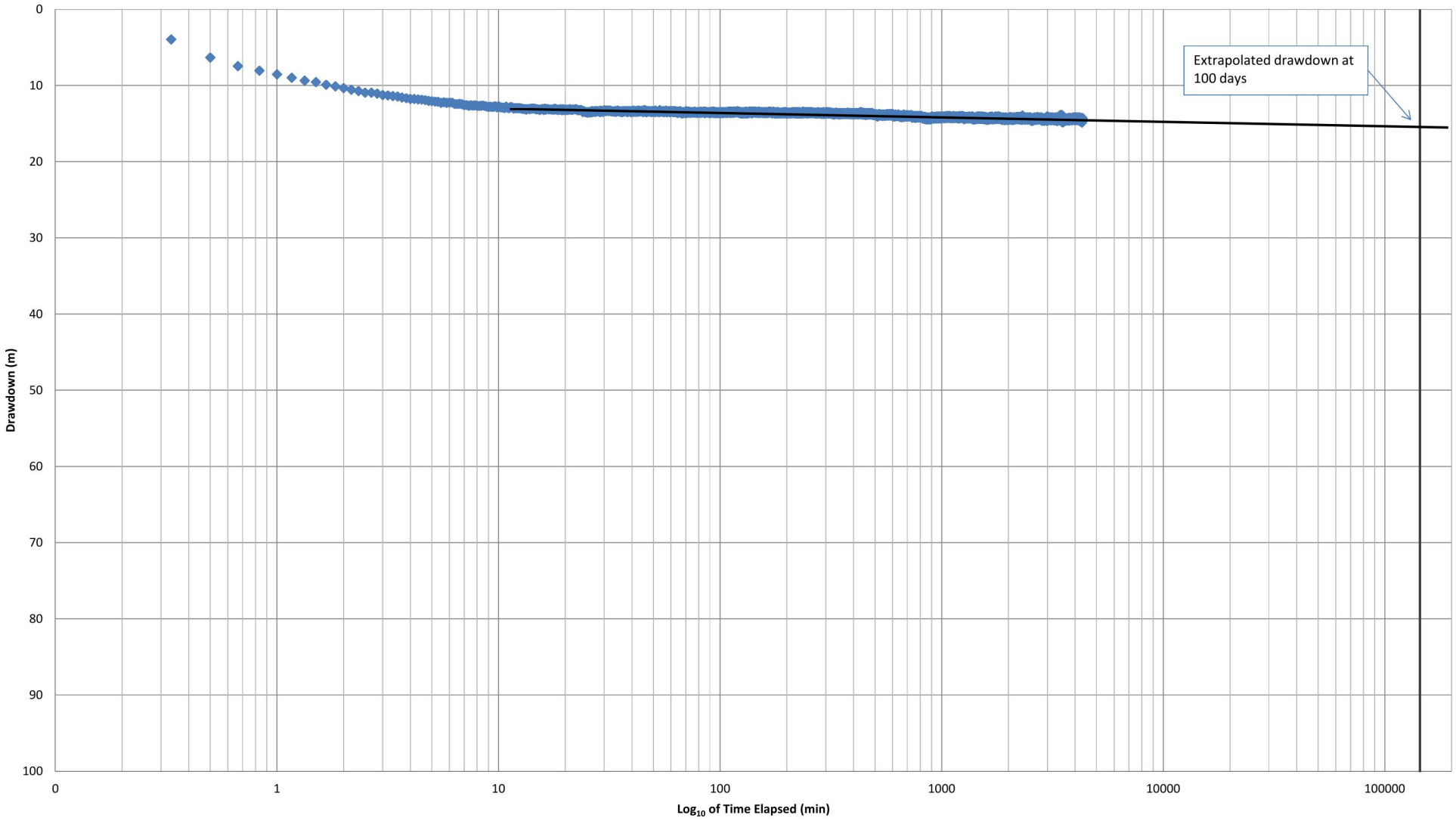
GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

KFN-L STEP TEST

PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

OFFICE	DATE
EBA-WHSE	October 3, 2012

Figure 4B



NOTE :
- Data has been corrected for Barometric Pressure

CLIENT
Yukon Government

A TETRA TECH COMPANY

GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

KFN-L DRAWDOWN VS LOG$_{10}$ TIME EXTRAPOLATED TO 100 DAYS - 72 HOUR CONSTANT RATE TEST

PROJECT NO.	DWN	CKD	REV
W23101568	CB	SKS	0

OFFICE	DATE
EBA-WHSE	October 3, 2012

Figure 5

PHOTOGRAPHS

Photo 1	Burwash geoexchange test well drill site prior to drill arrival. July 16, 2012
Photo 2	KFN-K and KFN-L during final pumping testing. August 23, 2012
Photo 3	KFN-L 10-slot well screen, riser and K-packer prior to installation. August 19, 2012
Photo 4	KFN-L wellhead after final pumping test. Note the two valves and pressure gauges. August 23, 2012.

Photo 1: Burwash geoexchange test well drill site prior to arrival of drill. July 16, 2012

Photo 2: KFN-K and KFN-L during final pumping testing. August 23, 2012

Photo 3: KFN-L 10-slot well screen, riser and K-packer prior to installation. August 19, 2012

Photo 4: KFN-L wellhead after final pumping test. Note the two valves and pressure gauges. August 23, 2012.

APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

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2.0 ALTERNATE REPORT FORMAT

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Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

APPENDIX B RELEVANT MEMOS

TECHNICAL MEMO

CREATING AND DELIVERING BETTER SOLUTIONS

www.eba.ca

TO:	Tom Renwick, Community Services, Government of Yukon	**DATE:**	December 13, 2010
C:		**MEMO NO:**	TM-1-REV1
FROM:	Stephan Klump, EBA	**FILE:**	W23101380
SUBJECT:	**Drill Site Location Options for Deep Geoexchange Test Well, Burwash Landing, Yukon**		

1.0 INTRODUCTION

EBA, A Tetra Tech Company (EBA) has been retained by the Government of Yukon (YG), Community Services, Community Infrastructure Branch to provide preliminary consulting services for a deep geoexchange test well drilling project. The intent of this project is to drill, construct, develop and hydraulically test a geoexchange test well in Burwash Landing, Yukon. The well will be used to evaluate the hydrogeological conditions and geothermal gradient at the site, and may also serve as a future supply well for geoexchange applications.

This technical memo summarizes the results of a site visit in Burwash Landing to assess options for a potential drill location. The site reconnaissance was conducted by YG representative Mr. Tom Renwick, Kluane First Nation (KFN) representatives Mr. Bob Dickson and Mr. Joe Bruneau, and EBA representatives Mr. Ryan Martin and Mr. Stephan Klump on October 20, 2010.

2.0 DRILLING METHOD

The drilling method to be used for this project must be able to penetrate all types of overburden sediments and bedrock to a maximum target depth of about 460 m (1500 ft). The drilling method must also be suitable to advance a borehole with a minimum terminal diameter of 152.4 mm (6") in overburden and bedrock under artesian conditions. Although hydrogeological conditions at depth greater than about 60 m below grade are unknown, artesian conditions are expected. The drilling method and auxiliary equipment must be able to control considerable artesian pressures and flowing wells.

EBA recommends using a truck-mounted mud rotary drilling method or possibly air rotary with the option of switching to mud rotary if artesian conditions are encountered and mud is required to control the well and advance the borehole. High density drilling mud such as barite should be kept on site during drilling in case it is required to bring a flowing well under control.

The contractor will also have to provide suitable grouting equipment to cement the casing and potentially grout the borehole in case a decision will be made to abandon the well.

EBA Engineering Consultants Ltd.
p. 867.668.3068 • f. 867.668.4349
Calcite Business Centre • Unit 6, 151 Industrial Road • Whitehorse, Yukon Y1A 2V3 • CANADA

3.0 DRILL PAD REQUIREMENTS

The drill pad required for this project should be about 30×30 m^2 of level solid ground. Additional stacking area will be required adjacent to the drill pad for well casing, supplies and equipment. There must be suitable road access for a truck-mounted drill rig, and supply and water trucks to both the drill pad and stacking area. Typical dimensions of a truck-mounted rotary drill (not including auxiliary equipment) would be approximately:

- Length: 12 m
- Width: 2.5 m
- Height: 4.5 m
- Weight: 35,000 kg

4.0 DRILL LOCATION

The selection of a drill location for this project should consider aspects including, but not necessarily limited to:

- Potential future design of district heating system;
- Distance to community buildings and other potential heat consumers;
- Access to and size of available land;
- Land tenure;
- Drainage from the drill site and water disposal options in the event that artesian conditions are encountered and the well is flowing out of control temporarily; and,
- Location relative to existing water supply wells and groundwater flow direction to ensure protection of the aquifer that is being used for community water supply.

Because artesian conditions are expected to be encountered, the drill site should ideally be located in an area that provides sufficient drainage in case the well is flowing out of control temporarily. Drainage should be to an area with little risk of damage to infrastructure, buildings, or the environment.

4.1 POTENTIAL DRILL SITE #1

Figure 1 shows the potential Drill Site Option #1 which is located to the south of the main village and about 150 m to the south of the existing community water supply well KFN-F. The shortest distance to the KFN administration building and community hall is about 500 m.

The site is situated on KFN Category B Surveyed Settlement Land (KFN C-4B, Lot 1027 QUAD 115G/07).

Pros:

The site provides good access and a large cleared and level area of sufficient size to accommodate a drill pad and additional stacking area.

Cons:

The site is located up-gradient of many of the existing water wells, including the community well KFN-F, based on a previously inferred groundwater flow direction toward north. Although precautionary measures will be taken during drilling of the geoexchange test well to avoid contamination of the aquifer at about 40 to 60 m depth that is used for drinking water production, the test well should ideally be located cross- or down-gradient of the existing water wells to minimize risk for affecting existing wells.

The site is also topographically up-gradient of the main village. Although there is anecdotal information that a natural trench to the north provides drainage of the area there is still significant concern that a flowing well may cause flooding of the adjacent road and possibly buildings that are located down-gradient of the site; particularly if drilling is completed during the winter.

4.2 POTENTIAL DRILL SITE #2

This site is located adjacent to a small pothole lake and Kluane Lake to the east of the main village (see Figure 1 and Photo 1-4). The shortest distance to the KFN administration building and community hall is about 800 m.

The land ownership of this site is unclear.

Pros:

The site is located cross- or down-gradient of all existing water supply wells which minimizes the risk for affecting existing wells including community well KFN-F in Burwash Landing. The site also provides good drainage into the small pothole lake to the north. In the event of a flowing well, a sump next to the drill pad could be used to let sediments and drill mud additives settle out and the water could then be disposed of into the pothole lake with little risk for environmental damage or flooding of nearby infrastructure and buildings.

Cons:

The site is smaller than Site Option #1 and may require some levelling, and tree and brush clearing. Road access is fair but less ideal than for Site Option #1. The area close to the escarpment which would provide the best drainage toward the pothole lake is likely large enough to accommodate the drill pad but additional stacking area on the adjacent land across the access trail to the south would likely be required.

4.3 POTENTIAL DRILL SITE #3

This site is located about 200 m southwest of Option #2 within the fire break line and about 750 m shortest distance from the KFN administration buildings and community hall (see Figure 1 and Photo 3). The site is situated on KFN Category B Surveyed Settlement Land (KFN C-4B, Lot 1027 QUAD 115G/07).

Pros:

Similar to potential drill site Option #2, this site is likely located cross- or down-gradient of existing water supply wells which minimizes the risk for affecting existing wells including community well KFN-F, based on an anticipated groundwater flow direction in a north-easterly direction.

Based on the topography in the area of the site, there is little risk for environmental damage or flooding of nearby infrastructure and buildings in case flowing-well conditions are encountered. If disposal of water from a temporarily flowing well is required, the water could be collected in a sump close to the drill pad and pumped either into the pothole lake about 250 m to the northeast or to the undeveloped forested area to the east of the site where it would eventually infiltrate to ground.

The site provides good access and a sufficiently large, level area to accommodate a drill pad and additional stacking area. Some brush clearing may be required.

Cons:

The site provides less ideal natural drainage compared to Drill Site Option #2. Because the exact groundwater flow direction in the area down-gradient of the site is unknown, the dwellings just southwest of the pothole lake may be down-gradient of the site. However, EBA is not aware of any existing water wells in this area. The Aquifer and Wellhead Protection Plan[1] identified a former dump about 100 m to the west of the site as an Area of Potential Environmental Concern (APEC). Based on the anticipated depth of the test well and the thick confining low permeability unit and permafrost which provide protection from surface contaminants, EBA does not expect any risk for potential effects from this former dump on the test well. However, the location and current condition of the former dump should be verified prior to making a final decision on the test well location.

5.0 CONCLUSIONS

Based on the site visit and information provided above, EBA draws the following conclusions:

- Drill Site Option #1 is ideal with respect to access and size; however, the site is located up-gradient of existing water supply wells and poses potential risk for flooding and damage of infrastructure and buildings in case the test well would be flowing out of control temporarily;

[1] EBA Engineering Consultants Ltd., 2007, Aquifer and Wellhead Protection Plan, Kluane First Nation Community Wells, Burwash Landing, YT. Contract report submitted to Kluane First Nation.

- Drill Site Option #2 is located in an area which minimizes risk for both potential contamination of existing water supply wells and potential damage due to flowing well conditions; and,
- Drill Site Option #3 is also located in an area with little risk for contamination of existing water supply wells and potential damage due to flowing well conditions. There is good access to the site but natural drainage is less ideal than for Drill Site Option #2 in case flowing-well conditions are encountered.

6.0 RECOMMENDATIONS

Based on the conclusions presented above, EBA makes the following recommendations for the selection of a drill site for the geoexchange test well in Burwash Landing:

- EBA recommends Drill Site Option #2 or #3 for the drilling of a deep geoexchange test well in Burwash Landing;
- Site ownership for Drill Site Option #2 is unclear and Option #3 may therefore be preferable;
- The absence of domestic water wells in the down-gradient area of Drill Site Option #3 should be confirmed prior to making a final decision on the test well location; and,
- The location and current condition of the former dump identified in the Aquifer and Wellhead Protection Plan should be verified prior to making a final decision on the test well location.

7.0 FUTURE STEPS

Future steps for this project should include:

- YG and KFN to confirm site selection or consider further options if available;
- The preparation of a YESAA project proposal is in progress;
- Preparation of a Request for Expression of Interest for drilling, well testing, and grouting contractor(s); and,
- Tender process as applicable and selection of contractor(s).

EBA is planning another drilling program as part of a geothermal exploration project for Yukon Energy Corporation in the Jarvis River area between Haines Junction and Kluane Lake. EBA therefore recommends using the same drilling contractor for both projects to save mob and demob costs. The drilling in the Jarvis River area is tentatively scheduled for March 2011. Because access to the drill site at Jarvis River is by winter trail, the drilling has to be conducted before the end of the winter. The geoexchange test well in Burwash Landing could therefore be drilled around April or May 2011.

8.0 LIMITATIONS OF REPORT

This technical memo and its contents are intended for the sole use of Government of Yukon and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the technical memo when the technical memo is used or relied upon by any Party other than Government of Yukon, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this technical memo is at the sole risk of the user. Use of this technical memo is subject to the terms and conditions stated in EBA's General Conditions attached to this technical memo.

9.0 CLOSURE

We trust this technical memo meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Respectfully submitted,

EBA, A Tetra Tech Company

Stephan Klump, Dipl.-Geol., Ph.D.
Hydrogeologist, Team Lead
Whitehorse Environment Group
Direct Line: 867.668.2071 x250
Email: sklump@eba.ca

Ryan Martin, M.Eng., P.Eng.
Project Director, Senior Hydrogeologist
Whitehorse Environment Group
Direct Line: 867.668.2071 x231
Email: rmartin@eba.ca

Attachments:

- Figure 1: Site plan showing drill site options
- Photographs 1-4
- EBA General Conditions

CLIENT

Government of Yukon
Community Services

GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

Site Plan showing Drill Site Options

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101380	SK	RMM	001

OFFICE	DATE
EBA-WHSE	December 3, 2010

Figure 1

Photo 1
Drill Site Option #2. Looking north.

Photo 2
Drill Site Option #2. Looking south.

Photo 3
Drill Site Option #2; potential stacking area adjacent to drill pad with access trail. Drill Site Option #3 is located within the Fire Break Line in the background of the photograph. Looking southwest.

Photo 4
Pothole lake with Kluane Lake in the background north of Drill Site Option #2. Looking northwest.

GEO-ENVIRONMENTAL REPORT – GENERAL CONDITIONS

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GOVERNMENT OF YUKON
COMMUNITY SERVICES – INFRASTRUCTURE DEVELOPMENT BRANCH

SPECIFICATIONS FOR TEST WELL DRILLING AND CONSTRUCTION
GEOEXCHANGE TEST WELL
BURWASH LANDING, YUKON

ISSUED FOR USE

W23101380

October 2010

EBA Engineering Consultants Ltd.
p. 867.668.3068 • f. 867.668.4349
Calcite Business Centre • Unit 6, 151 Industrial Road • Whitehorse, Yukon Y1A 2V3 • CANADA

1.0 INTENT AND OBJECTIVES

The intent of this project is to drill, construct, develop and hydraulically test a geoexchange test well (GTW1) in Burwash Landing, Yukon. This well will be used to evaluate the hydrogeological conditions and geothermal gradient at the site, and may also serve as a future supply well for geoexchange applications.

For the purpose of this specification, we assume that GTW1 will be drilled to an approximate depth of 460 m (1500 ft) below ground surface (bgs) and completed with 152 mm (6") diameter well screens. We have also assumed that GTW1 will be primarily drilled using the mud rotary drilling method and constructed in accordance with Canadian Groundwater Association Well Construction Guidelines. Following well development, GTW1 will be hydraulically tested by pumping at a constant rate for 72 hours.

Artesian conditions are expected at this site, and the drilling contractor is expected to have the appropriate drilling additives and equipment on site to successfully control the pressure and complete the well installation.

We expect subsurface conditions at Burwash Landing to consist of a surficial (<5 m) layer of silts, sands and gravels underlain by a silty to gravelly till to a depth of about 45 m. Most wells in Burwash Landing are completed at depths ranging from 45 – 60 m bgs and are completed within a gravel and sand aquifer. Some of the existing wells are artesian with a hydraulic head slightly above ground surface. Permafrost conditions have been documented from about 12 m to about 45 m. The subsurface conditions below about 60 m (196 ft) are unknown and artesian conditions likely exist in deeper aquifers. The depth to bedrock is also unknown and might be in the order of several hundreds of metres. Although it is anticipated to complete this well within overburden, it is possible that bedrock will be encountered within the proposed target depth of 460 m bgs.

The deepest known test well in the area was drilled in the nearby community of Destruction Bay to a depth of 165 m bgs, this well did not encounter water bearing aquifer material below a depth of 34.1 m.

The overall intent of this project is to install a deep test well within overburden deposits or bedrock at the site. If bedrock is not encountered within 460 m, the well may be completed with or without well screens depending on the conditions encountered and to potentially facilitate deeper drilling at a later date.

2.0 SCOPE OF CONTRACT

The scope of the contract will include providing materials and labour to complete a well construction and testing program as outlined in these specifications.

These specifications will form part of the Contract Documents and shall be read as part thereof. The contract outlined in these specifications will be between the Contractor and the Owner, Government of Yukon – Community Infrastructure Branch.

3.0 GENERAL REQUIREMENTS

3.1 The drilling method must be able to penetrate all types of overburden deposits and bedrock to a maximum depth of 460 m (1500 ft), and construct a well with a final screen diameter of 152 mm (6"). The drilling method must also be able to install a surface seal with a radial thickness of at least 2" into the till unit that is expected to start at a depth of about 5 to 10 m bgs (15 to 30 ft). The minimum length of the surface seal shall be 6 m (20 ft).

3.2 The diameter of the surface casing shall be large enough to allow for telescoping casing and facilitate a 6" ID production casing at the target depth of 460 m bgs (1500 ft).

3.3 A conductor casing shall be installed and properly cemented to case off the upper aquifer below the permafrost and reaching into the next confining unit. The purpose of the conductor casing is to protect the upper aquifer which is used by multiple wells for drinking water production and to provide control of potential artesian flow from a deeper aquifer. It is imperative that the conductor casing will be cemented properly to prevent any flow along the outside of the casing should an artesian aquifer be encountered at greater depth. The geological conditions below the upper aquifer at a depth of about 45 to 60 m bgs are unknown and installation of additional casing strings may be required to reach the proposed target depth if unstable zones or artesian aquifers are encountered.

3.4 Once reaching target drilling depth, the contractor will install 152 mm (6") production casing and well screens as directed by the EBA Hydrogeologist and develop the well until a sand free condition is achieved. Depending on the conditions encountered, the production casing will have to be cemented at the bottom or an external casing packer may have to be installed to isolate the aquifer in which the well will be completed.

3.5 Hydraulic testing for GTW1 will include a step test and a constant rate test. The step test will include 4 x 2 hour steps and a recovery interval until the hydraulic head has recovered to within 90% of the static head. The constant rate test will include up to 72 hours of constant rate pumping followed by up to 24 hours of recovery monitoring. Hydraulic tests will be conducted under the supervision and direction of the Hydrogeologist. The contractor is expected to provide the necessary pumping, piping, flow control and power supply to test GTW1 at rates up to 400 USgpm. Water from the hydraulic tests will be conveyed a minimum of 50 m away from the wellhead and discharged with erosion protection at a location determined by the Hydrogeologist.

3.6 All works shall be completed in accordance with the Canadian Groundwater Association's Guidelines for Water Well Construction.

3.7 The Hydrogeologist of EBA will oversee drilling, well construction, well development and hydraulic testing.

3.8 The Contractor shall provide to the Hydrogeologist a detailed well record indicating lithology encountered and well construction details. A Yukon Government Water Well Drillers form (http://www.gov.yk.ca/forms/forms/5000/yg5302_e.pdf) shall be completed and submitted to the Hydrogeologist. The Hydrogeologist will provide this to the Department of Environment for inclusion in the water well registry.

4.0 SITE LOCATION AND CONDITIONS

4.1 The Contractor may assume that the drilling site has been adequately prepared for safe access to the drilling location. The exact well location should be consulted with the Hydrogeologist prior to drilling. The well location will be selected such that there is sufficient space and appropriate drainage to deal with flowing well conditions without impacting existing infrastructure.

4.2 The Contractor shall satisfy themselves regarding all local conditions, available information, access to site, etc. by personal investigation. Neither the information contained in this section, nor that derived from the drawings provided by the Owner nor its agents shall act to relieve the Contractor from any responsibility hereunder or from fulfilling any and all of the terms and conditions of this contract.

5.0 MATERIALS

5.1 GENERAL

5.1.1 All materials supplied and installed under this contract shall be provided by the Contractor and shall conform to this specification and the appropriate standards for this type of work. No changes shall be allowed to the material schedule without the approval of the Owner or the Owner's representative.

5.1.2 All materials used shall be new. The re-use of well casing, screens or liners of any other materials shall not be permitted under any circumstances.

5.1.3 Modifications to suit local conditions encountered during the well construction may be made with written consent of the Hydrogeologist.

5.2 WELL CASING

The well casings shall extend a minimum of 600 mm above ground surface. The casing for the test well shall conform to the following specifications:

Nominal Size:	152 mm (6") ID at target depth of 460 m
Material:	Carbon Steel (ANSI/AWWA 0200, ASTM A53, ASTM A139 or API spec. 5L)
Minimum Wall Thickness:	6.35 mm
Joints:	Welded or threaded

5.3 WELL SCREEN

5.3.1 The screens shall be commercially manufactured telescoping stainless steel wire wound well screens of new material and with the following specifications:

Nominal Size: 152 mm (6") diameter

Material: Stainless Steel

Type: Continuous slot V-wire.

Length: To be determined by the Hydrogeologist.

5.3.2 The screen shall be free from jagged edges and any irregularities that may accelerate corrosion and encrustation. The screen shall have adequate strength to resist external forces that will be applied to it after it has been installed and to minimize the likelihood of damage during installation. In joining the screen, joints shall be straight and tight and retain 100 % of the screen strength. The Contractor shall provide any additional fittings, couplings, packers or other hardware necessary to complete the construction of the well.

5.4 DRILLING FLUIDS AND GROUT

No drilling fluids other than potable water shall be used without permission of the Hydrogeologist. The contractor is expected to have sufficient and appropriate drilling fluids and additives onsite and the ability to control artesian pressures which maybe encountered during drilling. It is imperative that the contractor will be able to use heavy drill mud to counteract significant artesian pressure if required. The contractor shall also be prepared to kill the well at any point during drilling as requested by the Hydrogeologist.

Grout products shall not impart harmful characteristics to the well and shall be mixed and placed according to the manufacturer's instructions.

The contractor will be responsible for drill water supply and, depending on the final drill location, may need to provide a suitable mud tank.

6.0 DETAILED DESCRIPTION OF WORK

6.1 INSTALLATION OF A SANITARY SURFACE SEAL

6.1.1 The Contractor shall drill and install a large diameter surface casing to a minimum depth of 6 m (20 ft) bgs into the till unit that is expected at about 5 to 10 m (15 to 30 ft) bgs. The surface casing shall be cemented with a minimum 2" radial thickness bentonite-cement grout that will act as the sanitary surface seal of the test well. A tremie pipe shall be used to cement the annulus to ensure that the seal is continuous by avoiding segregation or bridging.

6.1.2 The Contractor shall take necessary precautions to ensure that the surface casing and the overlap casings do not become filled with drill cuttings or fluids during the drilling or development process.

6.2 DRILLING AND SAMPLING

6.2.1 Borehole drilling and formation sampling to be completed by the Contractor shall be done in accordance with the specifications outlined in this document.

6.2.2 The Contractor shall collect representative samples at 3.0 m (10 ft) intervals and at formation changes. The samples shall be bagged and labelled with the name of the well,

depth interval and shall be available for review by the Hydrogeologist. The Contractor shall also record observations of soil texture and borehole stability.

6.3 GEOPHYSICAL BOREHOLE LOGGING

Upon reaching target depth a geophysical logging program shall be conducted to log formation properties and help with logging lithology and identifying aquifer zones. The geophysical logging program will depend on conditions encountered and the quality of cuttings that can be used for lithology logging; however, self potential, resistivity and temperature logging will likely be conducted.

6.4 INSTALLATION OF WELL CASING, SCREENS AND LINERS

6.4.1 The drill hole shall be fully cased with a continuous watertight casing from 600 mm above grade to the top of the well screen.

6.4.2 If productive overburden deposits are encountered, the Contractor shall collect the samples and submit to the Hydrogeologist for particle size analysis to determine the soil size distributions and to select a slot size(s) for the screen assembly based on a 50% sediment passing distribution. Based on the particle size distribution results and consultation with the Contractor, the Hydrogeologist will provide the screen assembly selection and the installation depth for both wells. The Contactor shall have a wide selection of screens available at the site.

6.4.3 Should the screen be installed at a depth other than the bottom of the borehole, the lower portion of the borehole shall be backfilled with a clean fill and compacted to prevent settling.

6.5 WELL DEVELOPMENT

The Contractor shall develop the well by high velocity water jetting with simultaneous pumping at a rate of 2 to 3 times the rate of injection. Other development methods may be used if approved by the Hydrogeologist. Development shall continue until the well produces water which is visually sand-free (with approximately less than 1 teaspoon of fines in a 5 Igal bucket) and drill fluid additives have been removed from the formation as determined by the Hydrogeologist. Depending on the drilling method and additives used, proprietary well development chemicals may be required.

6.6 HYDRAULIC TESTING

Hydraulic testing will involve a step rate and constant rate test. The step test will include 4 steps of up to two hours each followed by a recovery period to within 90% of the static water level. The constant rate test will run for 72-hours and also be followed by a recovery interval of 24 hours. The intent of the hydraulic tests will be to determine the yield and water quality of the aquifer.

The contractor will provide necessary power, pumping, and piping and flow monitoring to conduct the tests. The contractor will also collect manual water level reading for the

duration of the test and recovery periods on intervals specified by the Hydrogeologist. EBA will be present on site as necessary to direct the step test and constant rate tests. Electronic dataloggers will also be installed in GTW1 and in nearby test wells to record water levels during the hydraulic tests. The data loggers will be provided by EBA.

6.7 CAPPING

6.7.1 At all times during the progress of the work, the Contractor shall protect the well borehole in such a manner to prevent the entrance of foreign material and to prevent tampering with or vandalizing of the well.

6.7.2 Upon completion and acceptance of the well, the Contractor shall secure the well to the Owner's satisfaction. If artesian conditions are encountered the cap must securely seal the well.

6.7.3 The method used to cap the well must eliminate physical hazard, prevent contamination of groundwater, preserve the yield and hydrostatic head of the aquifer, and prevent the contamination of potable water with non-potable water.

6.8 SITE RESTORATION

The area immediately surrounding the wellhead shall be crowned from the well to provide positive drainage away from the well. The Contractor will take reasonable precautions to minimize damage to lands entered in the performance of the services under this agreement.

7.0 SAFETY

The Contractor must adhere to all Yukon safety requirements, maintain safety standards (i.e. WHMIS) and have at least one designated person on site with safety certification (i.e. St. John's Standard First Aid). A daily site-safety meeting must be held before work commences on-site. At this time an on-site safety coordinator shall be appointed.

8.0 WELL CONSTRUCTION REPORT

The Contractor shall also document detailed daily logs during the drilling and construction and the logs shall be available to review upon the owner's and/or the Hydrogeologist's request.

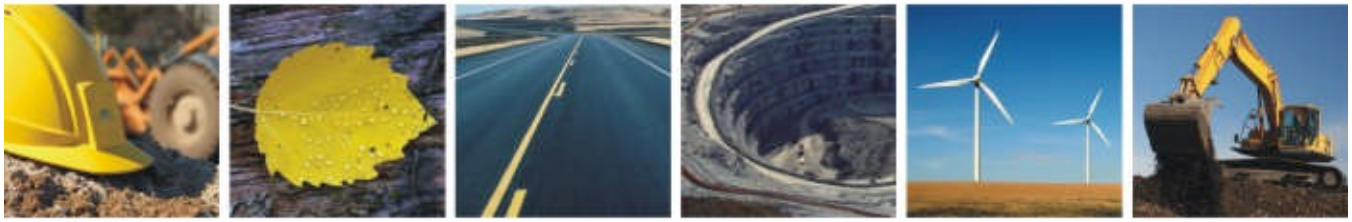
The Water Well Drillers form must be provided to the Owner or its representative within 1 week of the well completion.

9.0 REFERENCES

Canadian Ground Water Association (1995) Guidelines for Water Well Construction.

GOVERNMENT OF YUKON
COMMUNITY SERVICES, INFRASTRUCTURE DEVELOPMENT BRANCH

YESAA APPLICATION – PROJECT PROPOSAL BURWASH GEOEXCHANGE TEST WELL BURWASH LANDING, YUKON



REPORT

DECEMBER 2010
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ACRONYMS & ABBREVIATIONS

BGS	Below Ground Surface
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EBA	EBA, A Tetra Tech Company
KFN	Kluane First Nation
WRFN	White River First Nation
YESAA	Yukon Environmental and Socio-Economic Assessment Act
YESAB	Yukon Environmental and Socio-Economic Assessment Board
YG	Government of Yukon
YGCS	Government of Yukon Community Services Infrastructure Development Branch

1.0 PROPONENT CONTACT INFORMATION

The Government of Yukon, Community Services, Infrastructure Development Branch (YGCS) will be the proponent for the project. EBA, A Tetra Tech Company (EBA) has been retained by YGCS to prepare the project proposal and complete the effects assessment.

For the purposes of this assessment please use the following contacts:

Main Contact:
Kristina Gardner, MSF, RPF
Community & Regulatory Affairs Specialist
Whitehorse Environment Group
EBA, A Tetra Tech Company
Direct Line: 867.668.2071 x249
kgardner@eba.ca

Alternate Contact:
Stephan Klump, PhD
Hydrogeology Team Lead
Whitehorse Environment Group
EBA, A Tetra Tech Company
Direct Line: 867.668.2071 x250
sklump@eba.ca

2.0 REQUIREMENT FOR AN EVALUATION UNDER YESAA

The project is assessable under the *Yukon Environmental and Socio-Economic Assessment Act* (YESAA) Section 47 by the Yukon Environmental and Socio-Economic Assessment Board (YESAB) as it:

- Is located in the Yukon;
- Involves project and accessory activities listed in the Assessable Activities, Exceptions and Executive Committee Project Regulations, including:
  - Part 9, Item 1 (Drilling a well for the extraction of groundwater); and,
  - Part 13, Item 2 (Use of a vehicle off a road or trail maintained by a First Nation);
  - Part 13, Item 12 (Moving earth using a self-propelled machine); and,
- Requires or may require the following permit:
  - Kluane First Nation Land Use Permit;
- Will receive federal funding under the Building Canada fund provided by Infrastructure Canada.

3.0 PROJECT LOCATION

The proposed project site is located in the Village of Burwash Landing (Burwash). The project is located on KFN Category B Surveyed Settlement Land (KFN C-4B, Lot 1027 QUAD 115G/07).

The site is approximately located at (UTM NAD 83, Zone 07N): 608160 E, 6803850 N

The boundaries of the site are:

- NW Boundary: 6803873N, 608145E

- NE Boundary: 6803869N, 608194E
- SE Boundary: 6803823N, 608195E
- SE Boundary: 6803838N, 608127E

Please refer to the following documents for information describing the project location:

- Form 1 (YESAB Online Registry);
- Figure 3.0-1: Project Location; and,
- Figure 3.0-2: Site Plan.

4.0 PROJECT PURPOSE

4.1 Project History

Burwash is a growing community, with a limited water supply, currently operating on a bulk water delivery system. At present, the community water supply and water treatment plant are supplied by well KFN-F. Two additional wells, KFN-J and KFN-G, supply the Administration Building, Laundry Facility and Health & Social Services building, and the Teachers' Residence and Daycare. KFN has identified a need for increased water capacity (greater than 0.5 litres per second) to serve as a backup to the KFN-F, and to accommodate expected future growth.

Geoexchange systems for heating provide an opportunity to make use of renewable energy and replace fossil fuels widely used for heating buildings. Burwash Landing is situated in the Shakwak Valley, a broad tectonically active valley that separates the St. Elias Mountains terrane from the Yukon Plateau. Thick glaciolacustrine and till deposits fill the Shakwak valley bottom. The occurrence of warm springs in the Shakwak Valley at the Jarvis River approximately 70 km southeast of Burwash and a 385 m deep well in Haines Junction that produces 17°C warm water indicate geothermal potential in the Shakwak Valley region. Drilling of a test well is required to explore the geothermal potential in the Burwash area because subsurface conditions beyond about 60 m depth are currently unknown.

4.2 Project Purpose

The purpose of this project is to explore the geothermal potential and hydrogeological conditions in the Burwash area by drilling a deep test well. The test well will be used to identify the local geothermal gradient to prove the occurrence of groundwater warm enough for geoexchange applications and to confirm the existence of a productive aquifer suitable for open-loop geoexchange applications. If the test well would be successful the well would be used as a production well for geoexchange application and/or community water supply.

4.3 Project Alternatives

Two alternatives were considered during the project planning process:

- To rely upon existing community water wells for domestic water services. However, the projected demand for Burwash exceeds the existing community well supply; and,

- To rely upon existing diesel and wood services to provide heat to the community. However, alternative energy sources are preferred by the community.

5.0 PROJECT DESCRIPTION

5.1 Project Scope

The scope of the project is to drill, construct, develop and hydraulically test a geoexchange test well (GTW1) up to 460 m (1500 ft) deep in Burwash Landing, Yukon. This well would be used to evaluate the hydrogeological conditions and geothermal gradient at the site, and may also serve as a future supply well for geoexchange applications, or as a community water supply.

5.2 Principal Project Activities

The principal activity of the proposed project is to advance a 460 m deep test water well at one location in Burwash (Figure 3.0-2). The exact machinery used would be determined by the contractor but would likely include a truck-mounted rotary drill rig as it is typically used for drilling of water wells.

5.3 Accessory Project Activities

Accessory activities associated with the proposed project include:

- Driving a truck with mounted machine on an existing firebreak trail, and less than 50 m off the trail;
- Disturbing immature trees and shrubby vegetation, if necessary, to create a drill pad and to access the drill pad from the firebreak trail. The drill pad would be an area of about 30 m by 30 m on level solid ground. There is probably no ground disturbance required for drill pad preparation;
- Disturbing immature trees and shrubby vegetation in an area adjacent to the drill pad, in order to store well materials, if necessary;
- Collection of water samples from the water well and installing monitoring equipment within the water well, in order to test the hydrogeological conditions and geothermal gradient at the site; and,
- Potentially excavating a small sump with a tracked excavator or rubber tired backhoe if flowing well conditions were encountered.

5.4 Project Description

The project would advance a test water well in the firebreak south of the pothole lake in Burwash, approximately 750 m southeast of the KFN administration buildings and community hall (Figure 3.0-2). The project would advance a 460 m deep test water well, using a truck mounted drill rig, supported by a supply truck carrying drill casing and other materials. A water truck would supply water to the drill. Water used for the project would be sourced from the local community water well. The diameter of the test well will be 152 mm (6”) at target depth. The subsurface conditions below about 60 m (196 ft) are unknown and artesian conditions likely exist in deeper aquifers.

Precautionary measures in case artesian well conditions are encountered include:

- Installation of a conductor casing to case off the upper aquifer below the permafrost. The purpose of the conductor casing is to protect the upper aquifer which is used by multiple wells for drinking water production and to provide control of potential artesian flow from a deeper aquifer.
- Installation of additional casing strings if required to reach the proposed target depth in case unstable zones or artesian aquifers are encountered.
- Availability of appropriate heavy drill mud on site to control significant artesian pressure if necessary. Typical drill mud additives would include bentonite and barite, both of which are natural minerals and non-toxic.
- Availability of suitable grouting equipment on site to cement casing and grout the drill hole in case a decision would be made to abandon the well.
- Availability of equipment to excavate a sump or to construct another water containing structure and pump(s) to convey water in case the well would be flowing temporarily.
- Development of a contingency plan for safe water disposal in case temporary flowing well conditions are encountered.

Once the borehole is advanced to target depth and has encountered a productive aquifer, the test well would be completed with a well screen similar to a regular water supply well. Hydraulic testing of the well would include a step-rate pumping test for a maximum of 8 hours and a 72 hour constant rate pumping test. The pump rate would not exceed 300 m^3/day. The water would be disposed of in a safe manner away from the wellhead. The undeveloped, forested area east of the proposed well location would likely be suitable for water disposal without any risk for flooding infrastructure or for affects on other water wells.

5.5 Construction Staff and Accommodations

The project workforce is expected to employ a maximum of five employees. All employees would be accommodated locally in Burwash. No camp accommodation is anticipated with the project.

5.6 Fuel Management

The drill rig would be fuelled from a truck-mounted Tidy Tank, with an approximate capacity of 600 litres, at least 30 metres from the edge of any watercourse. Trucks would be fuelled in Burwash. No storage of petroleum products outside of Tidy Tanks is associated with the project.

5.7 Schedule of Activities

The proposed project would begin as soon as possible following necessary regulatory review and permitting. It is expected that the project would be completed by June 2011.

6.0 DESCRIPTION OF EXISTING ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

This section describes the existing conditions for the components listed below. This information is based on the existing information available at the time of the assessment.

Environmental Components

- Biophysical conditions
- Soils and permafrost
- Water
- Vegetation
- Fish and wildlife

Socio-economic Components

- Community characteristics
- Health and safety
- Heritage resources

6.1 Biophysical Conditions

The proposed project area is located in the Ruby Ranges Ecoregion of the Boreal Cordillera Ecozone (Smith et al. 2006). The Burwash area has a mean daily average temperature of -3.8°C, with the highest daily average of 12.8°C occurring in July, and the lowest daily mean temperature of -22°C occurring in January (Environment Canada 2010). Burwash receives an average of 192.1 mm of precipitation on a yearly basis (Environment Canada 2010).

6.2 Soils and Permafrost

Subsurface conditions are expected to consist of a surficial (<5 m) layer of silts, sands and gravels underlain by a silty to gravelly till to a depth of about 45 m. Most wells in Burwash Landing are completed at depths ranging from 45 – 60 m below ground surface (bgs) and are completed within a gravel and sand aquifer. Some of the existing wells are artesian with a hydraulic head slightly above ground surface. Permafrost conditions have been documented from about 12 m to about 45 m. The subsurface conditions below about 60 m are unknown and artesian conditions likely exist in deeper aquifers. The depth to bedrock is also unknown and might be in the order of several hundreds of metres.

6.3 Water

There are no watercourses in the project area; however the proposed drilling site is approximately 200 metres from a pothole lake inset into the shore of Kluane Lake (Figure 3.0-2 and Photo 1). Kluane Lake drains into the Kluane River which flows into the Donjek and White Rivers before reaching the Yukon River. The project area is estimated to be cross- or down-gradient of existing water supply wells in Burwash. Artesian groundwater conditions may exist in the area.

6.4 Vegetation

The project is located in a maintained firebreak within Burwash. Vegetation in the project area is comprised of willows (*Salix spp.*), grasses and other herbaceous vegetation, with immature white and black spruce (*Picea glauca* and *Picea mariana*) and trembling aspen (*Populus tremuloides*) typical of regeneration within a maintained firebreak (Photo 2). Surrounding the project area, the vegetation is comprised of white and black spruce and mature aspen which is typical of the boreal forest.

6.5 Fish and Wildlife

The Project area is north of Kluane Wildlife Sanctuary, near Kluane Lake, within Burwash. The Burwash area and Kluane Wildlife Sanctuary is known moose and caribou habitat, with wildlife key areas identified outside of the project area (YESAB 2010). Caribou, moose, and other urban habituated large mammals such as grizzly bears, black bears, and wolves are expected to pass through the project area. Small mammals, migratory birds, and other species typical of the boreal forest are also expected in the project area. There is a grizzly bear wildlife key area in the project area (YESAB 2010). Grizzly bear, wolverine and caribou are listed as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010).

6.6 Community Characteristics

Burwash is defined by its proximity to Kluane Wildlife Sanctuary, Kluane Park and Kluane Lake, 285 km west of Whitehorse on the Alaska Highway. The site of Burwash was a traditional summer camp location of the Southern Tutchone people, where a trading post was built in the early 1900's (Yukon Communities 2010). As of the 2006 Census the population was 73, of which 80% were Aboriginal First Nations. The community is the administrative centre of the Kluane First Nation.

6.7 Health and Safety

The project area is located in a maintained firebreak area in Burwash. The area may be accessed by local residents for purposes of hiking, berry picking, and use of recreational vehicles. There are some dwellings southwest of the pothole lake which may be down-gradient of the project site.

6.8 Heritage Resources

Burwash is the home of the Kluane First Nation (KFN; Travel Yukon 2010). The project area is within the Traditional Territories of the KFN and the White River First Nation (WRFN). The members of the KFN are Southern Tutchone, which belong to the Athapaskan Language family (Kluane First Nation 2010). The KFN are signatories to the KFN Final Agreement and the KFN Self-Government Agreement (YG ECO 2010). The WRFN is culturally affiliated with the Upper Tanana and Northern Tutchone people, based in Beaver Creek (White River First Nation 2010). The WRFN do not have a First Nation Final Agreement or Self-Government Agreement.

7.0 IDENTIFICATION OF POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS AND PROPOSED MITIGATIONS

This section, including the determination of valued components, the effects assessment and significance determination, is based on the information available at the time of the assessment.

Valued environmental and socio-economic components (VESEC) for the proposed project have been identified as:

Environmental Valued Components

- Soils and permafrost
- Water quality
- Vegetation
- Fish and wildlife

Socio-economic Valued Components

- Economy and employment
- Land and resource access
- Health and safety
- Heritage resources

7.1 Soils and Permafrost

7.1.1 Effects Characterization

The proposed test well may alter soil structure by excavating layered soils. No soil excavation is anticipated for creation of the drill pad. However a sump may be excavated if artesian conditions are encountered. Permafrost is present in the project area from about 12 m bgs to a depth of about 45 m. There are no significant adverse effects on permafrost anticipated to occur as a result of this project. Although it is anticipated to complete this well within overburden, it is possible that bedrock would be encountered within the proposed target depth of 460 m bgs.

7.1.2 Proposed Mitigation

The following measures would be implemented during the course of the project to minimize effects on soils and permafrost:

- Only one borehole would be advanced; and,
- The project would be conducted in late winter if possible in order to use snow cover to minimize impacts to vegetation and soil.

7.1.3 Significance Determination

It was determined through a review of the potential effects and associated project activities that the proposed project, with the recommended mitigation would not result in a significant, adverse effect to soils or permafrost.

7.2 Water Quality

7.2.1 Effects Characterization

Diesel fuel, gasoline and engine oil would be used in the project area. The primary risks associated with the proposed project include the potential release of deleterious substances (such as hydrocarbon fuels or lubricants) through soils to groundwater.

There is also the possibility that artesian conditions would be encountered during drilling, causing water to freely flow from the borehole. However, based on the topography in the area of the site, there is little risk for environmental damage or flooding of nearby infrastructure and buildings in case that flowing-well conditions are encountered. If required flowing water from the well would be contained in a sump close to the borehole where sediments would settle out before the water would be pumped to the disposal area. Possible disposal areas are the undeveloped forested area to the east of the proposed test well location or the pothole lake north of the site.

7.2.2 Proposed Mitigation

The following measures would be implemented during the course of the project to minimize effects on water quality:

- Deleterious substances (including but not limited to fuels, lubricants, hydraulics and coolants) of any type would not be deposited or allowed to be deposited into any waters, or in any place where the deleterious substances may enter any waters;
- The proponent/contractor would at all times have sufficient spill cleanup equipment and materials on site in readiness to immediately contain and clean up all deleterious substances which may be spilled and be familiar with spill protocols;
- The drill rig would be fuelled from a Tidy Tank, with an approximate capacity of 600 litres. Refueling would take place at least 30 m from the edge of any watercourse. Trucks would be fuelled in Whitehorse or Burwash. No storage of petroleum products outside of Tidy Tanks is associated with the project;
- A Spill Contingency Plan would be followed for prevention and mitigation of potential effects from accidents or equipment/vehicle malfunction. The Spill Contingency Plan would deal with the procedures and methods for spill notification, response mobilization, containment recovery and remedial measures for spills related to products used onsite;
- Vehicles and equipment would be maintained in good working condition to minimize risk of spills or leaks;

- A Flowing Well Contingency Plan would be prepared and followed in the case of encountering flowing well conditions. This would include the procedures and methods for controlling a flowing well or plugging the borehole if artesian conditions were encountered as well as water management at the site. Water management would include: collecting water in a sump, temporary containment or above-ground pool; allowing sediment and other materials to settle; pumping clean water to the pothole lake or to the undeveloped forested area to the east where it would infiltrate into the ground. The water chemistry would be tested prior to release of water into the pothole lake to ensure it does not contain any deleterious substances;
- All required materials and equipment (e.g. high density drilling mud such as barite) would be on site to control artesian conditions if encountered; and,
- A conductor casing would be cemented into place to contain artesian flow and avoid erosion of the borehole.

7.2.3 Significance Determination

It was determined through a review of the potential effects and associated project activities that the proposed project, with the recommended mitigation, would not result in a significant, adverse effect to surface or ground water quality.

7.3 Vegetation

7.3.1 Effects Characterization

Willows, shrubs, and immature aspen will be removed from the drill pad area, either by clearing with a brush saw or by hand, and may be crushed in an area adjacent to the drill pad, in order to store well materials, if necessary. They may also be crushed during access to the site if they have regenerated within the firebreak trail. The vegetative mat would be removed from the borehole site prior to excavation.

7.3.2 Proposed Mitigation

The following measures would be implemented during the course of the project to minimize effects on vegetation:

- Clearing of existing vegetation would be minimized to the extent possible to minimize ground disturbance; and,
- The project would be conducted in winter in order to use snow cover to minimize impacts to vegetation and soil.

7.3.3 Significance Determination

With the implementation of the mitigation measures described above, the proposed project activities should not result in a significant, adverse effect to existing vegetation.

7.4 Fish and Wildlife

7.4.1 Effects Characterization

There are no watercourses in the project area. The closest water bodies are the pothole lake and Kluane Lake about 200 m north of the proposed test well location. Given the distance of the proposed test well location to the pothole lake and Kluane Lake and the local topography, there is no risk of uncontrolled water release into these water bodies and therefore, no adverse effects on fish or fish habitat are anticipated.

With the onset of development, there is often the potential to disturb wildlife. Increased noise level from construction activities may result in temporary avoidance of the site. Once the project has been completed, noise levels would return to current levels.

Clearing vegetation during the migratory bird nesting period (May 15 to July 31) could result in the destruction of a bird or its nest, which would be in contravention of the *Migratory Bird Act*. Vegetation removal could result in habitat loss, if not revegetated.

Garbage, if not properly managed, could attract scavengers, including bears, which could result in negative human-bear or other animal interactions.

7.4.2 Proposed Mitigation

The following mitigations would be applied during the project:

- Mitigations as outlined above in Section 7.2.2 would be implemented to mitigate the release of deleterious substances into a watercourse;
- Mitigations as outlined above in Section 7.3.2 above would be implemented to mitigate for potential effects to vegetation;
- Clearing of vegetation would occur outside of the migratory bird nesting season (May 15 to July 31). If clearing must occur within this window, then nest surveys would be conducted by a qualified biologist prior to clearing. Once the biologist has conducted the surveys and has given permission to go ahead with work, then clearing would be conducted. Nest surveys would reduce the potential of bird mortality during vegetation clearing;
- All waste produced from the project would be managed in accordance with the *Yukon Wildlife Act*, to prevent attracting dangerous and nuisance wildlife, such as bears. Proper waste management would significantly decrease the potential for human-wildlife conflicts; and,
- The harassment of wildlife, as defined under the *Yukon Wildlife Act*, is prohibited.

7.4.3 Significance Determination

With the implementation of the mitigation measures described above, no significant negative effects on fish and wildlife are anticipated as a result of the proposed project.

7.5 Economy and Employment

7.5.1 Effects Characterization

Local contractors would be used for the project to the extent possible, (e.g., for drill pad clearing, snow removal, and water delivery). The employment of local contractors and their employees is expected to provide a positive effect on economy and employment in the Burwash and Destruction Bay area through the use of local resources and labour. The project workforce would be accommodated in existing establishments in the Burwash area during the project, resulting in increased revenues for local businesses.

7.5.2 Proposed Mitigation

As no negative effects on the economy and employment are predicted as a result of the project, no mitigations are proposed.

7.5.3 Significance Determination

It was determined through a review of the potential effects and associated project activities that the proposed project would not result in any significant, adverse effects to the economy and employment in the project area.

7.6 Land and Resource Use

7.6.1 Effects Characterization

During offloading of the excavator or drill rig, local effects on land use may include disruptions to recreational traffic patterns near the firebreak, however these are expected to be minor and temporary. The advancement of the borehole may have local effects on residents using the area for walking or other recreation.

7.6.2 Proposed Mitigation

The following measures would be implemented during the course of the project to minimize effects on land and resource use:

- Signs would be posted at the site during work to advise the public of work being undertaken and any changes in traffic or land use patterns (e.g. trail closures);
- All truck traffic would pull off the road in wide areas and allow the other vehicle to pass; and,
- Work would be completed as efficiently as possible.

7.6.3 Significance Determination

With the implementation of the mitigation measures described above, no significant negative effects on local land use are anticipated as a result of the proposed project.

7.7 Public Health and Safety

7.7.1 Effects Characteristics

As with any construction activities, the use of machinery, presence of construction equipment, noise, and dust have the potential to affect the health and safety of workers. These effects may be realized during the proposed project, but are anticipated to be short in duration.

A former dump approximately 100 m to the west of the site has been identified as potentially impacting the project well, however the depth of the well, its design, and the thick cover consisting of low permeability sediments and permafrost would provide extensive protection from potential surface contaminants.

7.7.2 Proposed Mitigation

The following mitigation measures would be implemented during the course of the project to minimize effects on health and safety:

- All contractors would be required to adhere to appropriate Occupational Health and Safety Regulations including wearing all appropriate personal protective equipment;
- YG Highways and Public Works safety measures would be employed when working in the right-of-way;
- Signs would be posted at the site during work to advise the public of work being undertaken, the associated health and safety risks and any changes in traffic patterns; and,
- The well would be installed to protect the well water from surface contaminants.

7.7.3 Significance Determination

Through the application of the identified mitigations, the project is not anticipated to result in significant adverse effects to health and safety.

7.8 Heritage Resources

7.8.1 Effects Characterization

There is a potential effect to heritage resources if resource items are uncovered. Resource items could be removed from the site, or heritage resources could be damaged or disturbed.

7.8.2 Proposed Mitigation

- Should any artifacts or heritage resource items of significance be uncovered during project groundworks, these activities would be stopped immediately and KFN, WRFN and YG Heritage Resources Branch would be notified. Groundworks would not resume until the items of significance had been recovered;
- No artifacts or objects would be removed from site by the contractor or other individuals, other than those permitted to do so; and,

- The YG Heritage Resources Branch, KFN and WRFN would be permitted to have a representative on site during excavations or groundworks to monitor these activities for the uncovering of heritage resources.

7.8.3 Significance Determination

It was determined through a review of the potential effects and associated project activities that the proposed project, with the recommended mitigation, would not result in a significant, adverse effect to heritage resources.

7.9 Summary of Mitigations for all Identified Effects

- Only one borehole would be advanced;
- The project would be conducted in late winter if possible in order to use snow cover to minimize impacts to vegetation and soil;
- Deleterious substances (including but not limited to fuels, lubricants, hydraulics and coolants) of any type would not be deposited or allowed to be deposited into any waters, or in any place where the deleterious substances may enter any waters;
- The proponent/contractor would at all times have on site sufficient spill cleanup equipment and materials in readiness to immediately contain and clean up all deleterious substances which may be spilled and be familiar with spill protocols;
- The drill rig would be fuelled from a Tidy Tank, with an approximate capacity of 600 litres. Refueling would take place at least 30 m from the edge of any watercourse. Trucks would be fuelled in Whitehorse or Burwash. No storage of petroleum products outside of Tidy Tanks is associated with the project;
- A Spill Contingency Plan would be followed for prevention and mitigation of potential effects from accidents or equipment/vehicle malfunction. The Spill Contingency Plan would deal with the procedures and methods for spill notification, response mobilization, containment recovery and remedial measures for spills related to products used onsite;
- Vehicles and equipment would be maintained in good working condition to minimize risk of spills or leaks;
- A Flowing Well Contingency Plan would be prepared and followed in the case of encountering flowing well conditions. This would include the procedures and methods for controlling a flowing well or plugging the borehole if artesian conditions were encountered as well as water management at the site. Water management would include: collecting water in a sump, temporary containment or above-ground pool; allowing sediment and other materials to settle; pumping clean water to the pothole lake or to the undeveloped forested area to the east where it would infiltrate into the ground;
- All required materials and equipment (e.g. high density drilling mud such as barite) would be on site to control artesian conditions if encountered; and,

- A conductor casing would be cemented into place to contain artesian flow and avoid erosion of the borehole.
- Clearing of existing vegetation would be minimized to the extent possible to minimize ground disturbance;
- The project would be conducted in late winter in order to use snow cover to minimize impacts to vegetation and soil;
- Mitigations as outlined above in Section 7.2.2 would be implemented to mitigate the release of deleterious substances into a watercourse and to mitigate for potential sediment release to fisheries habitat;
- Mitigations as outlined above in Section 7.3.2 above would be implemented to mitigate for potential effects to vegetation;
- Clearing of vegetation would occur outside of the migratory bird nesting season (May 15 to July 31). If clearing must occur within this window, then nest surveys would be conducted by a qualified biologist prior to clearing. Once the biologist has conducted the surveys and has given permission to go ahead with work, then clearing would be conducted. Nest surveys would reduce the potential of bird mortality during vegetation clearing;
- All waste produced from the project would be managed in accordance with the Yukon Wildlife Act, to prevent attracting dangerous and nuisance wildlife, such as bears. Proper waste management would significantly decrease the potential for human-wildlife conflicts;
- The harassment of wildlife, as defined under the Yukon Wildlife Act, is prohibited;
- Signs would be posted at the site during work to advise the public of work being undertaken and any changes in traffic or land use patterns (e.g. trail closures);
- All truck traffic would pull off the road in wide areas and allow the other vehicle to pass;
- Work would be completed as efficiently as possible;
- All contractors would be required to adhere to appropriate Occupational Health and Safety Regulations including wearing all appropriate personal protective equipment;
- YG Highways and Public Works safety measures would be employed when working in the right-of-way;
- Signs would be posted at the site during work to advise the public of work being undertaken, the associated health and safety risks and any changes in traffic patterns;
- The well would be installed to protect the well water from surface contaminants;
- Should any artifacts or heritage resource items of significance be uncovered during project groundworks, these activities would be stopped immediately and KFN, WRFN and YG Heritage Resources Branch would be notified. Groundworks would not resume until the items of significance had been recovered;

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of The Government of Yukon Community Services Infrastructure Development Branch and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than The Government of Yukon Community Services Infrastructure Development Branch, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

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- No artifacts or objects would be removed from site by the contractor or other individuals, other than those permitted to do so; and,
- The YG Heritage Resources Branch, KFN and WRFN would be permitted to have a representative on site during excavations or groundworks to monitor these activities for the uncovering of heritage resources.

7.10 Significance Determination

It was determined through a review of the potential effects and associated project activities that the proposed project, with the recommended mitigation, would not result in a significant, adverse effect to any of the valued components identified in this project proposal.

8.0 ADDITIONAL INFORMATION / RESOURCES

8.1 Sources of Information

See reference list.

9.0 ACKNOWLEDGEMENT AND CERTIFICATION

Please refer to Section 9.0 of the Form 1.

10.0 CLOSURE

With respect to regulatory compliance issues, please note that regulatory statutes and the interpretation of regulatory statutes are subject to change over time. Moreover, this report is not meant to represent a legal opinion regarding compliance with applicable laws.

EBA trusts this report meets your requirements at this time. If you have questions or require additional information, please contact the undersigned at your convenience.

Respectfully submitted,
EBA, A Tetra Tech Company

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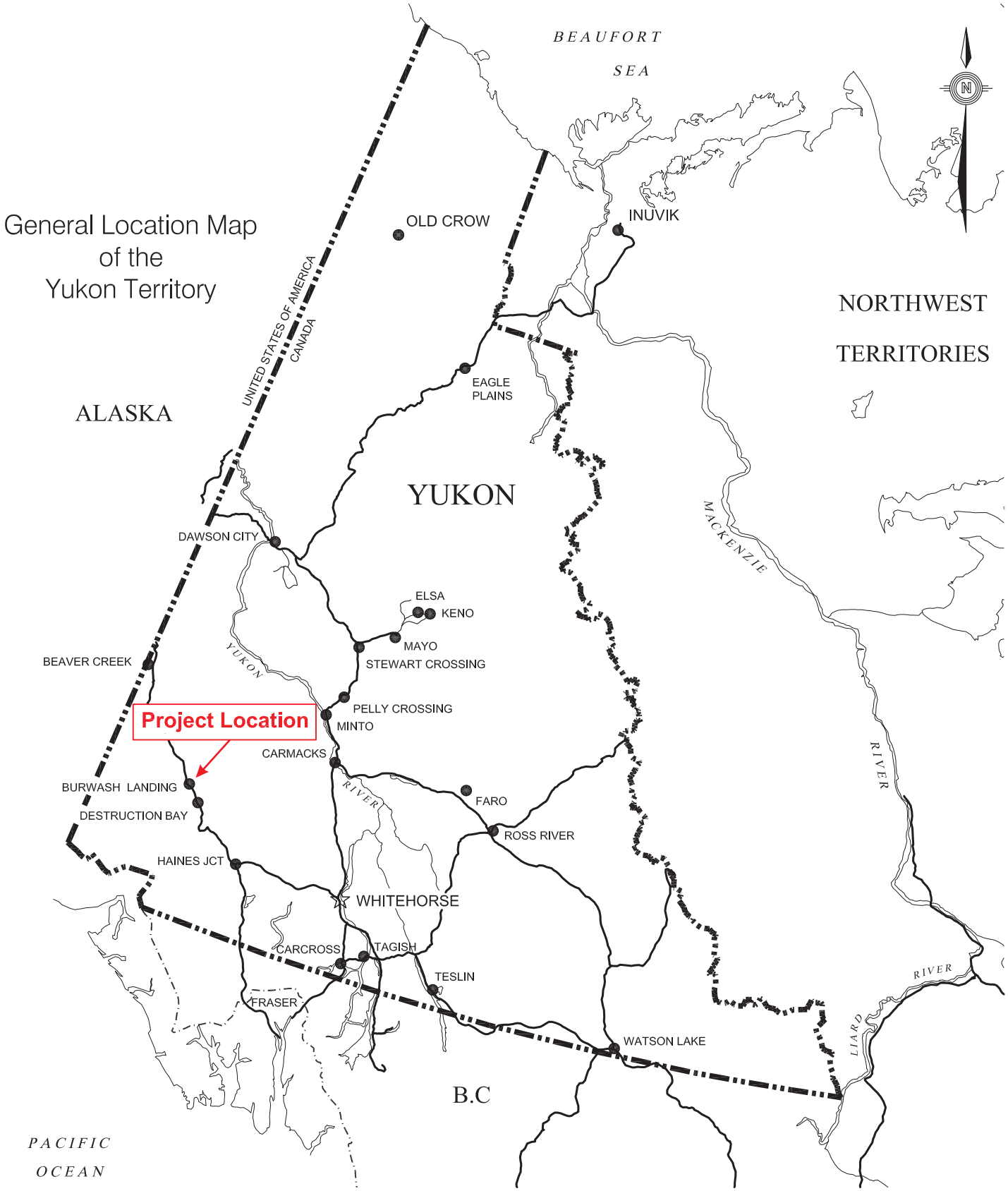
FIGURES



STATUS: ISSUED FOR USE	CLIENT: Government of Yukon Community Services	GEOEXCHANGE TEST WELL BURWASH LANDING, YUKON				
		Site Location Map				
	A TETRA TECH COMPANY	PROJECT NO. W23101380.003	DWN KR	CKD SK	APVD KG	REV 0
		OFFICE EBA-WHSE	DATE December 16, 2010			Figure 3.0-1

NOTES

STATUS
ISSUED FOR USE

CLIENT
Government of Yukon
Community Services

A TETRA TECH COMPANY

GEOEXCHANGE TEST WELL BURWASH LANDING, YUKON

Site Plan

PROJECT NO.	DWN	CKD	APVD	REV
W23101380.003	SK	KG	RMM	0

OFFICE	DATE
EBA-WHSE	December 16, 2010

Figure 3.0-2

PHOTOGRAPHS

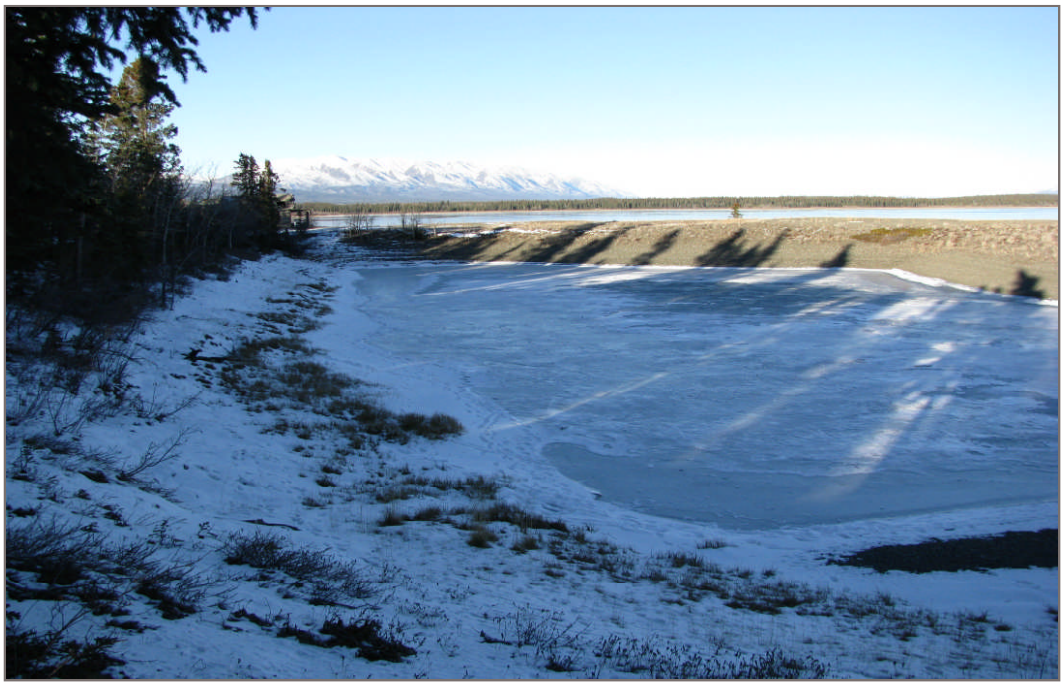


Photo 1: Pothole Lake

Photo 2: Project Site Vegetation

APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA’s client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA’s Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

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2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

January 10, 2011

ISSUED FOR USE
EBA FILE: W23101380.003

Yukon Environmental and Socio-Economic Assessment Board
Haines Junction Designated Office
Box 2126
Haines Junction, Yukon Y0B 1L0

Attention: Astrid Grawehr

Subject: Request for Additional Information, Burwash Geoexchange Test Well, YESAA Project Number 2010-0268.

1.0 INTRODUCTION

This document contains the information requested in the Yukon Environmental and Socio-Economic Assessment Board's (YESAB) *Request for Additional Information* dated January 5, 2011 (YESAB Project #2010-0268). This document should be considered an addendum to the original project proposal submitted to YESAB in December 2010.

The information contained in this addendum supersedes the relevant information contained in the project proposal. To help the reader follow the document each response follows the text of each of YESAB's information requests. YESAB's original information requests and rationales have been highlighted in bold to clearly separate them from the responses. The numbering of the responses matches that found in the *Request for Additional Information* dated January 5, 2011.

2.0 RESPONSES TO INFORMATION REQUESTS

1. **Please provide a detailed timeframe (length of time in days) for activities including but not limited to: clearing, drilling, testing and monitoring.**

The proposed project would begin as soon as possible following necessary regulatory review and permitting. It is expected that the project would be completed by June 2011. A detailed timeframe for project activities is included in Table 1.

2. **Please provide further information relating to the length of time the well will remain open for monitoring and the frequency of visitation.**

The well would be capped and locked following completion. Additional monitoring, if required, would occur as needed to determine the future use of the well (to be assessed as a future project under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA)).

Table 1 Detailed Project Timeframe for Burwash Geoexchange Test Well Installation and Monitoring

Activity	Estimated # Days to Complete
Create drill pad	1
Drill well	14
Test well	7
Monitor well (water level, temperature, water quality)	1 per monitoring event
Excavate sump (if required)	1
Grout drill hole (if well is to be abandoned)	1

3. **Please provide further detail regarding proposed reclamation activities and the projected start and end dates of all reclamation including, but not limited to: the sump and well.**

The purpose of this project is to explore the hydrogeological conditions and geothermal potential in the Burwash area by drilling a deep test well. If the test well would be successful, the well may be used as a production well for community water supply and/or geoexchange application, which would be considered a future project under YESAA if applicable. In this case, the eventual reclamation of the well would be included in a future project description. If the well is to be abandoned (for example, due to insufficient flows), the borehole would be grouted and sealed in accordance with applicable guidelines. The project would be conducted in late winter or spring. Reclamation of the drill site would occur shortly after drilling and testing are completed. The reclamation activities would be determined based on site conditions at the time of equipment demobilization and may include backfill of the sump with native soil, cutting of well casing below ground surface in case of well abandonment, and re-contouring of the site to pre-drilling configuration if necessary. Due to the small size of the proposed drill site, reseeding would be considered unnecessary and it is proposed that the site be left to reseed through natural processes. Reclamation activities would likely be completed within four weeks following well completion and testing depending on ground conditions and contractor availability.

3.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon, Community Services, Infrastructure Development Branch and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the Government of Yukon, Community Services, Infrastructure Development Branch, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

With respect to regulatory compliance issues, please note that regulatory statutes and the interpretation of regulatory statutes are subject to change over time. Moreover, this report is not meant to represent a legal opinion regarding compliance with applicable laws.

4.0 CLOSURE

With respect to regulatory compliance issues, please note that regulatory statutes and the interpretation of regulatory statutes are subject to change over time. Moreover, this report is not meant to represent a legal opinion regarding compliance with applicable laws.

We trust this information request response meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Sincerely,
EBA, A Tetra Tech Company

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KLUANE FIRST NATION

Yukon Environmental & Socio-Economic Assessment Act

KLUANE FIRST NATION DECISION DOCUMENT

Kluane First Nation hereby issues this Decision Document for the purposes of *Yukon Environmental and Socio-Economic Assessment Act* (YESAA), in relation to YESAB 2010-0268, Geothermal Test Well

Decision Document Date of Issue:	File Number:
April 7, 2011	YESAB 2010-0268

Approved by: KFN Chief & Council	
Signature of ~~Authorizing~~ Official Math'ieya Alatini Chief	Date: April 7,2011

Part 1:Proponent Information

Proponent Name: see attached	
Project Name:	
Contact Person	Phone:
Address:	
	Email:

Part 2: Project Summary and Scope

Project Description Summary:
See attached for project description and scope

The following components, phases and activities are included within the scope

of the project for the purposes of this Decision Document.

Components, Phases and Activities Included in Project Scope	
Components	
Phases	
Activities	o
The application of this Decision Document is limited to the components, phases and activities described above until *project is finished.*	

The following components, phases and activities are not included within the scope of the project for the purposes of this Decision Document.

Components, Phases and Activities Excluded from Project Scope	
Components	
Phases	
Activities	

Part 3: Assessable Activities and Assessment Triggers

The following activities are listed in the Assessable Activities Regulations and establish a requirement of the proposed project under YESAA.

Assessable Activities – *Assessable Activities Regulations*		
Part	**Item**	**Proposed Activity**
Date Activities Declared to be subject to Assessment in Accordance with section 48 of YESAA (if applicable):		

The Kluane First Nation has the following government role(s), as described in subsection 47(2) that establish the requirement for assessment of the proposed project under YESAA.	
	Authorization
	Grant of Interest in Land
	Proponent (if a private person would require an authorization or grant of interest in land
	None (i.e. assessment triggered by another government's role

Part 4: Decision Body Information

First Nation Decision Body: Kluane First Nation		
	Reason for Being Decision Body:	KFN, if the project is to be located wholly or partly on its settlement land and i) KFN has the power under the *Yukon First Nations Self-Government Act* or under its final agreement to issue an authorization that is required for the project to be undertaken, ii) KFN is a proponent of the project, has

		the power to grant an interest in land that is required for the project to be undertaken or has received an application for financial assistance for the project, or
X	Authorization	Contact Person:
X	Grant of Interest in Land	Phone: (867) 841-5501 Ext 235
X	Proponent	Fax: (867) 841-5506
	Funding	Email:
	Other	Address: P.O. Box 20 Burwash Landing, Yukon Y0B 1V0

Other Decision Bodies	
Other Decision Body:	Address:
Contact Person:	Email:
Phone: (867)	Fax:
Other Decision Body:	Address:
Contact Person:	Email:
Phone:	Fax:

Part 5: Land Base Information

Project Location			
Nearest Community: Burwash Landing			
Map Sheet(s): 115G07			
Latitude:		Longitude:	
Affected Watercourses: Copper Joe Creek and Kluane Lake			
X	Project Located On: Settlement Land Only Both Settlement Land and Non-Settlement Land		Settlement Land Block

Does the proposed project involve the right to work mines and minerals on Category B or Fee Simple Settlement Land?			
	Yes	X	No

Other Land Uses and Users	
Other Rights and Tenures on the same Settlement	*None*

Land Block	
Adjacent Land Users and Uses	

Has a Land Use Planning Commission been established for the project area?	Yes No	 X
Is a Regional Land Use Plan in effect?	Yes No	 X
If yes, is the proposed project in conformity with the Land Use Plan?	Yes No	
If there is a Land Use Plan in effect, can the project be undertaken even if it is not in conformity with the Land Use Plan? (See YESAA section 44 and subsection 81(2)	Yes No	

Part 6: Information about Assessment Recommendation

Evaluation Report From: Haines Junction Designated Office	
Date Evaluation Report Received: February 19, 2011	Designated Office File Number: 2010-0268
DO Contact Name: Daniel Beaudoin	Phone: (867) 634- 4040
Fax: (867) 634--4049	Email: daniel.beaudoin@yesab.ca
Address: P.O. Box 2126 Haines Junction, Yukon Y0B 1L0	

Part 7: Overall Recommendation and Decision

The following overall recommendation was provided by the Haines Junction Designated Office under YESAA subsection 56(1).

	56(1)(a): The Designated Office recommended that the project be allowed to proceed because it determined that the project will not have significant adverse environmental or socio-economic effects in or outside Yukon.
X	56(1)(b): The Designated Office recommended that the project be allowed to proceed, subject to specified terms and conditions, because it determined that the project will have significant adverse environmental or

	socio-economic effects in or outside Yukon that can be mitigated by those terms and conditions.
	56(1)(c): The Designated Office recommended that the project not be allowed to proceed because if determined that the project will have significant adverse environmental or socio-economic effects in or outside Yukon that cannot be mitigated.

Overall Decision of Kluane First Nation					
In accordance with the requirements of YESAA section 75, the Kluane First Nation, having considered the above recommendation including scientific information, traditional knowledge and other information provided with the recommendation, and having carried out consultation required under YESAA,					
X	Accepts		Rejects		Varies
the recommendation					

Reasons for Overall Decision
Specify reasons for variation:

Part 8: Decisions re: Terms and Conditions

Terms and Conditions Accepted
The following mitigative measures shall be complied with: 1) The proponent shall manage residential refuse in a manner that prevents access by bears and other wildlife, until the refuse and wastes can properly be disposed of by hauling to a licensed landfill facility. 2) The proponent shall ensure effective temporary and permanent erosion and sediment control measures are implemented on disturbed areas during and after construction to prevent erosion and sedimentation. Where applicable, measures shall be instituted in advance of ground disturbance.

Terms and Conditions Rejected	
List terms and conditions rejected	Specify reasons for rejecting terms and conditions

Terms and Conditions Varied or Added		
List terms and conditions that were varied – original version in this column	Specify varied terms and conditions or added terms and conditions	Specify reasons for varying or adding terms and conditions

The following accepted terms and conditions require project audits and/or effects monitoring:

List accepted terms and conditions that require project audits or effects monitoring

Part 9: Consultation

Mandatory Consultation with Other Decision Bodies (section 78)
Describe process, timing and results for consultation with other Decision Bodies including form of consultation, dates, correspondence, results, etc.
Is this a consolidation Decision Document for two or more Decision Bodies? Yes X No
If "Yes"{ identify which Decision Bodies?

Mandatory Consultation with Non-Self-Governing First Nation(s)
Is the proposed project located wholly or partly in the traditional territory of a non-self-governing First Nation, or might the project have significant adverse environmental or socio-economic effects in that territory? Yes X No
If "Yes", describe process, timing and results for consultation with the non-self-governing First Nation(s) including form of consultation, dates, correspondence, results, etc.

Other Consultation
Describe additional consultation that the Kluane First Nation chose to carry out to support its internal decision making process – i.e. consultation with First Nation members, elders, etc., if appropriate

Distribution List

	Person or Agency	Contact Information
Other Decision Bodies		
Proponent		
Designated Office		
Others Required Under YESAA (see section 81)		
Others (voluntary)		

Kluane First Nation

Yukon Environmental & Socio-economic Assessment Act
Decision Document

This document meets the requirements of a Decision Document as set out in the *Yukon Environmental & Socio-economic Assessment Act*

Decision Document Issued By

YG Decision Body:	N/A
Federal Decision Body(ies):	N/A
First Nation Decision Body(ies):	**Kluane First Nation**

Project

Project Name : Burwash Geoexchange Test Well	**YESAA File Number: 2010-0268**
Proponent Name:	Yukon Government- Community Services

Project Description:

The principal activity of the proposed project is the drilling of a geoexchange test well and associated activities for the extraction of groundwater, as well as to determine the geothermal potential and hydrological conditions of the area. The project is located in the community of Burwash Landing on Kluane First Nation settlement block KFN C-4B. Activities associated with this project are proposed to occur for approximately one month and be completed by the summer of 2011. The well may remain open to provide the community water supply or for geoexchange application, or be abandoned and reclaimed after project testing.

Associated activities include:
- Use of heavy machinery for activities including clearing, excavation and drilling;
- Potential clearing of drill site and adjacent area (approximately 60 m_2);
- Drilling of one borehole (152 mm diameter x 460 m deep); and
- Collecting of water samples and installation of monitoring equipment within well.

Accessory activities include:
- Potential excavation of sump for excess water if flowing water encountered;
- Storage of up to 600 litres of petroleum product in Tidy Tanks for refueling equipment; and
- Removal of equipment upon project completion.

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SPILL CONTINGENCY PLAN

EBA FILE: W23101568 **DATE:** July 13, 2012

SUBJECT: SPILL CONTINGENCY PLAN – GEOTHERMAL EXPLORATION DRILLING, BURWASH LANDING, YUKON

1.0 INTRODUCTION

The following Spill Contingency Plan (SCP) has been prepared for use by Fyfe Well and Water Services and EBA Engineering Consultants LTD, operating as EBA, A Tetra Tech Company (hereafter, EBA) during drilling, construction, testing and associated activities of the proposed geoexchange/water supply test well in Burwash Landing, Yukon (see EBA Proposal numbered W23101380 of June 17, 2011). The test well is to be drilled on a pre-selected Site (see Figure 1 attached).

EBA is committed to protecting the safety of its employees, subcontractors, and the environment in which we work. Spill response planning addresses the potential for accidents involving chemicals on the Site and is an essential part of emergency preparedness and safety planning. The purpose of this SCP is to ensure that all personnel are adequately informed in the event of a spill to ensure that the crew is protected and impacts to the environment are minimized. All personnel involved with the project should be familiar with the spill response plan and the procedures outlined herein. Personnel should be informed and aware of storage locations of fuel and other chemicals that may be used on the Site. Any concerns involving potential spill situations should be reported to the site Supervisor and the onsite EBA personnel.

2.0 ACCESS TO SITE

The Site will be accessed via existing roads in Burwash Landing. All chemicals will be properly stored to prevent tampering when personnel are offsite. All excess chemicals will be removed from the Site after completion of well construction and testing. Any spills occurring during mob and demob to the Site will be treated according to the procedures outlined in this SCP.

3.0 SPILL PREVENTION PROCEDURE

The primary substance which could be spilled at the Site is hydrocarbons in the form of fuel, hydraulic fluid or engine lubricants.

To prevent a spill of fuel/hydrocarbons on the Site, the land surrounding the Site or enroute to the Site, the following procedures will be adopted:

- All heavy equipment will be regularly inspected for any leakage and repaired accordingly to prevent any potential spills ;
- Any storage of potentially hazardous liquids will include appropriate containment, and be permitted in accordance with applicable regulations;
- Machinery will be washed, refuelled and serviced well away from any water body to prevent any deleterious substances from entering a watercourse;
- All personnel will be trained and aware of the procedures listed in this section of the plan;
- Equipment used for the work will be clean and in good working order;
- All transfers of fuel will be continually monitored to prevent overfilling or spills resulting from transfer hoses becoming dislodged; and,
- Any leaking equipment will be repaired as appropriate and in a timely fashion.

4.0 SPILL RESPONSE PROCEDURE

All onsite personnel will be informed of the procedures detailed in this SCP during the project safety kick-off meeting and a minimum of two (2) copies of the plan will be maintained onsite for reference during the project activities.

In the event of a hydrocarbon spill or leak onsite, the following general procedures will be considered:

1. First consider and then remove or minimize any hazard to human life, health, safety, or the environment;
2. Take necessary steps to initially contain or prevent the spread of the spill;
3. Try to identify and stop the source of the spill or leak;
4. Collect liquids through the use of such equipment as absorbent pads and/or vacuum trucks;
5. Immediately collect and store any contaminated soil resulting from the spill to be transported to an appropriate facility at a later date;
6. Notify the Site Supervisor;
7. Send for help if required;
8. Report the spill to and get direction from the Yukon Spills Report Centre (867) 667-7244 regarding additional response procedures and the disposal of contaminated material; and,
9. Complete the collection and disposal of contaminated materials as per directions from regulatory agencies or applicable regulations.

5.0 SPILL RESPONSE EQUIPMENT

A spills response kit will be available at the Site. The following or similar equipment will be included in the spills kit:

- Two packages of hydrocarbon adsorbent pads;
- Two rolls of paper towel;
- Two pairs of safety goggles;
- Two pairs of disposable Nitrile gloves;
- Two pairs of PVC oil resistant gloves;
- Ten large plastic garbage bags;
- One 45-gallon drum; and,
- Two spade shovels.

6.0 REPORTING

Spills will be reported to the Site Supervisor immediately. If the spill is greater than 100 L, the spill information will be brought to the attention of the Yukon Spills Report Centre 867.667.7244. Spill reporting should be immediate.

7.0 CONTACTS

Table 1 summarizes project contact information.

Table 1: Project Contacts

ROLE	NAME	TELEPHONE NUMBER	EMAIL
YG Senior Program Manager	Tom Renwick	867.456.6108	tom.renwick@gov.yk.ca
YG Backup Project Manager	Mark Thorvaldson	867.456.6187	mark.thorvaldson@gov.yk.ca
EBA Project Manager	Stephan Klump	867.335.4695	sklump@eba.ca
EBA Backup Project Manager	Ryan Martin	867.335.1598	rmartin@eba.ca
EBA Field Hydrogeologist	Sarah Sternbergh	867.668.3068	ssternbergh@eba.ca
EBA Environmental & Safety Advisor	Don Wilson	867.335.1750	dwilson@eba.ca
Drilling Supervisor	Jim Fyfe	250.248.0830	jfyfe@bcsupernet.com
Grouting Supervisor	Rick Cronin	604.308.3165	drillshark@shaw.ca
KFN Public Works Director	Bob Dickson	867.841.4274	pwms.director@kfn.ca

The applicable emergency contacts for this Spill Contingency Plan are summarized in Table 2.

Table 2: Emergency Contact Numbers for Burwash Landing, Yukon

ORGANIZATION OR DEPARTMENT	TELEPHONE NUMBER
Kluane First Nation - Burwash	867.841.5506
Ambulance - Burwash Landing	867.841.4444
Police- Burwash Landing	867.634.5555
Fire – Burwash Landing	867.841.2221
Emergency Spill Reporting	867.667.7244
Environmental Complaints/Violations	867.667.7244
Forest Fire-Yukon	888.798.3473
Poison Centre-Whitehorse	867.393.8700
Occupational Health and Safety-Whitehorse (24hrs)	867.667.5450

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FLOWING WELL CONTG. PLAN

EBA FILE: W23101568 **DATE:** July 13, 2012

SUBJECT: FLOWING WELL CONTINGENCY PLAN – GEOTHERMAL EXPLORATION DRILLING, BURWASH LANDING, YUKON

1.0 INTRODUCTION

The following Flowing Well Contingency Plan (FWCP) has been prepared for use by Fyfe Well and Water Services and EBA Engineering Consultants LTD, operating as EBA, A Tetra Tech Company (hereafter, EBA) during drilling, construction, testing and associated activities of the proposed geoexchange/water supply tests well in Burwash Landing, Yukon (see EBA Proposal numbered W23101380 of June 17, 2011).

EBA is committed to protecting the safety of its employees, subcontractors, and the environment in which we work. This FWCP addresses the potential for encountering flowing artesian well conditions during the drilling process. The purpose of this FWCP is to ensure that all personnel are adequately informed in the event of encountering such conditions to ensure that the crew is protected and impacts to the environment are minimized. All personnel involved with the project should be familiar with the FWCP and the procedures outlined herein.

2.0 DURING PROJECT ACTIVITIES

2.1 Flowing Well Control Measures

During the project activities it is expected (due to the planned depth of the exploration hole) that there is a chance of encountering artesian conditions. In the event of encountering flowing artesian conditions, measures will be taken to control the flow and/or confine the water produced.

2.1.1 Blowout Prevention

As pressurized aquifers may present a safety concern for drilling and engineering personnel onsite, the drilling contractor will take measures (such as the use of a blowout preventer) to protect personnel and equipment on site in the case of a sudden encounter of high pressure artesian conditions.

2.1.2 Flow Control Measures

If artesian conditions are encountered that do not present the potential for erosion of the wellbore when confined, flow will be controlled through appropriate action and drilling activities will continue as planned.

2.1.3 Infiltration Sump and Discharge of Water

In the event that the borehole encounters artesian flow that cannot be readily controlled, e.g., due to the risk of wellbore erosion, flow will be directed to an onsite sump where sediments can settle out. Excess water from the sump will be directed to an area where it can infiltrate to ground without any risk of flooding infrastructure or causing erosion. The best infiltration area will be determined based on flows encountered but would include the forested area to the northeast of the drill site and the pothole lake to the north of the drill site. Water samples will be collected for chemical analysis to ensure that infiltration of the water to ground is not of any environmental concern.

Measures will be taken immediately to secure the wellbore and control the flow as quick as possible without risking erosion and uncontrolled flow around the outside of the conductor casing.

3.0 UPON PROJECT COMPLETION

3.1 Flowing Well Completion

In the case that the exploration well is completed in an artesian aquifer, the well will be constructed according to accepted artesian well construction guidelines as outlined in the Canadian Groundwater Association Guidelines for Water Well Construction such that all flow is controlled.

3.2 Well Abandonment

If the decision will be made to abandon the flowing well, the well has to be permanently sealed to prevent any flow from the well or cross-formational flow through the abandoned wellbore.

4.0 COMMUNICATION

In the event that flowing artesian conditions are encountered during the drilling, the drilling contractor will immediately notify the EBA field hydrogeologist.

The EBA field hydrogeologist will contact the EBA Project Manager who will notify the YTG Project Manager and Kluane First Nation Public Works Director.

Upon assessment of the conditions encountered, further agencies will be informed as necessary.

5.0 CONTACTS

The applicable emergency contacts for this Flowing Well Contingency Plan are summarized below in Table 1.

Table 1: Flowing Well Emergency Contacts

ROLE	NAME	TELEPHONE NUMBER	EMAIL
YG Senior Program Manager	Tom Renwick	867.456.6108	tom.renwick@gov.yk.ca
YG Backup Project Manager	Mark Thorvaldson	867.456.6187	mark.thorvaldson@gov.yk.ca
EBA Project Manager	Stephan Klump	867.335.4695	sklump@eba.ca
EBA Backup Project Manager	Ryan Martin	867.335.1598	rmartin@eba.ca
EBA Field Hydrogeologist	Sarah Sternbergh	867.668.3068	ssternbergh@eba.ca
Drilling Supervisor	Jim Fyfe	250.248.0830	jfyfe@bcsupernet.com
Grouting Supervisor	Rick Cronin	604.308.3165	drillshark@shaw.ca
KFN Public Works Director	Bob Dickson	867.841.4274	pwms.director@kfn.ca
Yukon Water Board		867.456.3980	
Yukon Environment, Water Resources		867.667.3171	

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TECHNICAL MEMO

ISSUED FOR USE

TO:	Tom Renwick, Government of Yukon Community Services	**DATE:**	August 29, 2012
C:		**MEMO NO.:**	5
FROM:	Sarah Sternbergh, EBA, A Tetra Tech Company	**EBA FILE:**	W23101568

SUBJECT: Work Completed - Burwash Geothermal Exploration Program

1.0 INTRODUCTION

Government of Yukon Community Services (GYCS), operating on behalf of Kluane First Nation (KFN), retained EBA, A Tetra Tech Company operating as EBA Engineering Consultants, Ltd. (EBA) and Fyfe Well and Water Services (Fyfe) of Qualicum Beach, BC to complete a deep geothermal exploration well in Burwash Landing, Yukon. From July 15th through August 24th an EBA representative was onsite to oversee the completion of the deep geothermal test well and an additional shallow water supply well. Both wells were completed by Fyfe.

This technical memo is intended to summarize the work completed onsite, the materials and aquifers encountered during drilling and the site work that is required to complete the project.

2.0 WORK COMPLETED

2.1 Shallow Well

As part of the deep geothermal drilling project, Fyfe drilled a shallow supply well intended to supply clean water for drilling purposes. Upon encountering an artesian flowing aquifer at a depth of 69.8 m (229 feet) below ground surface (bgs), EBA and Fyfe consulted with KFN Chief Math'ieya Alatini and Government of Yukon representative Mark Thorvaldson, who approved completion of the well as a permanent supply well.

2.1.1 Completion

This well was completed in a cold (about 1-2 degrees Celsius) aquifer hosted in gravel and is intended as a potential back up supply well for the community of Burwash. The well is completed with a 100-slot screened section from 69.8 to 72.5 m bgs (229 to 238 feet).

This well was completed in accordance with Yukon regulations for Large Public Drinking Water Supply wells and includes a surface sanitary seal, sufficient well casing stick-up and adequate offset from potential sources of contamination.

Following the labelling system established in previous work for KFN, EBA will label this well KFN-K in well completion documentation.

2.1.2 Testing

Hydraulic and water quality testing was completed on this well from August 23rd to 24th. Results of these tests will be provided in a well completion report to follow.

2.2 Deep Well

The purpose of this program was to complete a deep geothermal test well to establish if there is potential to capture heat energy from groundwater to supply heating purposes for the community of Burwash.

2.2.1 Completion

The deep well was completed at a depth of 387.4 m bgs (1271 feet) in a warm water (15.9 degrees Celsius) artesian flowing aquifer with a 10-slot screened section extending from 384.0 to 387.4 m bgs (1260 to 1271 feet).

This well was completed in accordance with Yukon regulations for Large Public Drinking Water Supply wells and includes a surface sanitary seal, sufficient well casing stick-up and adequate offset from potential sources of contamination.

Following the labelling system established in previous work for KFN, EBA will label this well KFN-L in well completion documentation.

2.2.2 Testing

Hydraulic and water quality testing was completed on this well from August 20th to 23rd. Results of these tests will be provided in a well completion report to follow.

2.3 Site upgrades

During the course of the drilling project, several site upgrades were required to improve the drill pad stability and site drainage. These included trucking about 80 loads of gravel to build up the drill site, improvements to ditching from the drill site to the culvert near the Burwash Cemetery, the installation of two new culverts, the installation of two settling sumps on the drill site, and the temporary installation of a pump and lay flat hosing from the drill site to a small pothole lake next to Kluane Lake. Note that all groundwater produced during well drilling and testing (<300 m^3/day) was discharged into the existing drainage system. No water has been discharged into the forested area to the northeast of the site, into the pothole lake next to Kluane Lake, or directly into Kluane Lake.

This site work was completed by KFN as well as several contractors under the coordination and supervision of KFN.

3.0 LITHOLOGY AND AQUIFERS ENCOUNTERED

3.1 Shallow Well KFN-K

KFN-K was completed in a gravel aquifer with a screened section from 69.8 to 72.5 m bgs (229 to 238 feet). The lithology and water bearing zones (aquifers) encountered are summarized below.

Depth (m bgs)		Lithology Description	Aquifer Description
From	To		
0.0	0.6	Gravel fill	
0.6	1.8	Organic SILT, frequent organic inclusions, dark brown	
1.8	7.6	SILT (till), some sand to sandy, trace to some gravel, medium grey-brown, frozen	
12.2	16.8	SAND, (till), silty, trace fine gravel, light to medium grey, frozen	
16.8	18.3	SILT (till), gravelly, trace sand, intervals of trace clay, dark grey, frozen	
18.3	55.2	SAND, silty, trace gravel, fine-medium sand, dark grey, unfrozen	Approx. 10 -15 USgpm, silty
55.2	70.4	SILT (till) trace to some gravel, trace to some sand, dark grey	
70.4	72.5	GRAVEL, sandy, trace-some silt	Approx. 65 USgpm flowing artesian
72.5	73.5	SILT (till), medium - dark grey, End of hole	

3.2 Deep Well KFN-L

KFN-L was completed in a sand aquifer with a screened section from 384.0 to 387.4 m bgs (1260 to 1271 feet). The lithology and water bearing zones noted in this borehole are summarized below.

Depth (m bgs)		Lithology Description	Aquifer Description
From	To		
0	48.8	SILT (till) variable amounts of sand and gravel, zones of trace clay, frozen from about 2 m	
48.8	50.9	SAND, silty (fluvial),dark grey, unfrozen, water bearing	10-15 USgpm
50.9	71.6	SILT and SAND (till), trace gravel, trace cobbles, zones of trace clay	
71.6	74.7	GRAVEL, sandy, trace cobbles trace silt, water bearing	10-15 USgpm
74.7	85.3	SILT (till), sandy, trace gravel, trace clay	
85.3	89.3	SAND, gravelly, silty, trace cobbles	
89.3	90.5	GRAVEL, sandy, some silt, water bearing	Artesian, flowing
90.5	125	SILT (till), some sand, trace gravel, trace clay, boulders to 5.5 m	
125	128	GRAVEL, sandy, some silt, likely water bearing	unknown - controlled by mud
128	145.1	SILT (till), sandy, gravelly, some clay (pellets), hard drilling	
145.1	163.1	SAND and GRAVEL, trace silt, easier drilling, likely water bearing	unknown - controlled by mud

Depth (m bgs)		Lithology Description	Aquifer Description
From	To		
163.1	303.9	CLAY and SILT (very hard, overconsolidated till), trace sand, grades from trace gravel to gravelly, soft clay zone from 174 to 180	
303.9	309.8	Fracture zone SAND and SILT, possibly water bearing	unknown - controlled by mud
309.8	377.9	CLAY and SILT (very hard, overconsolidated till), trace sand, trace gravel, GRAVEL, trace sand, trace organics (sticks) from 365.8 to ~367	
377.9	384.0	Kluane Schist (BEDROCK/Boulder?)	
384.0	387.4	SAND, trace to some silt, water bearing, End of Hole	Artesian, ~10 USgpm flow

4.0 RECOMMENDED SITE WORK

EBA recommends the following be completed to secure the well site:

- Re-grade site to ensure drainage is away from the wellheads;
- Backfill sumps;
- Remove sump pump equipment from the site;
- Install either fencing around the site or wellhead protection such as bollards to protect wells from damage due to vehicle access to the site;
- Install heat trace into both wellheads to ensure that wells are maintained in a thawed state through the winter;
- Complete drainage upgrades in the vicinity of the site to ensure that ponding of water in the wellhead area is prevented; and,
- Update wellhead protection planning to include KFN-K and KFN-L.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Kluane First Nation/Government of Yukon Community Services and their agents. EBA Engineering Consultants Ltd. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than of Kluane First Nation/Government of Yukon Community Services, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's General Conditions that are attached to this memo.

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA’s client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA’s Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX C

APPENDIX C PARTICLE SIZE ANALYSIS FOR WELL SCREEN DESIGN

GRAIN SIZE DISTRIBUTION

ASTM C136 & D422

Project: Government of Yukon, Community Services

Project Number: W23101568

Date Tested: 8/14/2012

Borehole Number: KFN-L

Depth: 1261 ft

Soil Description: 0

Cu: N/A

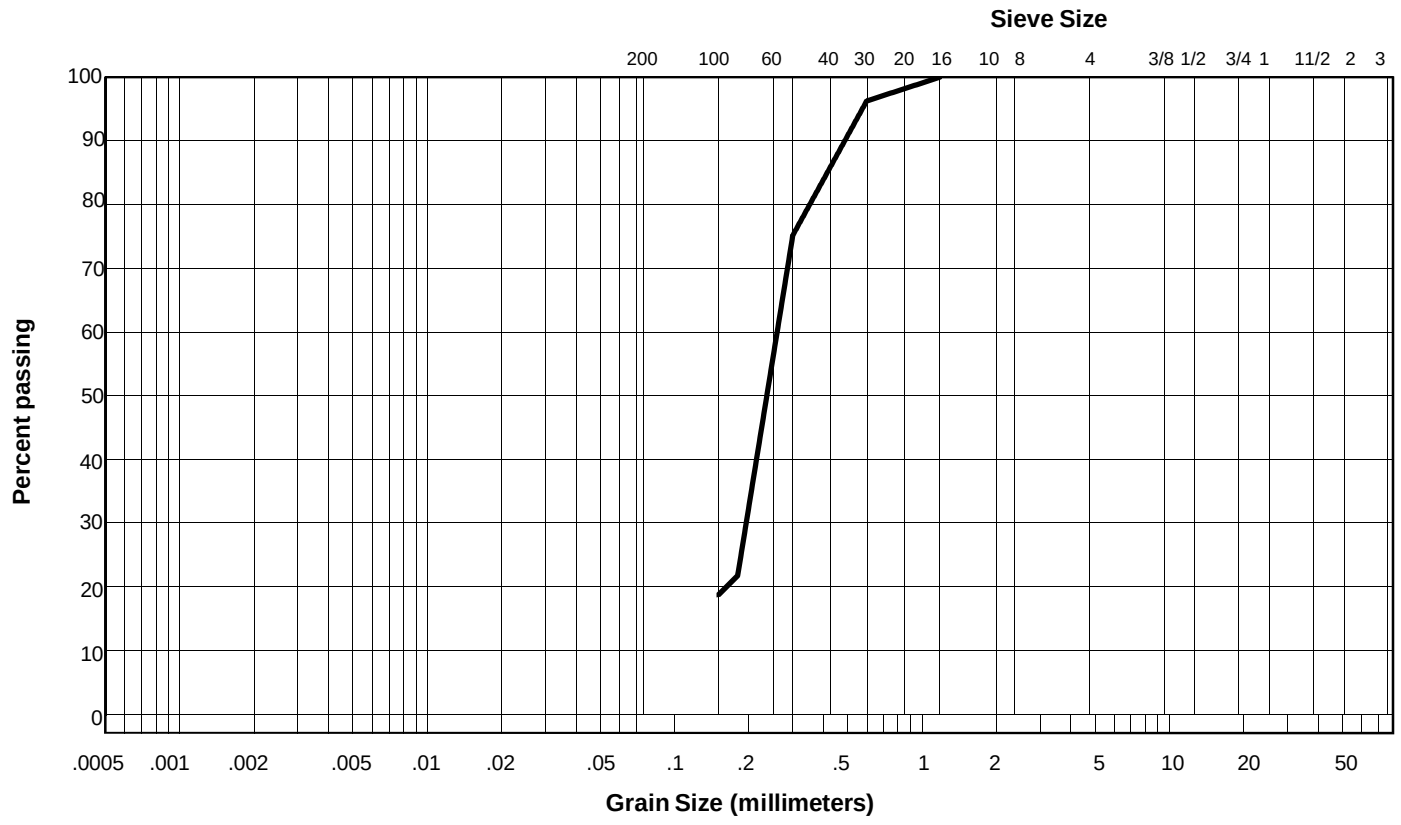
Cc: N/A

Natural Moisture Content: N/A

Remarks:

Sieve Size	Percent Passing
50.0	#N/A
37.5	#N/A
25.0	#N/A
19.0	#N/A
12.5	#N/A
9.5	#N/A
4.75	#N/A
2.36	#N/A
1.180	100.0
0.600	96.2
0.300	75.09
0.180	21.78
0.150	18.77

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: _____

EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

ASTM C136 & D422

Project: Government of Yukon, Community Services

Project Number: W23101568

Date Tested: 8/14/2012

Borehole Number: KFN-L

Depth: 1261 ft

Soil Description: 0

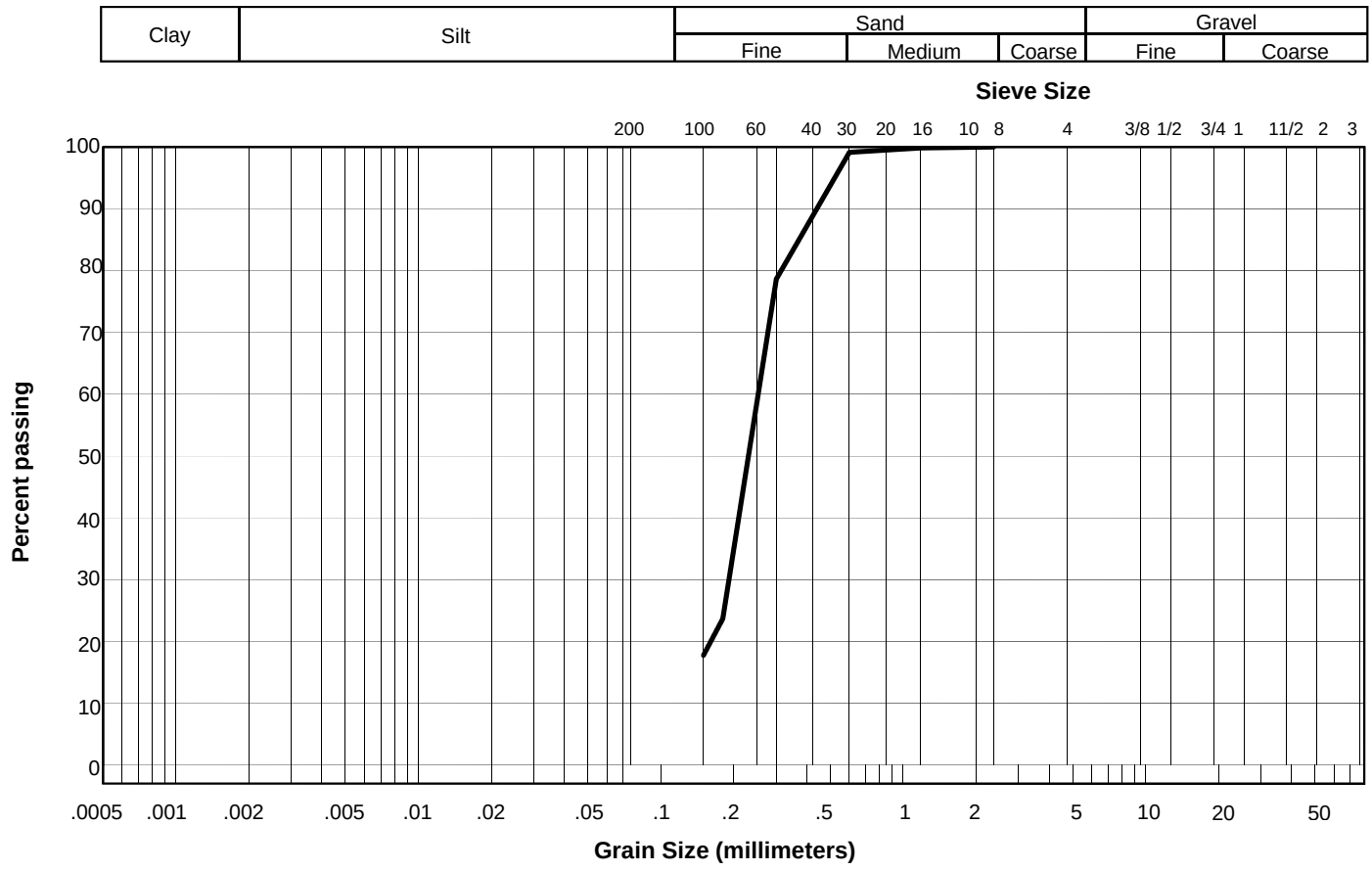
Cu: N/A

Cc: N/A

Natural Moisture Content: N/A

Remarks:

Sieve Size	Percent Passing
50.0	#N/A
37.5	#N/A
25.0	#N/A
19.0	#N/A
12.5	#N/A
9.5	#N/A
4.75	#N/A
2.36	100.0
1.180	99.8
0.600	99.1
0.300	78.67
0.180	23.72
0.150	17.75



Reviewed By: _____

EBA Engineering Consultants Ltd.

APPENDIX D

APPENDIX D DRILLERS WELL LOG

Fyfe WELL & WATER SERVICES

(Division of Fyfe Holdings Ltd.)
1541 Winchester Road, Qualicum Beach, B.C. V9K 1Y2
T: 250.752.4986 F: 250.752.4987

CLIENT: Yukon Government / Kluane First Nation — 6-inch Geothermal Test **Water Well** (Well Tag 22505)

CONTACT : Tom Renwick, - Program Manager — PHONE: Tel: 867.456.6108

MAILING ADDRESS: 2071 Second Avenue, P.O. Box 2703, Whitehorse Yukon Y1A 2C6

WELL LOCATION: Kluane First Nation - Burwash Landing, Yukon — GPS: N 61° 21.210´ W 138° 58.685´ Approx. Elev: 2,650 Ft AMSL

PROPOSED USE:

	Residential	X	Geothermal	X	Community
	Irrigation	X	Test Well		Domestic

TYPE OF WORK:

	Well Tag ID No.:	22505		
X	New Well	Method:	X	Air Rotary
X	Mud Rotary			Cable Tool
	Reconditioned/Altered		X	Dual Rotary

WELL DIMENSIONS:

Diameter of Production Well:	6	Inches
Total Depth Drilled:	1268	Ft bgl
Depth of Completed Well:	1271	Ft btoc

CONSTRUCTION DETAILS:

Well Casing:				X	Welded		
8	in	.250	in dia frm	0	ft. to	276	ft.
6	in	.250	in dia frm	0	ft. to	1258	ft.
Drive Shoe:		x	Yes	No	Size:	6	in.
Surface Seal:				X	Yes	12	in.
Material used in seal:				Neat Cement / Bentonite Chips			
Well Liner:					Yes	X	No
Type / Size					PVC		in.

WELL SCREEN INFORMATION:

6	in. dia.	10	slot frm.	1260	ft. to	1271	ft.
	in. dia.		slot frm.		ft. to		ft.
Total Screen Assembly Length:						13	ft.

WELL INFORMATION SUMMARY:

Final Well Depth:			1271	Feet
Total Well Casing Installed:			1257/09	Ft/in
Casing Stick-Up:			2	Ft agl
Estimated Well Yield:			100+	US gpm
Static Water Level:	*Artesian*		15	US gpm
Well Development Information:				
Development method:	X	Air	Bail	X Pump
Development time (hrs):		8		72+
Water Quality Notes (eg: Taste, Odour, Colour, Sand, etc.)				
clear, no odor, 17 deg C, effervescent, no sediment				

STRATUM (FT)		MATERIAL DESCRIPTION	CASING (FT/IN)	
		LITHOLOGY	***section***	***total***
0	2	clean brown sand & gravel (fill)	**12-inch Casing**	
2	6	soft, brown-black organic rick	0	20/03
		sandy silt/clay	20/00	40/03
6	25	compact brown silty sand & gravel	20/00	60/03
		(frozen - perma frost)	- 60/03	00/00
25	60	compact grey Till	**8-inch Casing**	
60	115	increase in gravel, cobbles	0	280/02
115	175	slightly less compact	- 0/06	279/08
175	181	w/b - medium to coarse grey sand	- 3/05	276/03
		with some gravel.	**8-inch Casing**	
181	231	compact grey Till	0	1265/06
230	238	w/b - coarse grey sand & gravel	- 5/00	1260/06
		artesian flowing 50+ gpm - clear	- 2/09	1257/09
238	241	compact grey Till		
290	295	w/b - coarse S & G (artesian)		
295	302	compact grey Till		
302	318	Bedrock? (greenish-black)		
		(Kluane schist appearance)		
318	410	mudstone - very compact		
410	420	w/b? very fractured schist		
		(wood in drill cuttings)		
420	445	mudstone - very compact		
445	476	very hard, greenish black schist		
476	540	loose, fractured schist		
540	560	very hard, greenish black schist		
560	590	cemented till - very compact		
590	650	mudstone - very compact		
650	685	cemented till - very compact		
685	1240	alternates between mudstone		
		and cemented till (v. hard)		
1240	1254	coarse, fractured geenish-black		
		(bed) rock		
1254	1257	very dense (bed) rock		

WELL CONSTRUCTION PERSONNEL:

Driller:	Jim Fyfe	License Number:	WD 05101401
Crewman:	Kyle / Kevin	Engineer/Tech:	EBA - Yukon
Start Date:	Aug 19, 2012	Completion Date:	Aug 25, 2012
Driller's Signature:	Jim Fyfe		

Fyfe WELL & WATER SERVICES

(Division of Fyfe Holdings Ltd.)
1541 Winchester Road, Qualicum Beach, B.C. V9K 1Y2
T: 250.752.4986 F: 250.752.4987

CLIENT: Yukon Government / Kluane First Nation — 6-inch Geothermal Test **Water Well** (Well Tag 22505)

CONTACT : Tom Renwick, - Program Manager — PHONE: Tel: 867.456.6108

MAILING ADDRESS: 2071 Second Avenue, P.O. Box 2703, Whitehorse Yukon Y1A 2C6

WELL LOCATION: Kluane First Nation - Burwash Landing, Yukon — GPS: N 61° 21.210´ W 138° 58.685´ Approx. Elev: 2,650 Ft AMSL

PROPOSED USE:

	Residential	X	Geothermal	X	Community
	Irrigation	X	Test Well		Domestic

TYPE OF WORK:

	Well Tag ID No.:	22505			
X	New Well		Method:	X	Air Rotary
X	Mud Rotary				Cable Tool
	Reconditioned/Altered			X	Dual Rotary

WELL DIMENSIONS:

Diameter of Production Well:	6	Inches
Total Depth Drilled:	1268	Ft bgl
Depth of Completed Well:	1271	Ft btoc

CONSTRUCTION DETAILS:

Well Casing:				X	Welded			
8	in	.250	in dia frm	0	ft. to	276	ft.	
6	in	.250	in dia frm	0	ft. to	1258	ft.	
Drive Shoe:		x	Yes	No	Size:	6	in.	
Surface Seal:				X	Yes	12	in.	
Material used in seal:				Neat Cement / Bentonite Chips				
Well Liner:					Yes	X	No	
Type / Size					PVC		in.	

WELL SCREEN INFORMATION:

6	in. dia.	10	slot frm.	1260	ft. to	1271	ft.
	in. dia.		slot frm.		ft. to		ft.
Total Screen Assembly Length:						13	ft.

WELL INFORMATION SUMMARY:

Final Well Depth:		1271	Feet
Total Well Casing Installed:		1257/09	Ft/in
Casing Stick-Up:		2	Ft agl
Estimated Well Yield:		100+	US gpm
Static Water Level:	*Artesian*	15	US gpm
Well Development Information:			
Development method:	X Air	H_2O	X Pump
Development time (hrs):	8	8	72+
Water Quality Notes (eg: Taste, Odour, Colour, Sand, etc.)			
clear, no odor, 17 deg C, effervescent, no sediment			

STRATUM (FT)		MATERIAL DESCRIPTION	CASING (FT/IN)	
		LITHOLOGY	***section***	***total***
		(continued from Page 1)		
1240	1254	coarse, fractured geenish-black		
		(bed) rock		
1254	1257	very dense (bed) rock		
		- install 6-inch casing to TD		
		- change to air-hammer drilling		
		- attempt to advance casing with		
		eccentric hammer bit		
		- production casing cannot be		
		rotated or advanced		
		- cleaned hole to TD, no formation		
		water entering production casing		
		- changed to 6-inch air hammer		
1257	1260	hard, dense greenish-black rock		
1260	1271	w/b - fine to medium grey sand		
		- sand heaving 200 ft up pipe		
		- air-lifting 100 + gpm w/ sand		
		- drill ahead of casing using mud		
		rotary (straight water only)		
		Install 6-inch Telescopic screen		
		assembly c/w 2-ft riser and		
		wash down valve on bottom		
		Develop with water (to start)		
		Air-lift from 800 ft bgs (100 gpm)		
		- sediment diminishing and		
		turbidity decreasing.		
		Complete 8 hr step test and 72 hr		
		constant rate test at 55 gpm		
		Install 150 psi flange well head,		
		2-inch valve & pressure gauge.		

WELL CONSTRUCTION PERSONNEL:

Driller:	Jim Fyfe	License Number:	WD 05101401
Crewman:	Kyle / Kevin	Engineer/Tech:	EBA - Yukon
Start Date:	Aug 19, 2012	Completion Date:	Aug 25, 2012
Driller's Signature:	Jim Fyfe		

APPENDIX E

APPENDIX E MANUAL PUMPING TEST DATA

KFN-L Step Drawdown Test

Time Elapsed (min)	Time Elapsed (s)	Depth to Water (m)	Depth to Water (ft)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Pumping Step
0	0	- artesian		-		
0.5	30	1.98	6.5	-		
1	60	2.58	8.45	-		
1.5	90	2.45	8.05	-		
2	120	2.64	8.65	20	0.0013	
2.5	150	3.54	11.6	30	0.0019	
3	180	4.39	14.4	30	0.0019	
3.5	210	4.72	15.5	30	0.0019	
4	240	5.00	16.41	24	0.0015	
4.5	270	4.75	15.6	23	0.0015	
5	300	4.60	15.1	23	0.0015	
6	360	4.34	14.25	21.3	0.0013	
7	420	4.35	14.28	23.8	0.0015	
8	480	4.37	14.35	23.8	0.0015	
9	540	4.97	16.31	25.1	0.0016	
10	600	4.60	15.08	23.3	0.0015	
12	720	4.74	15.55	24.8	0.0016	
14	840	4.78	15.69	25.3	0.0016	STEP 1 - 25 USgpm
16	960	5.56	18.23	29.4	0.0019	
18	1080	5.40	17.73	26.7	0.0017	
20	1200	5.10	16.72	25.2	0.0016	
25	1500	4.88	16.02	24.8	0.0016	
30	1800	4.89	16.05	24.4	0.0015	
35	2100	5.10	16.72	25	0.0016	
40	2400	4.93	16.16	24.9	0.0016	
45	2700	4.98	16.35	25.3	0.0016	
50	3000	4.92	16.13	24.8	0.0016	
55	3300	4.93	16.18	25	0.0016	
60	3600	4.96	16.28	24.9	0.0016	
70	4200	5.09	16.69	25.3	0.0016	
80	4800	4.96	16.27	25.5	0.0016	
90	5400	4.89	16.03	24.5	0.0015	
100	6000	5.01	16.44	24.9	0.0016	
110	6600	5.05	16.58	25.3	0.0016	
120	7200	5.04	16.55	25.2	0.0016	
120.5	7230	7.16	23.5	49.5	0.0031	
121	7260	8.26	27.1	50.3	0.0032	
121.5	7290	9.30	30.5	50.5	0.0032	
122	7320	9.74	31.95	50.3	0.0032	
122.5	7350	10.18	33.4	50.2	0.0032	
123	7380	10.41	34.15	50.1	0.0032	
123.5	7410	10.62	34.85	50.1	0.0032	
124	7440	10.76	35.3	50.1	0.0032	

KFN-L Step Drawdown Test

Time Elapsed (min)	Time Elapsed (s)	Depth to Water (m)	Depth to Water (ft)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Pumping Step
124.5	7470	10.86	35.62	50	0.0032	
125	7500	10.99	36.05	50	0.0032	
126	7560	11.15	36.58	49.9	0.0031	
127	7620	11.27	36.99	49.9	0.0031	
128	7680	11.34	37.19	49.9	0.0031	
129	7740	11.43	37.51	50.5	0.0032	
130	7800	11.52	37.78	50.1	0.0032	
132	7920	11.52	37.8	50	0.0032	
134	8040	11.55	37.91	50	0.0032	
136	8160	11.58	37.99	49.9	0.0031	STEP 2 - 50 USgpm
138	8280	11.58	38	49.9	0.0031	
140	8400	11.66	38.24	50	0.0032	
145	8700	11.66	38.25	49.8	0.0031	
150	9000	11.67	38.28	49.8	0.0031	
155	9300	11.77	38.63	50.3	0.0032	
160	9600	11.87	38.94	50.2	0.0032	
165	9900	11.82	38.79	49.9	0.0031	
170	10200	11.84	38.84	50.1	0.0032	
175	10500	11.84	38.86	50	0.0032	
180	10800	11.78	38.66	50	0.0032	
190	11400	11.86	38.9	50.1	0.0032	
200	12000	11.82	38.77	50	0.0032	
210	12600	11.83	38.8	50	0.0032	
220	13200	11.80	38.71	50	0.0032	
230	13800	11.71	38.43	50	0.0032	
240	14400	11.78	38.64	50.2	0.0032	
240.5	14430	13.41	43.99	72.2	0.0046	
241	14460	14.93	48.99	74.9	0.0047	
241.5	14490	15.93	52.25	75	0.0047	
242	14520	16.54	54.26	75	0.0047	
242.5	14550	17.13	56.21	75	0.0047	
243	14580	17.40	57.09	74.7	0.0047	
243.5	14610	17.71	58.11	75.1	0.0047	
244	14640	17.87	58.63	75.1	0.0047	
244.5	14670	18.04	59.2	75.2	0.0047	
245	14700	18.09	59.34	75.3	0.0048	
246	14760	18.36	60.24	75.2	0.0047	
247	14820	18.48	60.64	75.1	0.0047	
248	14880	18.56	60.9	75	0.0047	
249	14940	18.62	61.08	75	0.0047	
250	15000	18.66	61.23	75	0.0047	
252	15120	18.82	61.76	75	0.0047	
254	15240	18.91	62.04	75	0.0047	STEP 3 - 75 USgpm

KFN-L Step Drawdown Test

Time Elapsed (min)	Time Elapsed (s)	Depth to Water (m)	Depth to Water (ft)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Pumping Step
256	15360	19.00	62.34	75	0.0047	STEP 3 - 75 USgpm
258	15480	19.03	62.44	74.9	0.0047	
260	15600	19.03	62.44	75.1	0.0047	
265	15900	19.06	62.54	75.1	0.0047	
270	16200	19.08	62.61	75	0.0047	
275	16500	19.11	62.69	75	0.0047	
280	16800	19.10	62.67	75	0.0047	
285	17100	19.12	62.73	75	0.0047	
290	17400	19.12	62.74	74.9	0.0047	
295	17700	19.15	62.84	75	0.0047	
300	18000	19.17	62.9	75	0.0047	
310	18600	19.15	62.83	74.9	0.0047	
320	19200	19.20	62.98	74.9	0.0047	
330	19800	19.10	62.66	74.8	0.0047	
340	20400	19.30	63.33	75.4	0.0048	
350	21000	19.37	63.55	75.4	0.0048	
360	21600	19.35	63.5	75	0.0047	
360.5	21630	21.47	70.43	98.5	0.0062	STEP 4 - 100 USgpm
361	21660	22.73	74.56	99.5	0.0063	
361.5	21690	23.56	77.31	99.9	0.0063	
362	21720	24.23	79.5	100	0.0063	
362.5	21750	24.61	80.74	100.2	0.0063	
363	21780	24.96	81.89	100.3	0.0063	
363.5	21810	25.20	82.69	100	0.0063	
364	21840	25.36	83.21	99.9	0.0063	
364.5	21870	25.50	83.65	100	0.0063	
365	21900	25.63	84.08	100.2	0.0063	
366	21960	25.90	84.98	100.2	0.0063	
367	22020	26.05	85.48	99.8	0.0063	
368	22080	26.21	86	100	0.0063	
369	22140	26.30	86.3	100	0.0063	
370	22200	26.37	86.5	100	0.0063	
372	22320	26.40	86.63	100	0.0063	
374	22440	26.65	87.43	100	0.0063	
376	22560	26.58	87.19	100	0.0063	
378	22680	26.53	87.03	100	0.0063	
380	22800	26.64	87.41	100	0.0063	
385	23100	26.96	88.45	99.7	0.0063	
390	23400	27.12	88.97	100.1	0.0063	
395	23700	27.15	89.06	100.1	0.0063	
400	24000	27.31	89.59	100.1	0.0063	
405	24300	27.34	89.7	99.9	0.0063	
410	24600	27.44	90.01	99.9	0.0063	

KFN-L Step Drawdown Test

Time Elapsed (min)	Time Elapsed (s)	Depth to Water (m)	Depth to Water (ft)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Pumping Step
415	24900	27.70	90.89	100	0.0063	
420	25200	27.72	90.96	100	0.0063	
430	25800	27.73	90.99	100	0.0063	
440	26400	27.73	90.97	100	0.0063	
450	27000	27.86	91.42	100.1	0.0063	
460	27600	27.98	91.79	100	0.0063	
470	28200	28.15	92.34	100.1	0.0063	
480	28800	28.11	92.21	100.1	0.0063	
480.5	28830	13.97	45.82	Recovery		
481	28860	11.53	37.84			
481.5	28890	9.17	30.1			
482	28920	7.50	24.6			
482.5	28950	5.70	18.7			
483	28980	4.49	14.74			
483.5	29010	3.58	11.75			
484	29040	2.94	9.63			
484.5	29070	2.72	8.91			
485	29100	2.04	6.69			
486	29160	1.44	4.73			
487	29220	1.06	3.49			
488	29280	0.77	2.52			
489	29340	0.57	1.88			
490	29400	0.39	1.29			
492	29520	0.15	0.5			
494	29640	Flowing	Flowing			

KFN-L Constant Rate Test

Time Elapsed (m)	Time Elapsed (s)	Depth to water (ft)	Depth to water (m)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Test Step
0	0	0	0	0	0	
0.5	30	24.35	7.42	65	0.0041	
1	60	29.01	8.84	57.5	0.0036	
1.5	90	32.64	9.95	55.8	0.0035	
2	120	34.54	10.53	55.4	0.0035	
2.5	150	35.18	10.72	55.3	0.0035	
3	180	37.12	11.31	55	0.0035	
3.5	210	38.14	11.63	55.5	0.0035	
4	240	38.89	11.85	55	0.0035	
4.5	270	39.49	12.04	55	0.0035	
5	300	39.85	12.15	54.9	0.0035	
6	360	40.55	12.36	54.5	0.0034	
7	420	41.34	12.60	55.2	0.0035	
8	480	41.76	12.73	55.1	0.0035	
9	540	42.08	12.83	55	0.0035	
10	600	42.3	12.89	55	0.0035	
12	720	42.87	13.07	55.2	0.0035	
14	840	43.17	13.16	55	0.0035	
16	960	43.3	13.20	54.9	0.0035	
18	1080	43.47	13.25	55	0.0035	
20	1200	43.51	13.26	54.9	0.0035	
25	1500	44.31	13.51	55.1	0.0035	
30	1800	43.89	13.38	54.6	0.0034	
35	2100	44.21	13.48	55.1	0.0035	
40	2400	44.21	13.48	55	0.0035	
45	2700	44.2	13.47	55	0.0035	
50	3000	44.24	13.48	54.9	0.0035	
55	3300	44.31	13.51	54.9	0.0035	
60	3600	44.51	13.57	54.9	0.0035	
70	4200	44.58	13.59	55.1	0.0035	
80	4800	44.61	13.60	55.1	0.0035	
90	5400	44.64	13.61	55.1	0.0035	
100	6000	44.78	13.65	55.2	0.0035	
110	6600	44.56	13.58	54.9	0.0035	
120	7200	44.53	13.57	54.8	0.0035	
150	9000	44.65	13.61	55	0.0035	
180	10800	44.82	13.66	55.2	0.0035	
210	12600	44.85	13.67	55	0.0035	
240	14400	44.83	13.66	54.9	0.0035	
270	16200	44.78	13.65	54.9	0.0035	
300	18000	45.07	13.74	54.9	0.0035	
330	19800	45.3	13.81	55.1	0.0035	
360	21600	45.18	13.77	54.9	0.0035	
420	25200	45.27	13.80	54.9	0.0035	
480	28800	45.36	13.83	54.7	0.0035	
540	32400	45.85	13.98	55.1	0.0035	
600	36000	45.65	13.91	54.8	0.0035	
660	39600	46.35	14.13	55.5	0.0035	

KFN-L Constant Rate Test

Time Elapsed (m)	Time Elapsed (s)	Depth to water (ft)	Depth to water (m)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Test Step
720	43200	46.5	14.17	55.4	0.0035	55 USgpm Long Term Pumping Test
780	46800	46.65	14.22	55.8	0.0035	
840	50400	47.17	14.38	55.7	0.0035	
900	54000	47.35	14.43	55.7	0.0035	
960	57600	46.94	14.31	55.1	0.0035	
1020	61200	46.88	14.29	54.8	0.0035	
1080	64800	46.8	14.26	54.9	0.0035	
1140	68400	46.78	14.26	54.9	0.0035	
1200	72000	46.78	14.26	54.7	0.0035	
1260	75600	47.1	14.36	55.1	0.0035	
1320	79200	46.9	14.30	55	0.0035	
1380	82800	47.29	14.41	55.1	0.0035	
1440	86400	47.1	14.36	55	0.0035	
1500	90000	47.11	14.36	55	0.0035	
1560	93600	47.14	14.37	55.1	0.0035	
1620	97200	47.4	14.45	55.2	0.0035	
1680	100800	47.18	14.38	55	0.0035	
1740	104400	47.11	14.36	54.9	0.0035	
1800	108000	47.05	14.34	55	0.0035	
1860	111600	47.35	14.43	55.3	0.0035	
1920	115200	47.46	14.47	55.4	0.0035	
1980	118800	47.46	14.47	55.3	0.0035	
2040	122400	47.46	14.47	55.1	0.0035	
2100	126000	47.3	14.42	55.1	0.0035	
2160	129600	47.22	14.39	55.2	0.0035	
2220	133200	47.1	14.36	54.9	0.0035	
2280	136800	47.5	14.48	55.3	0.0035	
2340	140400	47.53	14.49	55.3	0.0035	
2400	144000	47.3	14.42	55	0.0035	
2460	147600	47.32	14.42	55	0.0035	
2520	151200	47.27	14.41	55	0.0035	
2580	154800	47.74	14.55	55.4	0.0035	
2640	158400	47.34	14.43	55	0.0035	
2700	162000	47.31	14.42	54.9	0.0035	
2760	165600	47.35	14.43	55	0.0035	
2820	169200	47.39	14.44	55.1	0.0035	
2880	172800	47.41	14.45	55.2	0.0035	
2940	176400	47.56	14.50	55.1	0.0035	
3000	180000	47.58	14.50	55	0.0035	
3060	183600	47.41	14.45	54.9	0.0035	
3120	187200	47.51	14.48	55.4	0.0035	
3180	190800	47.4	14.45	55	0.0035	
3240	194400	47.5	14.48	55	0.0035	
3300	198000	47.36	14.44	54.8	0.0035	
3360	201600	47.68	14.53	55.2	0.0035	
3420	205200	47.22	14.39	54.9	0.0035	
3480	208800	48.45	14.77	56.1	0.0035	
3540	212400	47.9	14.60	55.4	0.0035	

KFN-L Constant Rate Test

Time Elapsed (m)	Time Elapsed (s)	Depth to water (ft)	Depth to water (m)	Flow Rate (Usgpm)	Flow Rate (m3/s)	Test Step
3600	216000	47.74	14.55	55.2	0.0035	
3660	219600	47.69	14.54	55.2	0.0035	
3720	223200	47.8	14.57	55.2	0.0035	
3720	223200	47.79	14.57	55	0.0035	
3840	230400	47.57	14.50	55	0.0035	
3900	234000	47.38	14.44	54.9	0.0035	
3960	237600	47.42	14.45	54.9	0.0035	
4020	241200	47.74	14.55	55.1	0.0035	
4080	244800	47.35	14.43	55.1	0.0035	
4140	248400	47.42	14.45	54.8	0.0035	
4200	252000	47.78	14.56	55.2	0.0035	
4260	255600	47.83	14.58	55.2	0.0035	
4320	259200	47.5	14.48	55.1	0.0035	
4320.5	259230	31.55	9.62			
4321	259260	21.73	6.62			
4321.5	259290	14.52	4.43			
4322	259320	10.73	3.27			
4322.5	259350	7.91	2.41			
4323	259380	6.13	1.87			
4323.5	259410	4.89	1.49			
4324	259440	3.82	1.16			
4324.5	259470	3.18	0.97	0	0	Recovery
4325	259500	2.61	0.80			
4326	259560	1.75	0.53			
4327	259620	1.2	0.37			
4328	259680	1	0.30			
4329	259740	0.81	0.25			
4330	259800	0.59	0.18			
4332	259920	0.15	0.05			
4332.5	259950	0	0			

APPENDIX F

APPENDIX F PUMPING TEST DATA ANALYSIS

EBA, A Tetra Tech Company

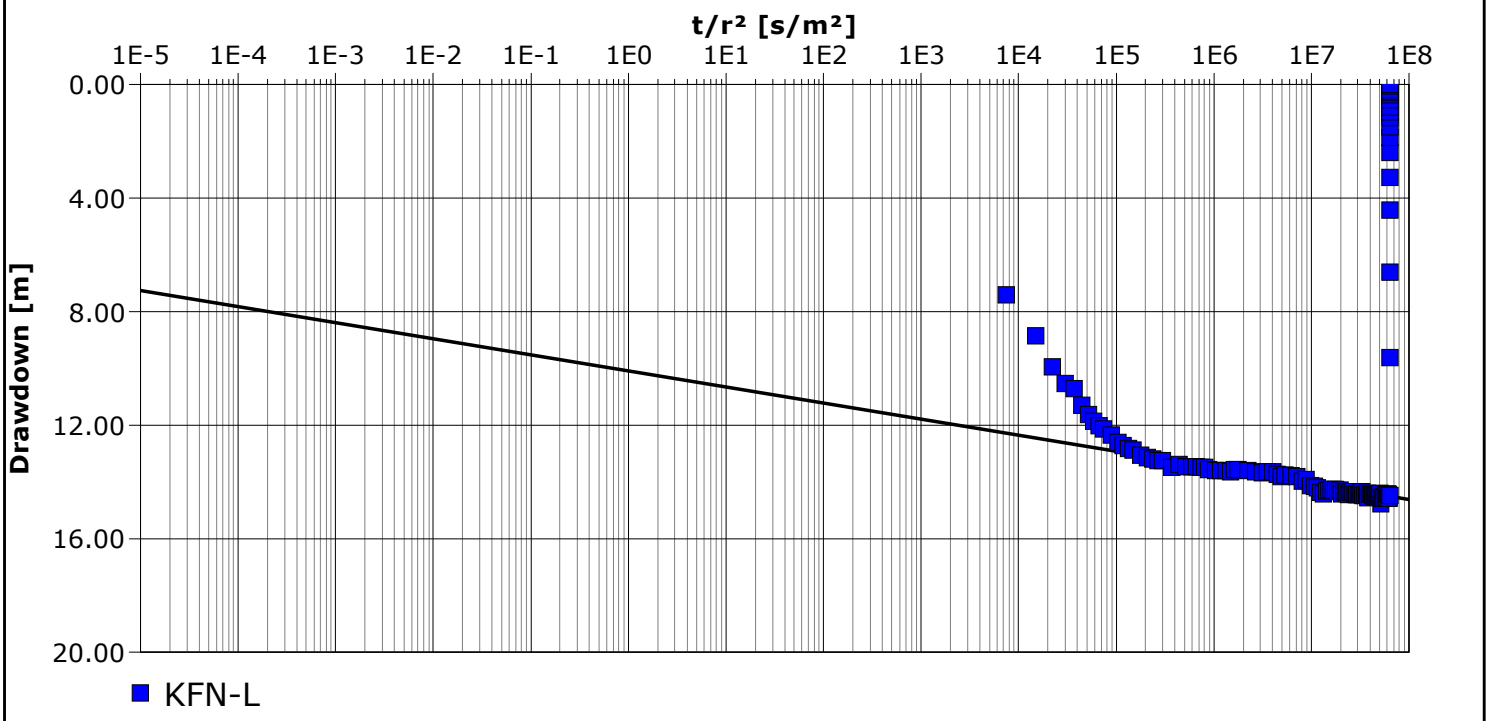
Pumping Test Analysis Report F

Project: Burwash Geothermal Exploration

Number: W23101568

Client: Goverment of Yukon

Location: Burwash Landing, Yukon	Pumping Test: KFN-L	Pumping Well: KFN-L
Test Conducted by: Fyfe Well and Water		Test Date: 8/31/2012
Analysis Performed by: Sarah Sternbergh	Coope Jacob III	Analysis Date: 10/4/2012
Aquifer Thickness: 3.35 m	Discharge: variable, average rate 0.0034751 [m³/s]	



Calculation using COOPER & JACOB

Observation Well	Transmissivity [m²/s]	Hydraulic Conductivity [m/s]	Storage coefficient	Radial Distance to PW [m]	
KFN-L	1.12×10^{-3}	3.35×10^{-4}	3.62×10^{-21}	0.06	

EBA, A Tetra Tech Company

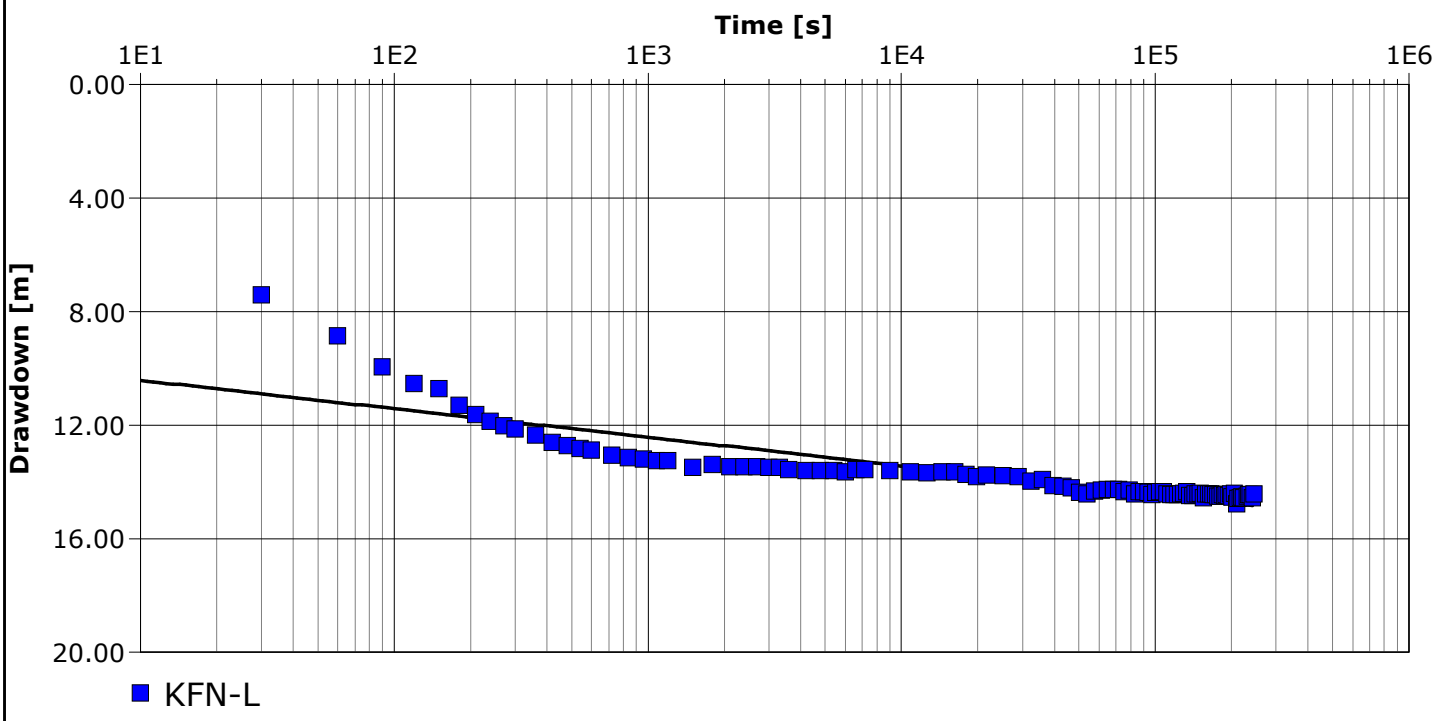
Pumping Test Analysis Report F

Project: Burwash Geothermal Exploration

Number: W23101568

Client: Goverment of Yukon

Location: Burwash Landing, Yukon	Pumping Test: KFN-L	Pumping Well: KFN-L
Test Conducted by: Fyfe Well and Water		Test Date: 8/31/2012
Analysis Performed by: Sarah Sternbergh	Theis	Analysis Date: 8/31/2012
Aquifer Thickness: 3.35 m	Discharge: variable, average rate 0.0034751 [m³/s]	



Calculation using Theis

Observation Well	Transmissivity [m²/s]	Hydraulic Conductivity [m/s]	Storage coefficient	Ratio K(v)/K(h)	Radial Distance to PW [m]	
KFN-L	6.35×10^{-4}	1.89×10^{-4}	1.44×10^{-10}	1.06×10^{-1}	0.06	

APPENDIX G

APPENDIX G LABORATORY RESULTS CERTIFICATES

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Report Transmission Cover Page

Bill To:	EBA Engineering Consultants	Project:		Lot ID:	**884123**
Report To:	EBA Engineering Consultants	ID:	W23101568.004	Control Number:	
	Calcite Business Centre	Name:	Burwash Geoexchange	Date Received:	Jul 26, 2012
	Unit 6, 151 Industrial Road	Location:	Burwash Landing	Date Reported:	Aug 1, 2012
	Whitehorse, YT, Canada	LSD:		Report Number:	1754397
	Y1A 2V3	P.O.:			
Attn:	Stephan Klump	Acct code:			
Sampled By:	SKS				
Company:	EBA				

Contact & Affiliation	Address	Delivery Commitments
Stephan Klump EBA Engineering Consultants Ltd -	Unit 6, 151 Industrial Road, Calcite Business Centre Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-2071 Fax: (867) 668-4349 Email: sklump@eba.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report On [Lot Creation] send (COR) by Email - Single Report
Ingrid Fuller EBA Engineering Consultants Ltd -	Unit 6, 151 Industrial Road, Calcite Business Centre Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-2071 Fax: (867) 668-4349 Email: ifuller@eba.ca	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report

Notes To Clients:

- The Arsenic result in sample 884123-1 exceeded the maximum acceptable concentration (MAC) as specified by the August 5th, 2008 Guidelines for Canadian Drinking Water Quality.
- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

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Analytical Report

Bill To:	EBA Engineering Consultants	Project:		Lot ID:	**884123**
Report To:	EBA Engineering Consultants	ID:	W23101568.004	Control Number:	
	Calcite Business Centre	Name:	Burwash Geoexchange	Date Received:	Jul 26, 2012
	Unit 6, 151 Industrial Road	Location:	Burwash Landing	Date Reported:	Aug 1, 2012
	Whitehorse, YT, Canada	LSD:		Report Number:	1754397
	Y1A 2V3	P.O.:			
Attn:	Stephan Klump	Acct code:			
Sampled By:	SKS				
Company:	EBA				

Reference Number	884123-1
Sample Date	July 18, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	DSW1 / Burwash
Sample Matrix	Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Inorganic Nonmetallic Parameters						
Organic Carbon	Total Nonpurgeable	mg/L	1.0	0.5		
Metals Extractable						
Aluminum	Extractable	mg/L	<0.005	0.005	0.1	Below OG
Antimony	Extractable	mg/L	<0.0002	0.0002	0.006	Below MAC
Arsenic	Extractable	mg/L	0.0121	0.0002	0.01	Above MAC
Barium	Extractable	mg/L	0.037	0.001	1	Below MAC
Boron	Extractable	mg/L	0.501	0.005	5	Below MAC
Cadmium	Extractable	mg/L	<0.00007	0.00007	0.005	Below MAC
Chromium	Extractable	mg/L	0.0015	0.0005	0.05	Below MAC
Copper	Extractable	mg/L	<0.001	0.001	1.0	Below AO
Lead	Extractable	mg/L	<0.0001	0.0001	0.01	Below MAC
Selenium	Extractable	mg/L	<0.0006	0.0006	0.01	Below MAC
Uranium	Extractable	mg/L	<0.0005	0.0005	0.02	Below MAC
Vanadium	Extractable	mg/L	0.0006	0.0001		
Zinc	Extractable	mg/L	<0.001	0.001	5.0	Below AO
Metals Total						
Mercury	Total	mg/L	<0.00001	0.00001	0.001	Below MAC
Physical and Aggregate Properties						
Turbidity		NTU	1.1	0.1		
Colour	Apparent	Colour units	10	5		
Routine Water						
pH	at 25 °C		8.15		6.5-8.5	Within AO
Electrical Conductivity		µS/cm at 25 C	412	1		
Calcium	Extractable	mg/L	18.9	0.1		
Iron	Extractable	mg/L	0.277	0.005	0.3	Below AO
Magnesium	Extractable	mg/L	27.0	0.1		
Manganese	Extractable	mg/L	0.032	0.001	0.05	Below AO
Potassium	Extractable	mg/L	4.3	0.1		
Silicon	Extractable	mg/L	10.6	0.05		
Sodium	Extractable	mg/L	34.7	0.1	200	Below AO
Bicarbonate		mg/L	245	5		
Carbonate		mg/L	<6	6		
Hydroxide		mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	201	5		
Chloride	Dissolved	mg/L	0.94	0.05	250	Below AO
Fluoride	Dissolved	mg/L	0.32	0.01	1.5	Below MAC

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Analytical Report

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	W23101568.004
	Calcite Business Centre	Name:	Burwash Geoexchange
	Unit 6, 151 Industrial Road	Location:	Burwash Landing
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SKS		
Company:	EBA		

Lot ID: **884123**
Control Number:
Date Received: Jul 26, 2012
Date Reported: Aug 1, 2012
Report Number: 1754397

Reference Number	884123-1
Sample Date	July 18, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	DSW1 / Burwash
Sample Matrix	Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Routine Water - Continued						
Nitrate - N	Dissolved	mg/L	<0.01	0.01	10	Below MAC
Nitrite - N	Dissolved	mg/L	0.17	0.01	1	Below MAC
Sulfate (SO4)	Dissolved	mg/L	35.3	0.5	500	Below AO
Hardness	as CaCO3	mg/L	158	1		
Total Dissolved Solids	Extractable	mg/L	271	1		

Approved by:

Mathieu Simoneau
Operations Manager

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Methodology and Notes

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	W23101568.004
	Calcite Business Centre	Name:	Burwash Geoexchange
	Unit 6, 151 Industrial Road	Location:	Burwash Landing
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SKS		
Company:	EBA		

Lot ID:	**884123**
Control Number:	
Date Received:	Jul 26, 2012
Date Reported:	Aug 1, 2012
Report Number:	1754397

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water	APHA	*	Alkalinity - Titration Method, 2320 B	27-Jul-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	Conductivity, 2510 B	27-Jul-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	pH - Electrometric Method, 4500-H+ B	27-Jul-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	Turbidity - Nephelometric Method, 2130 B	27-Jul-12	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	27-Jul-12	Exova Surrey
Apparent Color	APHA	*	Spectrophotometric - Single Wavelength Method, 2120 C	30-Jul-12	Exova Surrey
Carbon Organic (Total) in water (TOC)	APHA		High-Temperature Combustion Method, 5310 B	31-Jul-12	Exova Edmonton
Mercury Low Level (Total) in water	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	30-Jul-12	Exova Surrey
Metals SemiTrace (Extractable) in water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	27-Jul-12	Exova Surrey
Trace Metals (extractable) in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	27-Jul-12	Exova Surrey

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
US EPA	US Environmental Protection Agency Test Methods

Guidelines

Guideline Description	Health Canada GCDWQ
Guideline Source	Guidelines for Canadian Drinking Water Quality, Health Canada, May 2008
Guideline Comments	MAC = Maximum Acceptable Concentration AO = Aesthetic Objective OG = Operational Guideline for Water Treatment Plants Refer to Health Canada GCDWQ for complete guidelines and additional drinking water information at www.hc-sc.gc.ca

Comments:

- The Arsenic result in sample 884123-1 exceeded the maximum acceptable concentration (MAC) as specified by the August 5th, 2008 Guidelines for Canadian Drinking Water Quality.
- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

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Methodology and Notes

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	W23101568.004
	Calcite Business Centre	Name:	Burwash Geoexchange
	Unit 6, 151 Industrial Road	Location:	Burwash Landing
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SKS		
Company:	EBA		

Lot ID:	**884123**
Control Number:	
Date Received:	Jul 26, 2012
Date Reported:	Aug 1, 2012
Report Number:	1754397

The comparison of test results to guideline limits is provided for information purposes only. This is not to be taken as a statement of conformance / nonconformance to any guideline, regulation or limit. The data user is responsible for all conclusions drawn with respect to the data and is advised to consult official regulatory references when evaluating compliance.

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.

LOT: 884123 COC

Exova

Assurity

Control Number

ıtal Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Billing Address:				**Copy of Report To:**			
Company:	EBA Engineering Consulting Ltd.			Company:		Copy of invoice:	
Address:	Unit 6, 151 Industrial Road Whitehorse, YT Y1A 2V3	QA/QC Report	x	Address:		Mail invoice to this address for approval	
		Report Result:				Report Result:	
Attention:	Stephan Klump	Fax		Attention:		Fax	
Phone:	867-668-2071 ext. 250	Mail		Phone:		Mail	
Fax:	867-668-4349	Courier		Fax:		Courier	
Cell:		e-mail	x	Cell:		e-mail	
e-mail:	sklump@eba.ca	Results Online	x	e-mail:		Results Online	

nformation to be included on Report and Invoice		**RUSH**	**Please contact the laboratory to confirm rush dates and times before submitting samples.**	Sample Custody (Please Print)	
Project ID:	W23101568.004	Upon filling out this section, client accepts that surcharges will be attached to this analysis		Sampled by: SKS	
Project Name:	Burwash Geoexchange	RUSH required on:	All Analysis ☐ or As indicated ☐	Company EBA Signature	
Project Location:	Burwash Landing	Date Required:		I authorize Exova to proceed with the work work indicated on this form:	
Legal Location:		Signature:		Date: July 24 2012 Initial: SK	
PO#:		Exova Authorization:		Received by:	Sample Temp. 16°C
Proj. Acct. Code:				Waybill #:	Date July 26/12
Agreement ID:	**87038**			Company	Time 3:15 pm

Special Instructions / Comments

FOR LAB USE ONLY
Condiftion of containers/coolers upon arrival at lab

☐ Check here if Exova is required to report results directly to a regulatory body (Please include contact information)

☐ Check here if you are testing POTABLE WATER for **HUMAN CONSUMPTION**

Please indicate which regulations you are required to meet: Canadian DW Quality

	Sample Identification	Location	Depth IN	Depth CM	Depth M	Date/Time Sampled	Matrix	Sampling Method	↓ Number of Containers	W99YT	TOC	Enter tests above (✓ relevant samples below)
1	DSW1	Burwash				July 18	Water	grab	4	☒	☒	

NOTE: All hazardous samples must be labelled according to WHIMIS guidelines.

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Report Transmission Cover Page

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID: **890749**
Control Number:
Date Received: Aug 31, 2012
Date Reported: Sep 7, 2012
Report Number: 1762667

Contact & Affiliation	Address	Delivery Commitments
Stephan Klump EBA Engineering Consultants Ltd -	Unit 6, 151 Industrial Road, Calcite Business Centre Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-2071 Fax: (867) 668-4349 Email: sklump@eba.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report On [Lot Creation] send (COR) by Email - Single Report
Sarah Sternbergh EBA Engineering Consultants Ltd -	Unit 6, 151 Industrial Road, Calcite Business Centre Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-3068 Fax: (867) 668-4349 Email: ssternbergh@eba.ca	On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (Test Report) by Email - Single Report
Ingrid Fuller EBA Engineering Consultants Ltd -	Unit 6, 151 Industrial Road, Calcite Business Centre Whitehorse, Yukon Territory Y1A 2V3 Phone: (867) 668-2071 Fax: (867) 668-4349 Email: ifuller@eba.ca	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report

Notes To Clients:

- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

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Analytical Report

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID: **890749**
Control Number:
Date Received: Aug 31, 2012
Date Reported: Sep 7, 2012
Report Number: 1762667

Reference Number	890749-1
Sample Date	August 24, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	KFN-K
Sample Matrix	Drinking Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Inorganic Nonmetallic Parameters						
Organic Carbon	Total Nonpurgeable	mg/L	1.1	0.5		
Metals Extractable						
Aluminum	Extractable	mg/L	<0.005	0.005	0.1	Below OG
Antimony	Extractable	mg/L	<0.0002	0.0002	0.006	Below MAC
Arsenic	Extractable	mg/L	0.0118	0.0002	0.01	Above MAC
Barium	Extractable	mg/L	0.036	0.001	1	Below MAC
Boron	Extractable	mg/L	0.525	0.005	5	Below MAC
Cadmium	Extractable	mg/L	<0.00007	0.00007	0.005	Below MAC
Chromium	Extractable	mg/L	0.0019	0.0005	0.05	Below MAC
Copper	Extractable	mg/L	<0.001	0.001	1.0	Below AO
Lead	Extractable	mg/L	<0.0001	0.0001	0.01	Below MAC
Selenium	Extractable	mg/L	<0.0006	0.0006	0.01	Below MAC
Uranium	Extractable	mg/L	<0.0005	0.0005	0.02	Below MAC
Vanadium	Extractable	mg/L	0.0006	0.0001		
Zinc	Extractable	mg/L	0.043	0.001	5.0	Below AO
Metals Total						
Mercury	Total	mg/L	<0.00001	0.00001	0.001	Below MAC
Physical and Aggregate Properties						
Turbidity		NTU	<0.1	0.1		
Colour	Apparent	Colour units	6	5		
Routine Water						
pH	at 25 °C		8.10		6.5-8.5	Within AO
Electrical Conductivity		µS/cm at 25 C	403	1		
Calcium	Extractable	mg/L	17.6	0.1		
Iron	Extractable	mg/L	0.032	0.005	0.3	Below AO
Magnesium	Extractable	mg/L	25.8	0.1		
Manganese	Extractable	mg/L	0.026	0.001	0.05	Below AO
Potassium	Extractable	mg/L	3.7	0.1		
Silicon	Extractable	mg/L	10.2	0.05		
Sodium	Extractable	mg/L	32.6	0.1	200	Below AO
Bicarbonate		mg/L	242	5		
Carbonate		mg/L	<6	6		
Hydroxide		mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	198	5		
Chloride	Dissolved	mg/L	1.26	0.05	250	Below AO
Fluoride	Dissolved	mg/L	0.38	0.01	1.5	Below MAC

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Analytical Report

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID: **890749**
Control Number:
Date Received: Aug 31, 2012
Date Reported: Sep 7, 2012
Report Number: 1762667

Reference Number	890749-1
Sample Date	August 24, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	KFN-K
Sample Matrix	Drinking Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Routine Water - Continued						
Nitrate - N	Dissolved	mg/L	<0.01	0.01	10	Below MAC
Nitrite - N	Dissolved	mg/L	0.06	0.01	1	Below MAC
Sulfate (SO4)	Dissolved	mg/L	36.4	0.5	500	Below AO
Hardness	as CaCO3	mg/L	150	1		
Total Dissolved Solids	Extractable	mg/L	264	1		

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Analytical Report

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID: **890749**
Control Number:
Date Received: Aug 31, 2012
Date Reported: Sep 7, 2012
Report Number: 1762667

Reference Number	890749-2
Sample Date	August 23, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	KFN-L
Sample Matrix	Drinking Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Inorganic Nonmetallic Parameters						
Organic Carbon	Total Nonpurgeable	mg/L	1.1	0.5		
Metals Extractable						
Aluminum	Extractable	mg/L	<0.005	0.005	0.1	Below OG
Antimony	Extractable	mg/L	<0.0002	0.0002	0.006	Below MAC
Arsenic	Extractable	mg/L	0.0750	0.0002	0.01	Above MAC
Barium	Extractable	mg/L	0.047	0.001	1	Below MAC
Boron	Extractable	mg/L	0.530	0.005	5	Below MAC
Cadmium	Extractable	mg/L	<0.00007	0.00007	0.005	Below MAC
Chromium	Extractable	mg/L	0.0070	0.0005	0.05	Below MAC
Copper	Extractable	mg/L	<0.001	0.001	1.0	Below AO
Lead	Extractable	mg/L	<0.0001	0.0001	0.01	Below MAC
Selenium	Extractable	mg/L	<0.0006	0.0006	0.01	Below MAC
Uranium	Extractable	mg/L	<0.0005	0.0005	0.02	Below MAC
Vanadium	Extractable	mg/L	0.0025	0.0001		
Zinc	Extractable	mg/L	0.393	0.001	5.0	Below AO
Metals Total						
Mercury	Total	mg/L	<0.00001	0.00001	0.001	Below MAC
Physical and Aggregate Properties						
Turbidity		NTU	4.2	0.1		
Colour	Apparent	Colour units	29	5		
Routine Water						
pH	at 25 °C		7.50		6.5-8.5	Within AO
Electrical Conductivity		µS/cm at 25 C	1060	1		
Calcium	Extractable	mg/L	55.5	0.1		
Iron	Extractable	mg/L	0.557	0.005	0.3	Above AO
Magnesium	Extractable	mg/L	64.9	0.1		
Manganese	Extractable	mg/L	0.029	0.001	0.05	Below AO
Potassium	Extractable	mg/L	3.5	0.1		
Silicon	Extractable	mg/L	26.2	0.05		
Sodium	Extractable	mg/L	90.3	0.1	200	Below AO
Bicarbonate		mg/L	651	5		
Carbonate		mg/L	<6	6		
Hydroxide		mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	534	5		
Chloride	Dissolved	mg/L	8.82	0.05	250	Below AO
Fluoride	Dissolved	mg/L	<0.10	0.01	1.5	Below MAC

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W: www.exova.com

Exova

Analytical Report

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID: **890749**
Control Number:
Date Received: Aug 31, 2012
Date Reported: Sep 7, 2012
Report Number: 1762667

Reference Number	890749-2
Sample Date	August 23, 2012
Sample Time	NA
Sample Location	Burwash
Sample Description	KFN-L
Sample Matrix	Drinking Water

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Routine Water - Continued						
Nitrate - N	Dissolved	mg/L	<0.10	0.01	10	Below MAC
Nitrite - N	Dissolved	mg/L	<0.10	0.01	1	Below MAC
Sulfate (SO4)	Dissolved	mg/L	110	0.5	500	Below AO
Hardness	as CaCO3	mg/L	406	1		
Total Dissolved Solids	Extractable	mg/L	725	1		

Approved by:

Aaron Zentner, B.SC., P.Chem.
Team Leader - Organics

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Methodology and Notes

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID:	**890749**
Control Number:	
Date Received:	Aug 31, 2012
Date Reported:	Sep 7, 2012
Report Number:	1762667

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water	APHA	*	Alkalinity - Titration Method, 2320 B	01-Sep-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	Conductivity, 2510 B	01-Sep-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	pH - Electrometric Method, 4500-H+ B	01-Sep-12	Exova Surrey
Alk, pH, EC, Turb in water	APHA	*	Turbidity - Nephelometric Method, 2130 B	01-Sep-12	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	04-Sep-12	Exova Surrey
Apparent Color	APHA	*	Spectrophotometric - Single Wavelength Method, 2120 C	05-Sep-12	Exova Surrey
Carbon Organic (Total) in water (TOC)	APHA		High-Temperature Combustion Method, 5310 B	04-Sep-12	Exova Edmonton
Mercury Low Level (Total) in water	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	05-Sep-12	Exova Surrey
Metals SemiTrace (Extractable) in water	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	04-Sep-12	Exova Surrey
Trace Metals (extractable) in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	04-Sep-12	Exova Surrey

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
US EPA	US Environmental Protection Agency Test Methods

Guidelines

Guideline Description	Health Canada GCDWQ
Guideline Source	Guidelines for Canadian Drinking Water Quality, Health Canada, May 2008
Guideline Comments	MAC = Maximum Acceptable Concentration AO = Aesthetic Objective OG = Operational Guideline for Water Treatment Plants Refer to Health Canada GCDWQ for complete guidelines and additional drinking water information at www.hc-sc.gc.ca

Comments:

- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

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Methodology and Notes

Bill To:	EBA Engineering Consultants	Project:	
Report To:	EBA Engineering Consultants	ID:	
	Calcite Business Centre	Name:	
	Unit 6, 151 Industrial Road	Location:	
	Whitehorse, YT, Canada	LSD:	
	Y1A 2V3	P.O.:	
Attn:	Stephan Klump	Acct code:	
Sampled By:	SS		
Company:	EBA		

Lot ID:	**890749**
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The comparison of test results to guideline limits is provided for information purposes only. This is not to be taken as a statement of conformance / nonconformance to any guideline, regulation or limit. The data user is responsible for all conclusions drawn with respect to the data and is advised to consult official regulatory references when evaluating compliance.

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.

Exova Testing Advising Assuring

LOT: _____ Control Number _____

Environmental Sample Information Sheet

Note: Proper completion of this form is required in order to proceed with analysis

Billing Address:				**Copy of Report To:**			
Company:	EBA Engineering Consulting Ltd.			Company:	EBA Engineering Consulting Ltd.	Copy of invoice:	
Address:	Unit 6, 151 Industrial Road Whitehorse, YT Y1A 2V3	QA/QC Report	x	Address:	Unit 6, 151 Industrial Road Whitehorse, YT Y1A 2V3	Mail invoice to this address for approval	
		Report Result:				Report Result:	
Attention:	Stephan Klump	Fax		Attention:	Sarah Sternbergh	Fax	
Phone:	867-668-2071 ext. 250	Mail		Phone:	867-668-3068	Mail	
Fax:	867-668-4349	Courier		Fax:	867-668-4349	Courier	
Cell:		e-mail	x	Cell:		e-mail	x
e-mail:	sklump@eba.ca	Results Online		e-mail:	ssternbergh@eba.ca	Results Online	

Information to be included on Report and Invoice

Project ID:
Project Name:
Project Location:
Legal Location:
PO#:
Proj. Acct. Code:
Agreement ID: **87038**

RUSH **Please contact the laboratory to confirm rush dates and times before submitting samples.**

Upon filling out this section, client accepts that surcharges will be attached to this analysis

RUSH required on: All Analysis ☐ or As indicated ☐

Date Required: _____

Signature: _____

Exova Authorization: _____

Sample Custody (Please Print)

Sampled by: Sarah Sternbergh

Company EBA Signature: _____

I authorize Exova to proceed with the work work indicated on this form:

Date: 29.Aug.12 Initial: SES.

Received by:	Sample Temp. 9.8C
Waybill #:	Date
Company	Time

Special Instructions / Comments
Please ensure detection limits sufficient for CCME Guidelines

FOR LAB USE ONLY
Condition of containers/coolers upon arrival at lab

☐ Check here if Exova is required to report results directly to a regulatory body (Please include contact information)

☐ Check here if you are testing POTABLE WATER for **HUMAN CONSUMPTION**

Please indicate which regulations you are required to meet: _____

	Sample Identification	Location	Depth IN CM M	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	W99YT	TOC	Enter tests above (✓ relevant samples below)
1	KFN-K	Burwash		24.Aug.12	Water	Grab	3	☒	☒	
2	KFN-L	Burwash		23.Aug.12	Water	Grab	3	☒	☒	
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

NOTE: All hazardous samples must be labelled according to WHIMIS guidelines.

SRC Group # 2012-10452

Oct 22, 2012

SRC ANALYTICAL

422 Downey Road
Saskatoon, Saskatchewan, Canada
S7N 4N1
(306) 933-6932 or 1-800-240-8808

EBA Engineering Consultants Ltd.
6-151 Industrial Rd
Whitehorse, YT Y1A 2V3
Attn: Sarah Sternbergh

Date Samples Received: Oct-05-2012

Client P.O.: W23101568.003 + W23101599

This is a final report.

Organics results have been authorized by Pat Moser, Supervisor

ICP results have been authorized by Keith Gipman, Supervisor

Inorganics and Radiochemistry results have been authorized by Jeff Zimmer, Supervisor

SLOWPOKE-2 results have been authorized by Dave Chorney

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as

    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

SRC ANALYTICAL

Oct 22, 2012

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(306) 933-6932 or 1-800-240-8808

EBA Engineering Consultants Ltd.
6-151 Industrial Rd
Whitehorse, YT Y1A 2V3
Attn: Sarah Sternbergh

Date Samples Received: Oct-05-2012 Client P.O.: W23101568.003 + W23101599

38289 08/24/2012 BURWASH LANDING YUKON, KFN-K *WATER*
38290 08/23/2012 BURWASH LANDING YUKON, KFN-L *WATER*
38291 09/10/2012 DEEP CREEK #1, YUKON *WATER*

Analyte	Units	38289	38290	38291
Radio Chemistry				
Gross alpha	Bq/L	<0.20	<0.46	<0.32
Gross beta	Bq/L	0.15	<0.26	<0.20

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

SRC ANALYTICAL

Oct 22, 2012

EBA Engineering Consultants Ltd.

38292 09/06/2012 DEEP CREEK #2, YUKON *WATER*

Analyte	Units	38292
Radio Chemistry		
Gross alpha	Bq/L	<0.54
Gross beta	Bq/L	<0.35

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.