

Government of Yukon- Property Management Agency

WELL COMPLETION REPORT  
DESTRUCTION BAY GRADER STATION  
PMA BUILDING 3186  
DESTRUCTION BAY  
YUKON

EBA FILE: 1260008

January 2006



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## 1.0 INTRODUCTION

EBA was retained by Government of Yukon (YTG) Property Management Agency (PMA) to co-ordinate the drilling, construction and testing of a new water supply well (3186-C) at the Destruction Bay Grader Station. The Destruction Bay Grader Station water system is currently supplied by a 5.0 m deep well located within the grader station building. An evaluation of the well and water supply system completed by EBA in 2005 entitled "Small Public Water System Assessments- Government of Yukon Maintained Buildings- Western Region" found several high risk deficiencies with the system including poor surface completion of the well, poor water quality and several potential contaminant sources within 30 m of the wellhead. EBA recommended that a new water supply well be drilled and commissioned to address existing deficiencies with the current well. Recommendations also included the decommissioning of abandoned well 3186-B located 0.65 m from well 3186-A. Authorization to proceed with the work was granted on November 7, 2005.

### 1.1 SCOPE OF WORK

The following tasks were completed in accordance with EBA's proposal dated October 14, 2005:

- Development of specifications for drilling;
- Completion of a preliminary environmental screening for drilling;
- Arranging for qualified drilling and pumping test contractors;
- Co-ordinating and supervising drilling and well construction and pump testing; and,
- Preparation of this well completion report.

## 2.0 FIELD PROGRAM

### 2.1 WELL DRILLING, CONSTRUCTION AND TESTING

The well drilling and testing contract was awarded to Double D Drilling of Whitehorse, Yukon on November 7, 2005. Drilling of well 3186-C commenced on November 26, 2005 and was completed on December 1, 2005. Testing took place between December 2 and 3, 2005.

Well 3186-C was drilled using the dual rotary drilling method. Samples were retained continuously during drilling. A summary of soils encountered and observations made during drilling is included on the well log in Appendix A.

A water-bearing sand and gravel unit was encountered from 27.4 to 30.8 m below ground (m-bg). A screen was designed based on grain size analysis of the material from this zone and installed between 29.6 and 30.8 m-bg. The screen was developed by lifting and surging with air for 14 hours. A summary of relevant well construction details is included on Table 1 on the following page.

TABLE 1: SUMMARY OF WELL INFORMATION AND CONSTRUCTION DETAILS	
REQUIRED DETAILS	DETAILS OR REPORT REFERENCE
Date of construction:	Well was drilled between November 26 <sup>th</sup> and December 1 <sup>st</sup> , 2005.
Name and address of the owner of the well:	Government of Yukon- Department of Highways and Public Works- Property Management Agency Box 2703, Whitehorse, Yukon Y1A 2C6
Description of the property:	Destruction Bay Grader Station, km 1743 Alaska Highway, Destruction Bay, Yukon
UTM Co-ordinates ( $\pm$ 8 m):	UTM Zone 7 E 617868 N 6792542
Location of the well on the property:	See Figure 1.
Method of construction:	Drilling completed using the dual air rotary drilling method.
Description, depth and thickness of geologic materials encountered during construction:	See Well log 3186-C in Appendix A. Double D Drilling Log is also included in Appendix A.
Depth and diameter of the well:	The well construction details are provided on Well log in Appendix A. Total depth of well completion is 30.7 m-bg.
Type of casing materials and thickness:	Steel Casing – 0.250 inches (6.35 mm) thick.
Static water level:	0.4 m below top of casing (0.6 m above ground level)
Type, size, length and location of screen:	Stainless steel V-wire 6 (0.040”) slot Johnson screen. Total screen length is 1.2 m., set between 29.6 m and 30.8 m bg.
Location of major water-bearing zones:	Water bearing sand and gravel zone from 27.4 to 30.8 m bg.
Location, type and thickness of grout sealant placed around the well:	Bentonite seal was placed between annulus of conductor pipe and native sand and gravel. Seal is completed from grade to 6.0 m bg.

## 2.2 WELL AND AQUIFER TESTING

Testing of 3186-C was completed on December 3 and 4, 2005 by Double D Drilling. A temporary submersible pump was installed in the well at a depth of 27.1 m –bg, flow was monitored during the pumping test with a totalizer located near the wellhead, and checked using a graduated barrel and stopwatch. Water from the pumping well was conveyed to a location 30.5 m away from the well.

A step rate test was first conducted to determine the optimal rate to perform the constant rate pumping test at. The step rate test was initiated on December 2, 2005 at 5:00 PM, three 60 min steps were completed at rates of 1.52, 2.27 and 3.03 L/s. The final step was continued for 24 hours as the constant rate test. A plot of drawdown and recovery is included as the upper portion of Figure 2. The lower portion of Figure 2 includes a plot of flow rate vs. specific capacity and drawdown as observed at 60 min into each step. The water level in 3186-C and flow rate was monitored continuously during the constant rate pumping test. The pumping test concluded at 17:00 on December 3, 2005, and recovery was monitored for 4 hours. Data collected during the step test and constant rate test is included as Appendix B.

## 2.3 WATER QUALITY ANALYSIS

Water samples were collected from a sample port located at the wellhead at the end of the constant rate pumping test. Samples were collected in laboratory supplied sample containers in accordance with laboratory sampling procedures. Samples were shipped by air cargo to ALS Environmental in Vancouver, B.C. for detailed drinking water analysis. ALS is a member of the Canadian Association of Environmental Analytical Laboratories (CAEAL). Analytical results are summarized in Table 3. Laboratory reports and certificates are included as Appendix C.

## 3.0 RESULTS

### 3.1 PUMPING TEST

#### Step Test

A plot of observed drawdown in 3186-C during the step rate pumping test is included as the upper graph in Figure 2. The lower graph details specific capacity and drawdown observed at 60 min into each step. As the flow rate increased from 1.52 to 3.03 L/s, the specific capacity dropped from 1.13 to 0.70 L/s/m. As expected, drawdown vs. flow rate behaved in a linear fashion.

#### Constant Rate Test

Drawdown observed in 3186-C during the constant rate pumping test is plotted on Figure 3. To facilitate aquifer analysis, the drawdown data has been compared to elapsed time since the beginning of the constant rate pumping interval. Also included on Figure 3 is residual drawdown vs. residual time factor  $(t/t')$ <sup>1</sup> as observed during the recovery interval. The maximum drawdown observed during the constant rate pumping test was 6.383 m. No evidence of recharge, or positive boundaries was observed during the constant rate pumping test.

As indicated on a plot of drawdown vs. log time (Figure 3) the steepening of the drawdown curve likely indicates that the expanding zone of depression encountered negative boundaries (i.e. less permeable sediments) where a change in slope is observed.

The plot of  $t/t'$  intercepts zero residual drawdown at  $t/t'$  greater than 1, indicating that some recharge to the aquifer occurred during the pumping interval. The projected 100 day drawdown is approximately 9.38 m, which is significantly less than the available drawdown of 25.8 m.

The observed and residual drawdown was analyzed using the Cooper-Jacob straight-line method, which assumes the following:

- The aquifer is infinite in aerial extent, and uniform in thickness.
- The aquifer is homogeneous and isotropic.
- The pumping well fully penetrates the aquifer thickness, and pumps at a constant rate.

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<sup>1</sup>  $t/t' = (\text{time since pump started}) / (\text{time since pump stopped})$

- The piezometric surface was horizontal prior to pumping.
- Water is released instantaneously from storage with a decline in head.
- The well diameter is small such that well storage is negligible.
- Flow is laminar.

The results of the Cooper-Jacob analysis for the constant rate pumping test are included on Figure 3 and summarized in Table 2 below. The straight line approximation was applied separately for the early and late pumping, and early and late recovery intervals. Summarized in Table 2 below are the transmissivity and conductivity values calculated from the constant rate pumping test data. Also included are the conductivity values calculated based on grain size analyses.

**TABLE 2: AQUIFER TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY**

CONDUCTIVITY BASED ON PUMPING TEST RESULTS			CONDUCTIVITY BASED ON GRAIN SIZE ANALYSIS	
INTERVAL	T TRANSMISSIVITY	K CONDUCTIVITY	SAMPLE DEPTH	K CONDUCTIVITY <sup>2</sup>
EARLY PUMPING (T <sub>1</sub> ,K <sub>1</sub> )	179 m <sup>2</sup> /day	6.1 x 10 <sup>-4</sup> m/sec	29.0 m	6.1 x 10 <sup>-5</sup> m/sec
LATE PUMPING (T <sub>2</sub> ,K <sub>2</sub> )	74 m <sup>2</sup> /day	2.5 x 10 <sup>-4</sup> m/sec		
EARLY RECOVERY (T <sub>3</sub> ,K <sub>3</sub> )	104 m <sup>2</sup> /day	3.6 x 10 <sup>-4</sup> m/sec	29.9 m	3.4 x 10 <sup>-4</sup> m/sec
LATE RECOVERY (T <sub>4</sub> ,K <sub>4</sub> )	43 m <sup>2</sup> /day	1.5 x 10 <sup>-4</sup> m/sec		

As expected, the aquifer conductivity calculated from the pumping test analysis is comparable to the conductivity calculated from the grain size analysis.

### 3.2 WATER QUALITY

Groundwater analytic results are presented in Table 4, and, laboratory results and certificates can be found in Appendix C. Water from this well is very hard a calcium-bicarbonate type water. The following items are of note:

- Water from well 3186-C meets all current Canadian Drinking Water Quality Guidelines (CDWQG) for health based parameters;
- Although below the current MAC, the arsenic concentration at 0.0111 mg/L is above the proposed CDWQG MAC of 0.005 mg/L;

<sup>2</sup> Based on the geometric mean of 10 approximation methods as shown on Figure A2 (Appendix A)

- Total dissolved solids (TDS) at 548 mg/L is above the CDWQG aesthetic objective (AO) or 500 mg/L; although not a health concern, TDS at this concentration may effect water aesthetic qualities of the water such as taste and odour;
- Total iron at 0.173 mg/L is above the CDWQG AO of 0.3 mg/L; although not a health concern, iron at this concentration may result in staining of fixtures; and
- Total manganese at 0.0677 mg/L is slightly above the CDWQG AO of 0.05 mg/L.

#### 4.0 WELL CAPACITY

To calculate the safe yield of a well, 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 constant rate drawdown to 100 days as shown on Figure 3. This conservatively assumes that well 3186-C would be continuously pumped at the same rate for 100-days with no recharge to the aquifer. The safe available drawdown of the well is determined by applying a safety factor of 70% of the physical available drawdown after an allowance has been made for seasonal fluctuations in static water level. For a well completed in a confined aquifer (such as 3186-C), the water level should never be drawn below the bottom of the confining unit. In this case, the safe available drawdown accounts for this. The safe yield of a well can also be limited by what the well screen is capable of delivering based on the maximum recommended screen entrance velocity. Table 3 (on the following page) details the safe yield calculations for well 3186-C.

TABLE 3: SAFE YIELD CALCULATIONS			
WELL PARAMTER	VALUE	UNIT	KEY
Constant Rate Pumping Test Discharge Rate	3.0	L/s	a
Projected 100-Day Drawdown	9.38	m	b
100-Day Specific Capacity	0.3	L/s/m	c
Lowest Expected Seasonal Water Table (1.0 m fluctuation)	0.4	m	d
Depth to top of Screen Interval	29.6	m	e
Available Drawdown	29.2	m	f = e-d
Safety Factor	70	%	g
Safe Available Drawdown	20.4	m	h = f x g
<b>Safe Yield Based on Constant Rate Pumping Test</b>			
Safe Estimated Sustainable Yield	6.6	L/s	c x h
Safe Estimated Sustainable Yield	<b>87</b>	IGPM	
<b>Check for Maximum Screen Entrance Velocity</b>			
Reccommended Maximum Screen Entrance Velocity	0.03	m/s	k
Intake Area (m <sup>2</sup> / m of 0.040" Well Screen)	0.18	m <sup>2</sup> /m	l
Maximum Yield per m screen	5.4	L/s	k x l
Maximum Yield for Screen Interval (1.2 m)	6.5	L/s	
Maximum Well Yield	<b>85</b>	IGPM	m
Check: Greater than Safe Estimated Sustainable Yield?	<b>NO</b>		

Based on specific capacity and available drawdown, the aquifer at 3186-C could theoretically be pumped at a rate of 6.6 L/s (87 IGPM). In this case, however, the capacity of well 3186-C is limited by screen entrance velocity. To prevent damage to the screen, maintain laminar flow conditions within the well and minimize biofouling, the maximum well yield at 3186-C is 6.5 L/s (85 IGPM).

## 5.0 WELL DECOMMISSIONING

The abandoned well 3186-B (Figure 1) at the Destruction Bay Grader Station was decommissioned on November 29, 2005 by backfilling with bentonite chips. Well decommissioning was completed by Double D Drilling.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

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

- In December 2005, a new drinking water well (3186-C) was drilled at the Destruction Bay Grader Station. The well was drilled to a depth of 65.5 m below ground, and a screen was set from 29.6 to 30.8 m below ground within a confined sand aquifer. The well was constructed in accordance with Canadian Groundwater Association's (CGWA) Water Well Construction Guidelines and Guidelines for Part III – Small Public Drinking Water Systems (Draft).
- Pumping test results indicate aquifer transmissivity ranging from 43 m<sup>2</sup>/day to 179 m<sup>2</sup>/day.
- The safe sustainable yield for well 3186-C is 6.5 L/s (85 IGPM), which is sufficient to meet the required demand.
- Water from well 3186-C meets all current Canadian Drinking Water Quality Guidelines (CDWQG) for health based parameters;
- Although below the current MAC, the arsenic concentration at 0.0111 mg/L is above the proposed CDWQG MAC of 0.05 mg/L;
- Total iron at 0.173 mg/L is above the CDWQG aesthetic objective (AO) of 0.3 mg/L; although not a health concern, iron at this concentration may result in staining of fixtures.
- Total manganese at 0.0677 mg/L is above the aesthetic objective (AO) of 0.05 mg/L; and
- Water from well 3186-C was not analyzed for bacteriological parameters due to constraints with sample holding times.

Proper well operation and maintenance are fundamental to ensuring a reliable drinking water source. Recommendations pertinent to the operation of well 3186-C are presented below:

- To maximize available drawdown, the pump intake should be installed at approximately 21 m–bg. The pump should also be equipped with a low level sensor or auto shut off to ensure minimum pump submergence and prevent burn out of the pump.
- Any alterations to well 3186-C (including well hook-up) should be in compliance with the Guidelines for Part III – Small Public Drinking Water Systems (Draft), or the final document when in effect.
- After extended periods of non-pumping the well should be allowed to discharge to waste until the water runs clear, pumping of small amounts of sand or discoloured water is normal after extended periods of non-pumping. The well should be connected to the system only once water clarity has ceased to improve.
- The pump should not be continuously turned off and on as this can severely decrease the lifetime of the pump, and promote sand build up within the casing thereby increasing the need for re-development of the well.

- The water level and specific capacity in a water supply well should be routinely monitored over time to facilitate evaluation of well performance.
- The well should be shock chlorinated (disinfected) bi-annually with a 200 mg/L sodium hypochlorite solution.
- Well 3186-C should be re-tested for arsenic to confirm the exceedance of the proposed CDWQG MAC. Arsenic removal treatment may be required when this MAC comes into effect.
- Well 3186-C should be tested for bacteriological parameters including *E.Coli* and total coliform upon connection to the water supply system.

## 7.0 CLOSURE

Conclusions and recommendations in this report are based upon the Hydrogeological Investigations as described in the previous sections. This report has been prepared for the use of Government of Yukon Property Management Agency. It has been prepared in accordance with generally accepted hydrogeological practices. For further limitations regarding the use of the report, reference should be made to the EBA Environmental Report – General Conditions attached, which form a part of this report.

EBA trusts that this report satisfies your present requirements. Should you have any questions or comments please do not hesitate to contact the undersigned.

Respectfully submitted,

EBA Engineering Consultants Ltd.

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**EBA Engineering Consultants Ltd. (EBA)**  
**ENVIRONMENTAL REPORT – GENERAL CONDITIONS**

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

**A.1 USE OF REPORT**

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.

**A.2 LIMITATIONS OF REPORT**

This report is based solely on the conditions which existed on site at the time of EBA’s investigation. The client, and any other parties using this report with the express written consent of the client and EBA, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and EBA, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

**A.2.1 Information Provided to EBA by Others**

During the performance of the work and the preparation of this report, EBA may have relied 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.

**A.3 LIMITATION OF LIABILITY**

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of EBA providing the services requested, the client agrees that EBA’s liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

- (1) With respect to any claims brought against EBA by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to EBA under this Agreement, whether the action is based on breach of contract or tort;
- (2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless EBA from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by EBA, whether the claim be brought against EBA for breach of contract or tort.

**EBA Engineering Consultants Ltd. (EBA)**  
**ENVIRONMENTAL REPORT – GENERAL CONDITIONS**

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**A.4 JOB SITE SAFETY**

EBA is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of EBA personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

**A.5 DISCLOSURE OF INFORMATION BY CLIENT**

The client agrees to fully cooperate with EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for EBA to properly provide the service, EBA is relying upon the full disclosure and accuracy of any such information.

**A.6 STANDARD OF CARE**

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

**A.7 EMERGENCY PROCEDURES**

The client undertakes to inform EBA of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of EBA may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect EBA employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay EBA for any expenses incurred as a result of such discoveries and to compensate EBA through payment of additional fees and expenses for time spent by EBA to deal with the consequences of such discoveries.

**A.8 NOTIFICATION OF AUTHORITIES**

The client acknowledges that 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.

**A.9 OWNERSHIP OF INSTRUMENTS OF SERVICE**

The client acknowledges that all reports, plans, and data generated by EBA during the performance of the work and other documents prepared by EBA are considered its professional work product and shall remain the copyright property of EBA.

**A.10 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), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that 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.

The Client recognizes and agrees that 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.



# TABLES



TABLE 4  
SUMMARY OF LABORATORY CHEMISTRY RESULTS

	ALS Report	3186-C	Canadian Drinking Water Quality Guidelines		
		Destruction Bay			
		W8265	Lower Limit	Upper Limit	
		Date	3-Dec-05	AO	MAC
<b>Physical Tests</b>					
Colour	CU	6.1			15
Conductivity (Field)	uS/cm	-			
Conductivity (Lab)	uS/cm	781			
Total Dissolved Solids (Field)	mg/L	-			
Total Dissolved Solids (Lab)	mg/L	<b>548</b>			500
Hardness (CaCO <sub>3</sub> )	mg/L	384			
pH (field)	pH units	-	6.5		8.5
pH (lab)	pH units	8.18			
Turbidity	NTU	0.85			5
UV Absorbance		0.0800			
<b>Dissolved Anions</b>					
Alkalinity-Total CaCO <sub>3</sub>	mg/L	265			
Chloride	mg/L	0.62			250
Fluoride	mg/L	0.28		1.5	
Sulphate	mg/L	213			500
<b>Nutrients</b>					
Nitrate Nitrogen N	mg/L	<0.10		10	
Nitrite Nitrogen N	mg/L	<0.10		3.2	
<b>Total Metals</b>					
Aluminum	mg/L	<0.020			
Antimony	mg/L	<0.0010		0.006	
Arsenic	mg/L	<i>0.0111</i>		0.025	
Barium	mg/L	0.061		1	
Boron	mg/L	1.31		5	
Cadmium	mg/L	<0.00040		0.005	
Calcium	mg/L	57.3			
Chromium	mg/L	<0.0040		0.05	
Copper	mg/L	<0.0020			1
Iron	mg/L	<b>0.173</b>			0.3
Lead	mg/L	<0.0020		0.01	
Magnesium	mg/L	58.5			
Manganese	mg/L	<b>0.0677</b>			0.05
Mercury	mg/L	<0.00020		0.001	
Potassium	mg/L	4.880			
Selenium	mg/L	<0.0020		0.01	
Sodium	mg/L	26.9			200
Uranium	mg/L	0.00098		0.02	
Zinc	mg/L	<0.10			5
<b>Organic Parameters</b>					
Total Organic Carbon	mg/L	5.68			

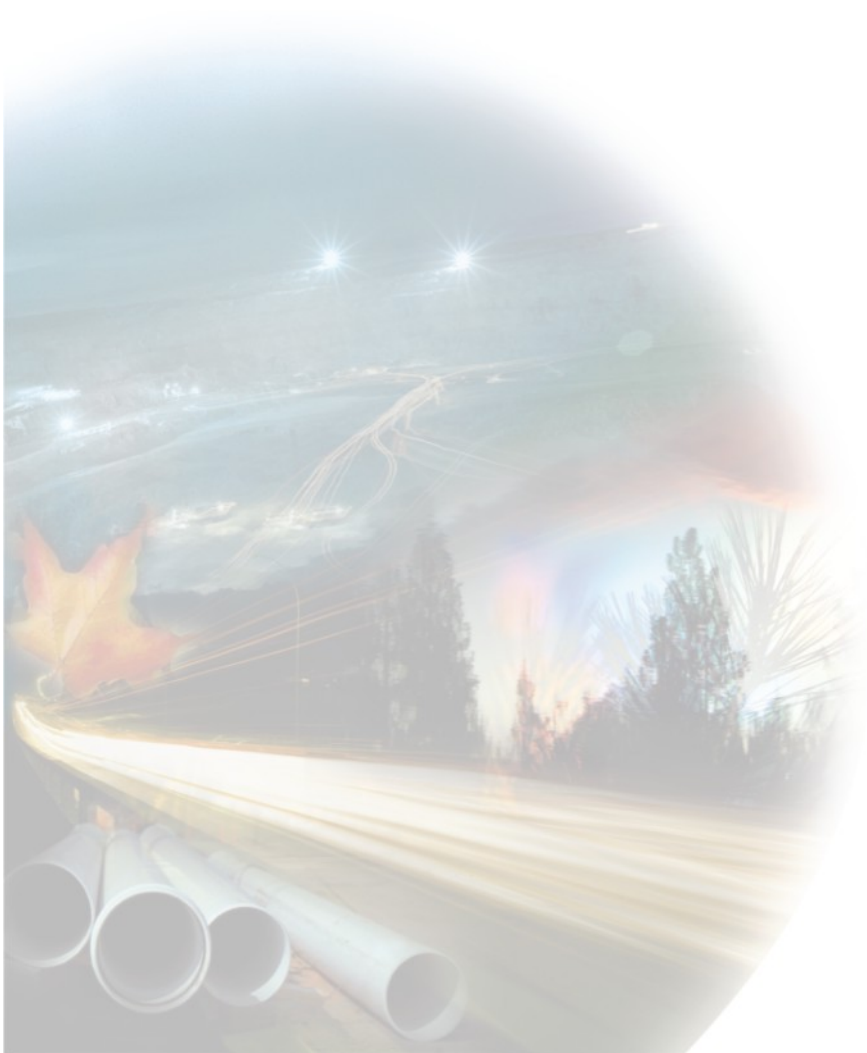
Notes:

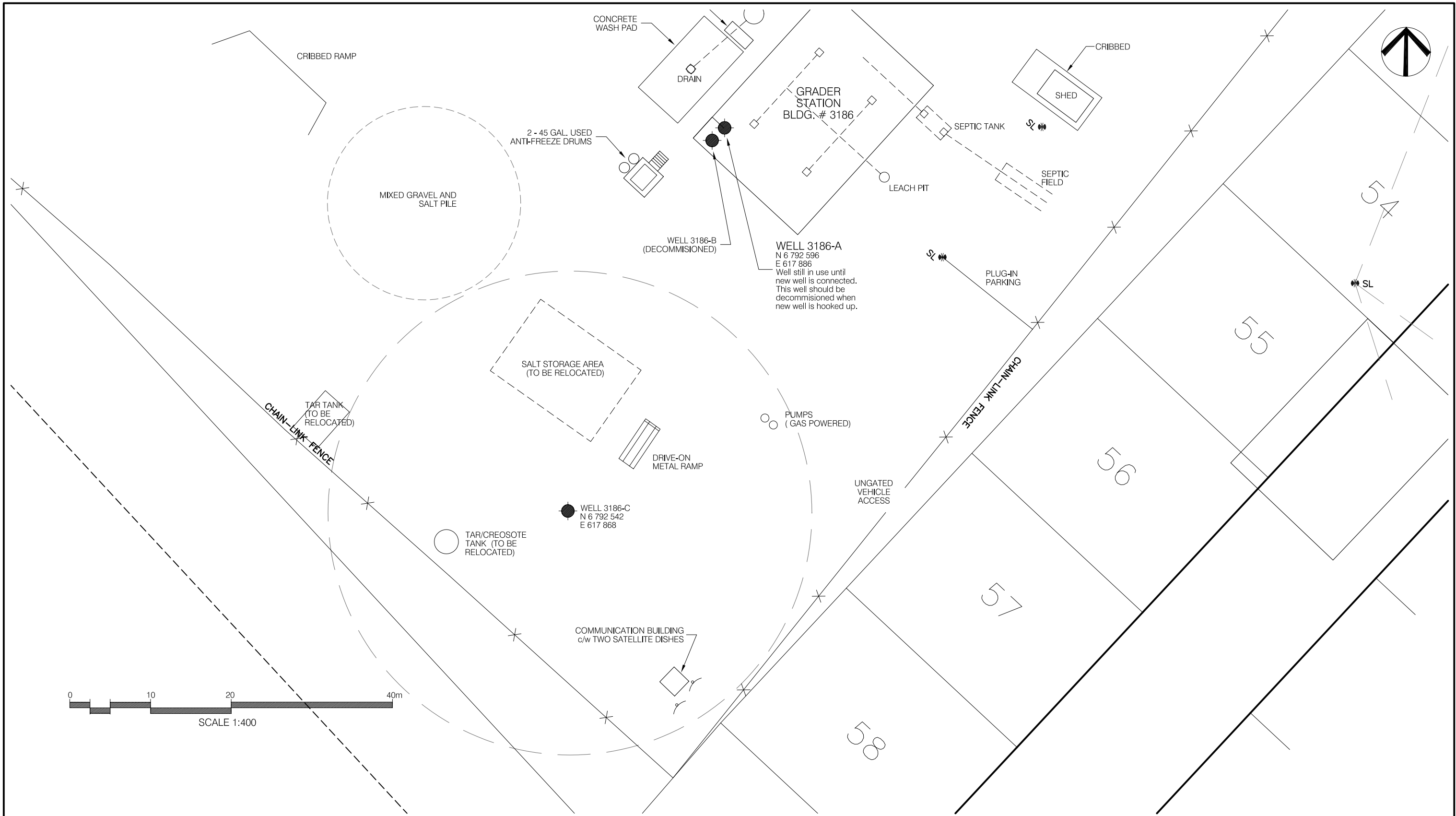
- 1) CDWQG criteria are taken from the "Canadian Drinking Water Quality Guidelines, April 2004."
- 2) MAC refers to the Maximum Acceptable Concentration according to the CDWQG criteria.
- 3) AO refers to the Aesthetic Objective according to the CDWQG criteria.
- 4) "-" indicates not analyzed.
- 5) *Italics* indicates parameter above proposed CDWQG MAC.
- 6) **Bold** indicates parameter above CDWQG AO.






# FIGURES





NOTES:  
 1. UTM COORDINATES OBTAINED WITH A HAND HELD GPS USING NAD83 SYSTEM AND ARE CONSIDERED TO BE ACCURATE TO 10.0 m, APPROXIMATELY.

 30 m RADIUS FROM WATER WELL FOR CONSIDERATION OF PROXIMITY TO POTENTIAL CONTAMINANT SOURCES.  
 BUILDING STRUCTURES RELATIVE TO PROPERTY LINES ARE APPROXIMATE ONLY.

No.	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR CLIENT REVIEW	DD/MM/YY	XXX
REVISION			

**EBA Engineering Consultants Ltd.**

DESIGNED BY: R. MARTIN  
 DRAWN BY: J. BUYCK  
 DATE: JAN. 2006  
 SCALE: AS SHOWN  
 PROJECT No.: 1260008  
 ACAD FILENAME: 003-WESTERN REGION

CLIENT:

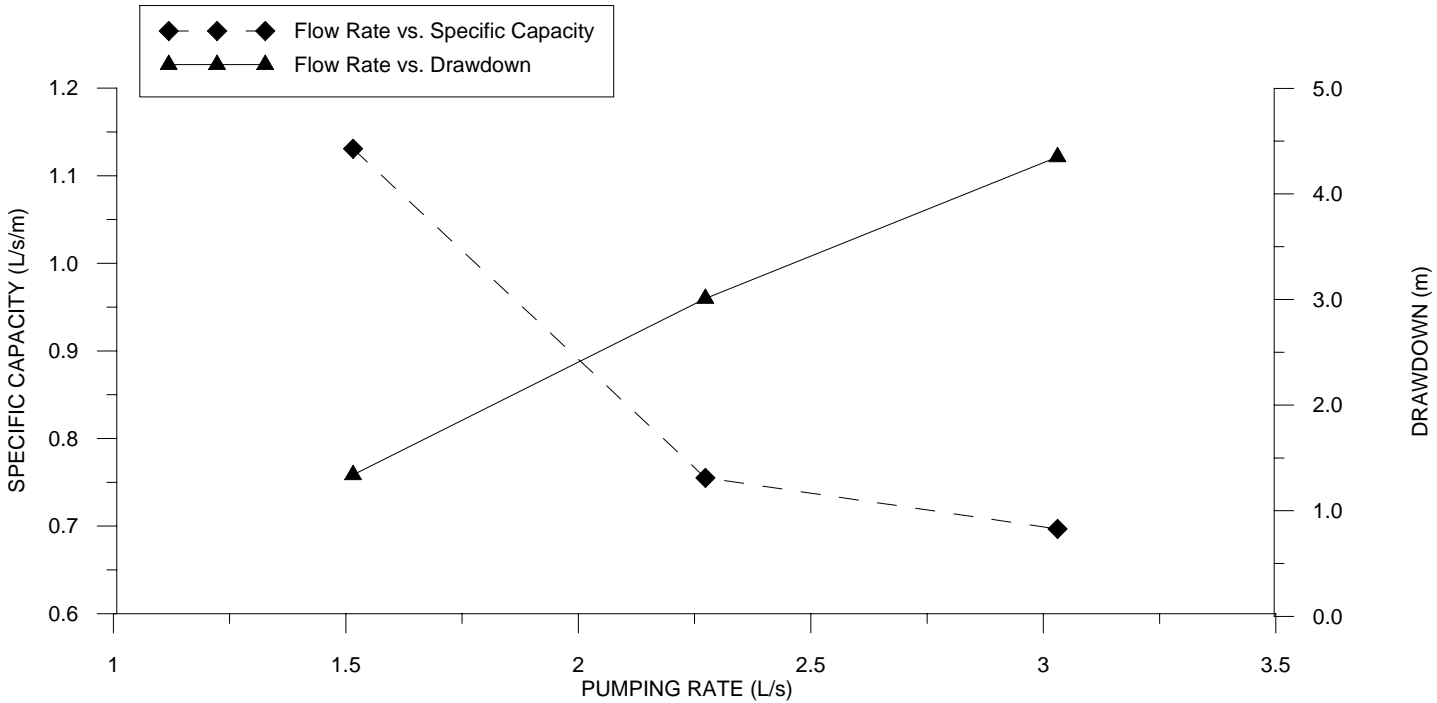
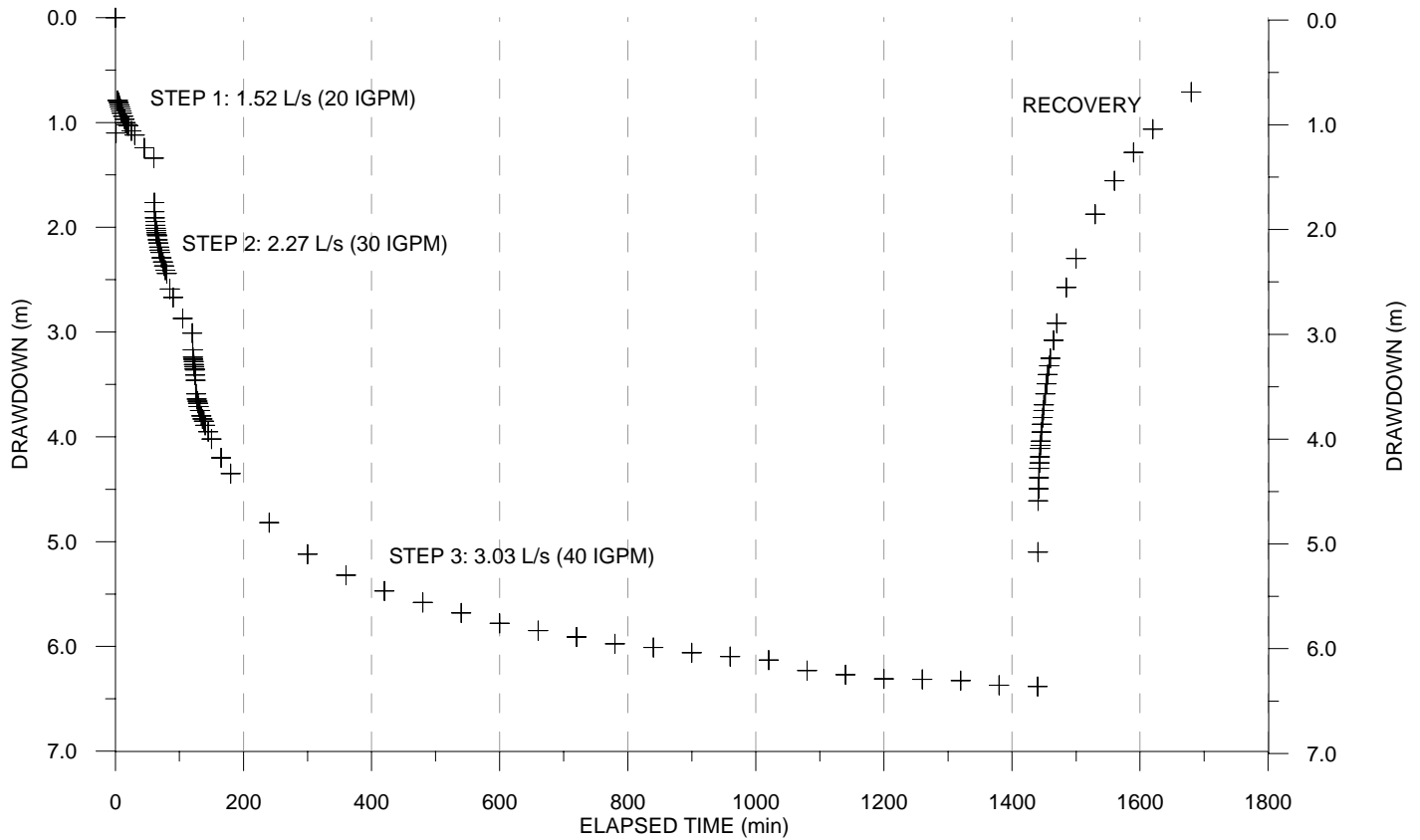
**Yukon**  
 Highways and Public Works  
 Property Management Branch

WELL COMPLETION REPORT

GOVERNMENT OF YUKON  
 HIGHWAYS & PUBLIC WORKS

DESTRUCTION BAY GRADER  
 STATION BUILDING # 3186  
 SITE LOCATION DIAGRAM  
 WELL ID: 3186-C

REVISION	ISSUE
	0
FIGURE No.	FIGURE 1



**EBA Engineering Consultants Ltd.**

PROJECT WELL COMPLETION REPORT  
DESTRUCTION BAY GRADER STATION

CLIENT



TITLE

**STEP TEST AND SPECIFIC CAPACITY**

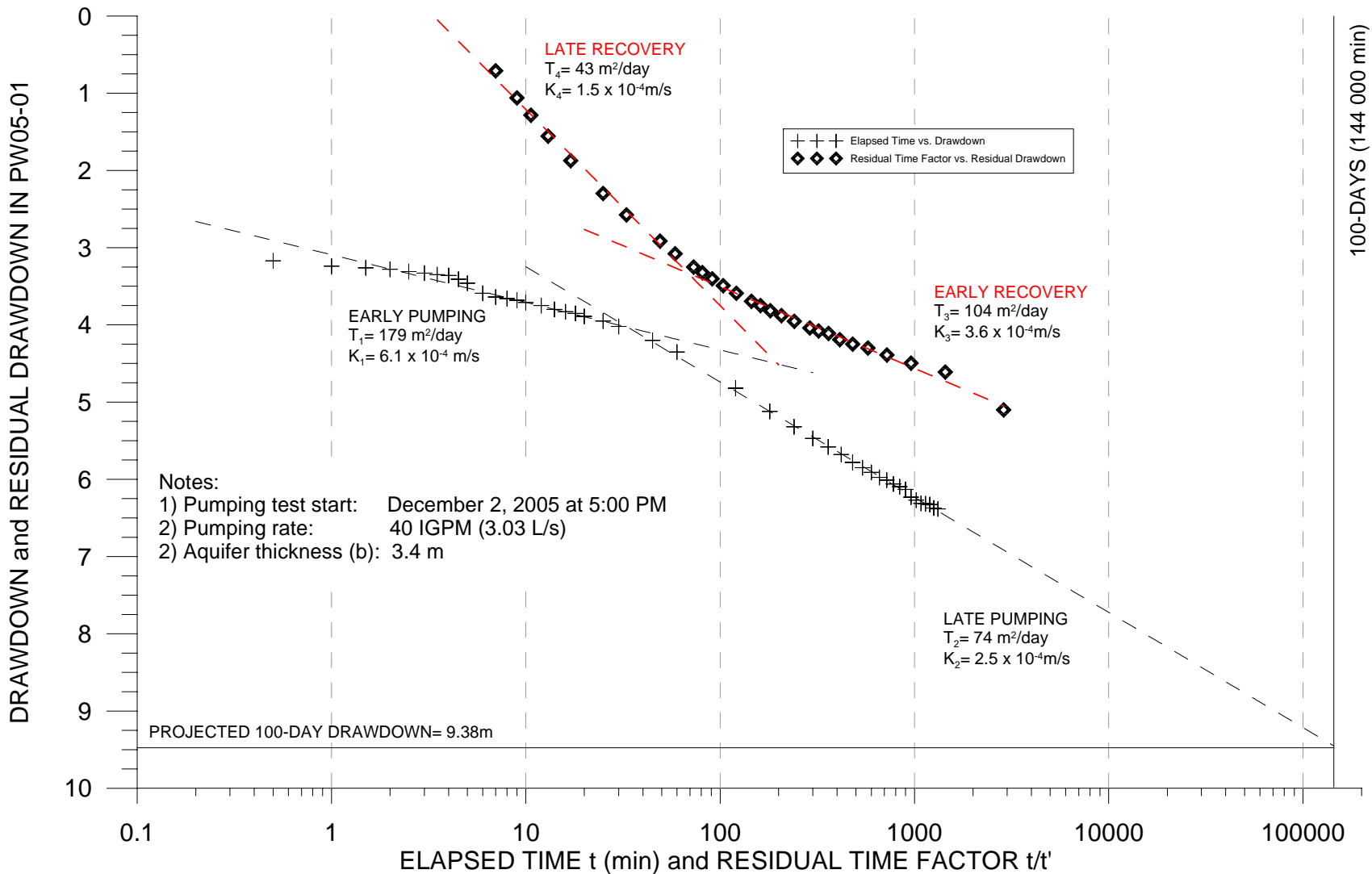
DATE OCTOBER 2005



DWN. KSJ

CHKD.

FILE NO. 1260008

DRWG. FIGURE 2



 <b>EBA Engineering Consultants Ltd.</b>		PROJECT WELL COMPLETION REPORT DESTRUCTION BAY GRADER STATION	
CLIENT		TITLE <b>PUMPING TEST ANALYSIS-          3186-C</b>	
		FILE NO. 1260008	
DATE	DWN. KSJ	CHKD.	DRWG. FIGURE 3



# APPENDIX A

## WELL LOG AND GRAIN SIZE ANALYSIS



# HYDROGEOLOGIC LOG

BOREHOLE NO.

3186-C

PURPOSE OF HOLE: Water Supply Well  
 DRILLING METHOD: Dual Air Rotary  
 START DRILLING: November 26, 2005  
 SCREEN INSTALLED: December 1, 2005  
 CONTRACTOR: Double "D" Drilling Ltd.

GROUND ELEV. (m-geod): N/A  
 TOP OF CASING (m-geod): N/A  
 CASING STICK UP (m): 1.0 m-above grd.  
 DEPTH TO STATIC (m): 0.4 m-btoc.  
 DEPTH TO SCREEN TOP (m): 29.6 m-bg.

Depth (m)	Lithology	Comments	Well Installation Summary
0m	SILT/CLAY (TILL) - trace of organics		<p>Circle Plate - lockable                      Static Water Level 0.6 m-ag                      Bentonite Surface Seal                      8" (203 mm) ID Steel Well Casing                      Nominal (Telescopic) continuous slot stainless steel 1.0 mm (0.040") well screen exposed from 29.6 m to 30.8 m-bg.                      SAND BACKFILL                      CUTTINGS</p>
5m			
9.1 m			
10m	SAND - silty	10.9 m	
	SILT/CLAY (TILL)		
15m			
16.8 m			
	SAND & SILT - trace of organics, fine-med. grained sand, wet, brown		
20m			
25m			
27.4 m			
	SAND AND GRAVEL - silty	28.9 m	
30m	SAND AND GRAVEL - some silt	30.8 m	
	SILT/CLAY (TILL)		
35m			
40m			
42.6 m			
	SAND - silty	45.7 m	
45m			
	SILT/CLAY (TILL)		
50m			
55m			
60m			
65m		65.5 m	
	END OF BOREHOLE		

**EBA Engineering Consultants Ltd.**

PROJECT WELL COMPLETION REPORT  
 GRADER STATION - DESTRUCTION BAY, YUKON

CLIENT   
 Highways and Public Works  
 Property Management Branch

TITLE WELL LOG 3186-C

DATE JAN. 2006

DWN. JSB

CHKD. KSJ

FILE NO. 1260008

DRWG. FIGURE A1

MAP Z E N WELL No.      ELEV      Location Accuracy       
 Date 19      Well Type     

Owners Name & Address       
 Legal Description & Address     

Descriptive Location DESTRUCTION DAM GRAVEL STN. DESTRUCTION DAM Y1.

1. TYPE OF WORK: 1  New Well 2  Reconditioned 3  Deepened 4  Abandoned
2. WORK METHOD: 1  Cable tool 2  Bored 3  Jetted 4  Rotary a  mud b  air c  reverse  Other
3. WATER WELL USE: 1  Domestic 2  Municipal 3  Irrigation 4  Comm. & Ind.  Other
4. DRILLING ADDITIVES NONE

9. CASING: 1  Steel 2  Galvanized 3  Wood 4  Plastic 5  Concrete  Other

Hole Diameter	6.78									units
Diameter	6									ins
from	0									ft
to	96									ft
Thickness	.250									ins
Weight										lb/ft

5. MEASUREMENTS from 1  ground level 2  top of casing casing height above ground level 3.28 ft.

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	30	LOAM TILL	
30	35	SILT SAND.	
35	90	TILL	
<del>90</del>	<del>101</del>		
90	95	W/B SAND + GRAVEL + SILT VERY DRY	
95	101	W/B SAND + GRAVEL + SILT CLEANER ZONE.	
101	140	TILL	
140	150	SILT SAND.	
150	215	TILL	
		* 10" SURFACE SEAL FROM 0' - 20 FT	
		* BACKFILL 215 TO 170 SAND + GRAVEL, 170 TO 101 FT 10-20' FINE SAND	

Pitless unit      ft 1  above 2  below ground level  
 1  Welded 2  Cemented 3  Threaded | 1  New 2  Used  
 Performations:     

Shoe(s): BARBER DRIVE SHOE  
 Open hole, from      to      ft Diameter      ins  
 Grout:     

10. SCREEN: 1  Nominal (Telescope) 2  Pipe Size  
 Type 1  Continuous Slot 2  Perforated 3  Louvre  Other  
 Material 1  Stainless Steel 2  Plastic  Other  
 Set from 97 to 101 ft below ground level

RISER, SCREEN & BLANKS						units
Length	2.5	4				ft
Diam. I.D.	5	5				ins
Slot Size	0	.040				ins
from	94.5	97				ft
to	97	101				ft

Fittings, top KAPLER bottom THREADED PLUG  
 Gravel Pack     

11. DEVELOPED BY: 1  Surging 2  Jetting 3  Air 4  Boiling 5  Pumping  Other
12. TEST 1  Pump 2  Bail 3  Air Date 05/12/06  
 Rate 40 USgpm Temp      °C SWL before test      ft  
 Water Level      ft after test of      hrs

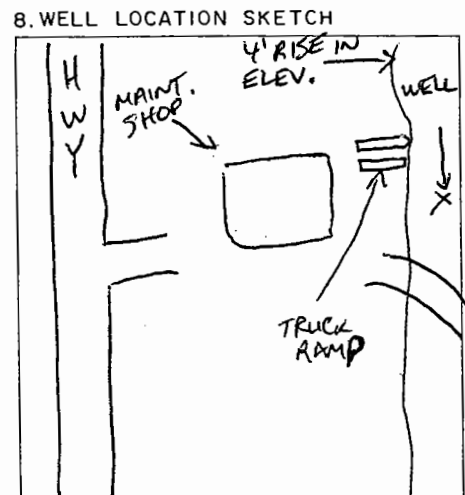
DRAWDOWN in ft				RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13. RECOMMENDED PUMP TYPE      RECOMMENDED PUMP SETTING      ft RECOMMENDED PUMPING RATE      USgpm

14. WATER TYPE: 1  Fresh 2  Salty 3  Clear 4  Cloudy  
 colour NO smell SULFUR; gas 1  yes 2  no  
SIGHT

15. WATER ANALYSIS: 1 Hardness      mg/L  
 2 Iron      mg/L 3 Chloride      mg/L  
 4 pH      Field Date     

7. CONSULTANT       
 Address     



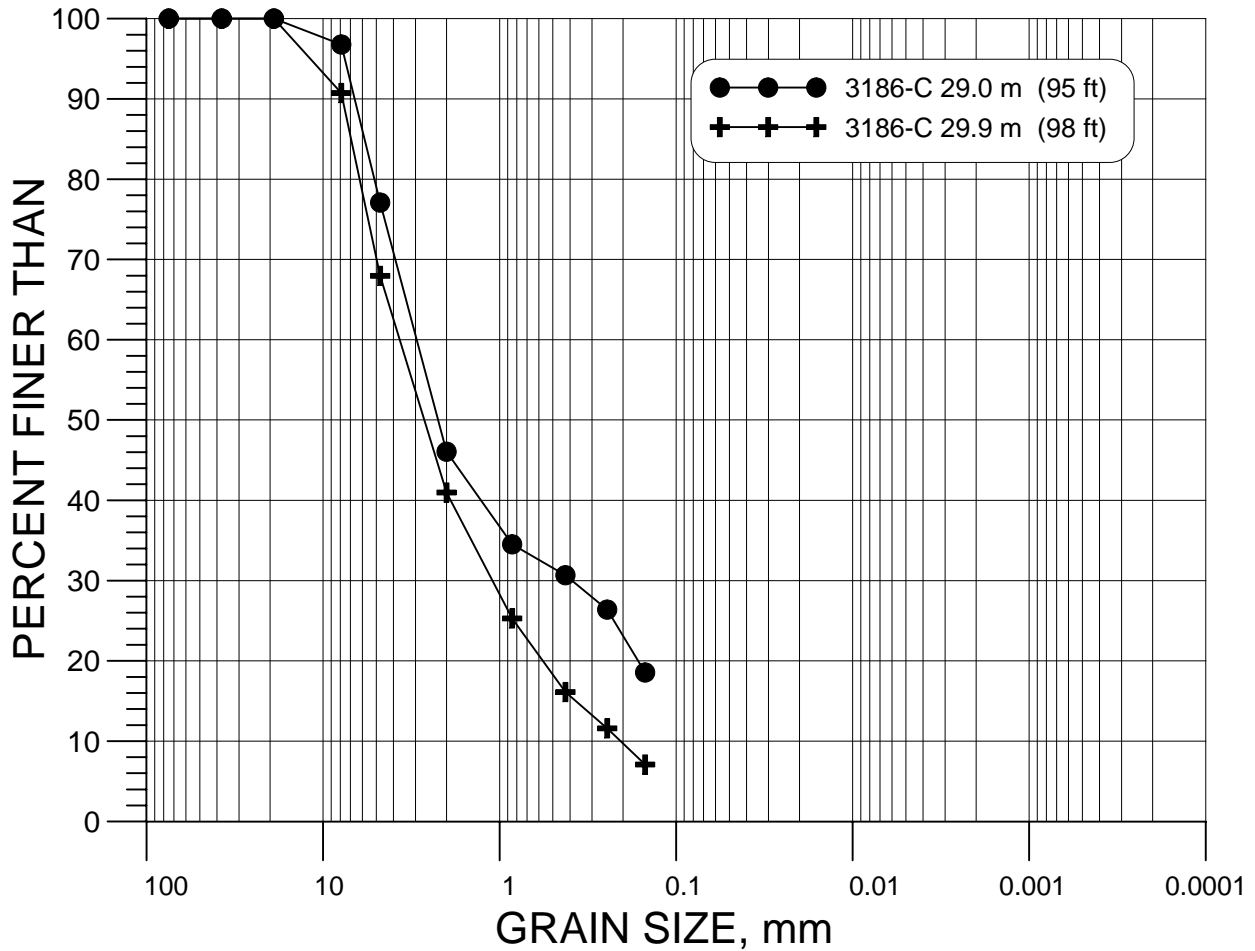
SITE ID No      Lab Date     

16. FINAL WELL COMPLETION DATA  
 Well Depth 110.1 ft Well Yield 40 PPM USgpm  
 Static Water Level 2 A.G.L. ft Artesian Flow YES? USgpm Pressure Head      ft  
 Back filter BACK FILLED W/ 10-20 FILTER SAND  
 Well Head Completion HINGED LOCKABLE PLATE

17. DRILLER SURNAME STANICE FIRST NAME DOUGLAS  
 Signature     

18. CONTRACTOR, DOUBLE D DRILLING CO.  
 Address Box 766 TERRACE B.C. V8G 4R1  
(250) 635-7877  
 Member, BCGWA  yes  no; DOUG STANICE

UNIFIED SOIL CLASSIFICATION SYSTEM 1992



USCS	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	Coarse	Medium	Fine	Coarse	Medium	Fine	SILT SIZE	CLAY SIZE
COBBLE SIZE								

HYDRAULIC CONDUCTIVITY (K) ESTIMATES

	29.0 m (95 ft)	29.9 m (98 ft)
HAZEN	4.14E-05 m/sec	2.12E-04 m/sec
TERZAGHI	1.19E-05 m/sec	6.24E-05 m/sec
SAUERBREI	2.10E-05 m/sec	2.01E-04 m/sec
KOZENY	2.13E-04 m/sec	7.57E-04 m/sec
ZAMARINU	2.38E-04 m/sec	9.33E-04 m/sec
SLICHTER	8.22E-06 m/sec	4.25E-05 m/sec
BEYER	4.90E-05 m/sec	2.55E-04 m/sec
KRUGER	2.97E-04 m/sec	1.24E-03 m/sec
ZUNKER	1.80E-04 m/sec	6.60E-04 m/sec
USBR	6.56E-05 m/sec	1.12E-03 m/sec
MINIMUM	8.22E-06 m/sec	4.25E-05 m/sec
GEOMETRIC MEAN	<b>6.12E-05 m/sec</b>	<b>3.37E-04 m/sec</b>
MAXIMUM	2.97E-04 m/sec	1.24E-03 m/sec

**EBA Engineering Consultants Ltd.**

PROJECT WELL COMPLETION REPORT  
DESTRUCTION BAY GRADER STATION

CLIENT  
**Yukon**  
Highways and Public Works  
Property Management Branch

TITLE  
**GRAINSIZE ANALYSIS 3186-C**

DATE DECEMBER 2005 DWN. KSJ

CHKD.

FILE NO. 1260008

DRWG. APPENDIX A2

**SAMPLE NO.** 4  
 LOCATION Destruction Bay  
 BORING NO. 3186-C  
 DEPTH 95 ft (29.0 m)

DATE 28-Nov-05  
 TECHNICIAN KSJ  
 JOB NO. 1260008

	SIEVE NO.		OPENING SIZE (mm)	TARE + SAMPLE (g)	SAMPLE (g)	WEIGHT RETAINED (%)	WEIGHT PASSING (%)
	TYLER	U.S. EQUIV					
COBBLES		3.0"	75.0	0.00	0.00	0.0	100.0
GRAVEL	MESH	1.5"	37.5	0.00	0.00	0.0	100.0
	.742	3/4"	19.0	0.00	0.00	0.0	100.0
	0.313	5/16"	7.9	52.00	52.00	3.2	96.8
	4	4	4.75	317.00	317.00	19.7	77.1
S A N D	9	10	2.00	500.00	500.00	31.0	46.1
	20	20	.850	186.00	186.00	11.5	34.5
	35	40	.425	62.00	62.00	3.8	30.7
	60	60	.246	69.00	69.00	4.3	26.4
FINES	100	100	.150	126.00	126.00	7.8	18.6
	PAN		< .075	299.00	299.00	18.6	0.0
TOTAL					1611.00	100.0	

TARE (g): 0

TOTAL GRAVEL (g) : 369.00

TOTAL SAMPLE (g) : 1611.00

% GRAVEL : 22.91

TOTAL SAND (g) : 943.00

TOTAL SAMPLE (g) : 1611.00

% SAND : 58.54

TOTAL FINES (g) : 299.00

TOTAL SAMPLE (g) : 1611.00

% FINES : 18.56

HYDROMETER (Y/N) : NO

**SAMPLE DESCRIPTION** : Brown/grey medium-coarse SAND, trace gravel.

**SAMPLE NO.** 5  
**LOCATION** Destruction Bay  
**BORING NO.** 3186-C  
**DEPTH** 98 ft (298.7 m)

**DATE** 28-Nov-05  
**TECHNICIAN** KSJ  
**JOB NO.** 1260008

	SIEVE NO.		OPENING SIZE (mm)	TARE + SAMPLE (g)	SAMPLE (g)	WEIGHT RETAINED (%)	WEIGHT PASSING (%)
	TYLER	U.S. EQUIV					
COBBLES		3.0"	75.0	0.00	0.00	0.0	100.0
GRAVEL	MESH	1.5"	37.5	0.00	0.00	0.0	100.0
	.742	3/4"	19.0	0.00	0.00	0.0	100.0
	0.313	5/16"	7.9	179.00	179.00	9.3	90.7
	4	4	4.75	441.00	441.00	22.8	68.0
S A N D	9	10	2.00	522.00	522.00	27.0	41.0
	20	20	.850	304.00	304.00	15.7	25.3
	35	40	.425	177.00	177.00	9.1	16.1
	60	60	.246	88.00	88.00	4.5	11.6
	100	100	.150	87.00	87.00	4.5	7.1
FINES	PAN		< .075	137.00	137.00	7.1	0.0
TOTAL					1935.00	100.0	

TARE (g): 0

TOTAL GRAVEL (g) : 620.00

TOTAL SAMPLE (g) : 1935.00

% GRAVEL : 32.04

TOTAL SAND (g) : 1178.00

TOTAL SAMPLE (g) : 1935.00

% SAND : 60.88

TOTAL FINES (g) : 137.00

TOTAL SAMPLE (g) : 1935.00

% FINES : 7.08

HYDROMETER (Y/N) : NO

**SAMPLE DESCRIPTION** : Brown/grey medium-coarse SAND, trace gravel.



# APPENDIX B

PUMPING TEST DATA



## APPENDIX B PUMPING TEST DATA

WELL NAME: 3186-C  
 STATIC WATER LEVEL (m): 1.340  
 DATUM: Top of Casing  
 DATUM STICK-UP(m): 1.000  
 WELL DIAMETER (mm): 152 mm (6")

PUMP INTAKE DEPTH (m): 27.13  
 SCREEN INTERVAL: 29.5 - 30.8 m-bgl  
 SLOT SIZE ("): 0.040 (40 Slot)  
 AVAILABLE DRAWDOWN(m): 25.79  
 SCREEN DIAMETER (mm): 6" Nominal

DATE	TIME	ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (m)	TOTALIZER (ft <sup>3</sup> )	FLOW RATE (IGPM)	FLOW RATE (L/s)	SPECIFIC CAPACITY (L/s/m)	pH	EC	TEMP	COMMENTS
2-Dec-05	17:00:00	0	1.340	0.000	0	-	-	-	-	-	-	STEP 1
2-Dec-05	17:01:00	1	2.440	1.100	-	20	1.52	1.38	-	-	-	
2-Dec-05	17:03:00	3	2.130	0.790	-	20	1.52	1.92	-	-	-	
2-Dec-05	17:04:00	4	2.130	0.790	-	20	1.52	1.92	-	-	-	
2-Dec-05	17:05:00	5	2.150	0.810	-	20	1.52	1.87	-	-	-	
2-Dec-05	17:06:00	6	2.170	0.830	-	20	1.52	1.83	-	-	-	
2-Dec-05	17:07:00	7	2.190	0.850	-	20	1.52	1.78	-	-	-	
2-Dec-05	17:08:00	8	2.210	0.870	-	20	1.52	1.74	-	-	-	
2-Dec-05	17:09:00	9	2.230	0.890	-	20	1.52	1.70	-	-	-	
2-Dec-05	17:10:00	10	2.250	0.910	-	20	1.52	1.67	-	-	-	
2-Dec-05	17:12:00	12	2.280	0.940	-	20	1.52	1.61	-	-	-	
2-Dec-05	17:14:00	14	2.310	0.970	-	20	1.52	1.56	-	-	-	
2-Dec-05	17:16:00	16	2.340	1.000	-	20	1.52	1.52	-	-	-	
2-Dec-05	17:18:00	18	2.360	1.020	-	20	1.52	1.49	-	-	-	
2-Dec-05	17:20:00	20	2.370	1.030	-	20	1.52	1.47	-	-	-	
2-Dec-05	17:25:00	25	2.420	1.080	-	20	1.52	1.40	-	-	-	
2-Dec-05	17:30:00	30	2.460	1.120	-	20	1.52	1.35	-	-	-	
2-Dec-05	17:45:00	45	2.580	1.240	190	20	1.52	1.22	-	-	-	
2-Dec-05	18:00:00	60	2.680	1.340	-	20	1.52	1.13	8.58	712	2.2	
2-Dec-05	18:00:30	60.5	3.105	1.765	-	30	2.27	1.29	-	-	-	START STEP 2
2-Dec-05	18:01:00	61	3.190	1.850	-	30	2.27	1.23	-	-	-	
2-Dec-05	18:01:30	61.5	3.250	1.910	-	30	2.27	1.19	-	-	-	
2-Dec-05	18:02:00	62	3.285	1.945	-	30	2.27	1.17	-	-	-	
2-Dec-05	18:02:30	62.5	3.320	1.980	-	30	2.27	1.15	-	-	-	
2-Dec-05	18:03:00	63	3.350	2.010	-	30	2.27	1.13	-	-	-	
2-Dec-05	18:03:30	63.5	3.370	2.030	-	30	2.27	1.12	-	-	-	
2-Dec-05	18:04:00	64	3.390	2.050	-	30	2.27	1.11	-	-	-	
2-Dec-05	18:04:30	64.5	3.410	2.070	-	30	2.27	1.10	-	-	-	
2-Dec-05	18:05:00	65	3.420	2.080	-	30	2.27	1.09	-	-	-	
2-Dec-05	18:06:00	66	3.460	2.120	-	30	2.27	1.07	-	-	-	
2-Dec-05	18:07:00	67	3.490	2.150	-	30	2.27	1.06	-	-	-	
2-Dec-05	18:08:00	68	3.530	2.190	-	30	2.27	1.04	-	-	-	
2-Dec-05	18:09:00	69	3.560	2.220	-	30	2.27	1.02	-	-	-	
2-Dec-05	18:10:00	70	3.580	2.240	-	30	2.27	1.01	-	-	-	
2-Dec-05	18:12:00	72	3.630	2.290	-	30	2.27	0.99	-	-	-	
2-Dec-05	18:14:00	74	3.670	2.330	-	30	2.27	0.98	-	-	-	
2-Dec-05	18:16:00	76	3.710	2.370	-	30	2.27	0.96	-	-	-	
2-Dec-05	18:18:00	78	3.750	2.410	-	30	2.27	0.94	-	-	-	
2-Dec-05	18:20:00	80	3.780	2.440	-	30	2.27	0.93	8.5	697	2.2	
2-Dec-05	18:25:00	85	3.930	2.590	-	30	2.27	0.88	-	-	-	
2-Dec-05	18:30:00	90	4.010	2.670	-	30	2.27	0.85	-	-	-	
2-Dec-05	18:45:00	105	4.210	2.870	-	30	2.27	0.79	-	-	-	
2-Dec-05	19:00:00	120	4.350	3.010	-	30	2.27	0.76	-	-	-	
2-Dec-05	19:00:30	120.5	4.510	3.170	480	40	3.03	0.96	-	-	-	START STEP 3
2-Dec-05	19:01:00	121	4.580	3.240	-	40	3.03	0.94	-	-	-	
2-Dec-05	19:01:30	121.5	4.600	3.260	-	40	3.03	0.93	-	-	-	

## APPENDIX B PUMPING TEST DATA

WELL NAME: 3186-C  
 STATIC WATER LEVEL (m): 1.340  
 DATUM: Top of Casing  
 DATUM STICK-UP(m): 1.000  
 WELL DIAMETER (mm): 152 mm (6")

PUMP INTAKE DEPTH (m): 27.13  
 SCREEN INTERVAL: 29.5 - 30.8 m-bgl  
 SLOT SIZE ("): 0.040 (40 Slot)  
 AVAILABLE DRAWDOWN(m): 25.79  
 SCREEN DIAMETER (mm): 6" Nominal

DATE	TIME	ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (m)	TOTALIZER (ft <sup>3</sup> )	FLOW RATE (IGPM)	FLOW RATE (L/s)	SPECIFIC CAPACITY (L/s/m)	pH	EC	TEMP	COMMENTS
2-Dec-05	19:02:00	122	4.620	3.280	-	40	3.03	0.92	-	-	-	
2-Dec-05	19:02:30	122.5	4.650	3.310	-	40	3.03	0.92	-	-	-	
2-Dec-05	19:03:00	123	4.670	3.330	-	40	3.03	0.91	-	-	-	
2-Dec-05	19:03:30	123.5	4.690	3.350	-	40	3.03	0.90	-	-	-	
2-Dec-05	19:04:00	124	4.700	3.360	-	40	3.03	0.90	-	-	-	
2-Dec-05	19:04:30	124.5	4.750	3.410	-	40	3.03	0.89	-	-	-	
2-Dec-05	19:05:00	125	4.800	3.460	-	40	3.03	0.88	-	-	-	
2-Dec-05	19:06:00	126	4.930	3.590	-	40	3.03	0.84	-	-	-	
2-Dec-05	19:07:00	127	4.980	3.640	-	40	3.03	0.83	-	-	-	
2-Dec-05	19:08:00	128	5.000	3.660	-	40	3.03	0.83	-	-	-	
2-Dec-05	19:09:00	129	5.020	3.680	-	40	3.03	0.82	-	-	-	
2-Dec-05	19:10:00	130	5.050	3.710	-	40	3.03	0.82	-	-	-	
2-Dec-05	19:12:00	132	5.090	3.750	-	40	3.03	0.81	-	-	-	
2-Dec-05	19:14:00	134	5.140	3.800	-	40	3.03	0.80	-	-	-	
2-Dec-05	19:16:00	136	5.170	3.830	-	40	3.03	0.79	-	-	-	
2-Dec-05	19:18:00	138	5.190	3.850	-	40	3.03	0.79	-	-	-	
2-Dec-05	19:20:00	140	5.230	3.890	-	40	3.03	0.78	-	-	-	
2-Dec-05	19:25:00	145	5.290	3.950	-	40	3.03	0.77	-	-	-	
2-Dec-05	19:30:00	150	5.360	4.020	-	40	3.03	0.75	-	-	-	CONTINUE STEP 3
2-Dec-05	19:45:00	165	5.540	4.200	-	40	3.03	0.72	-	-	-	FOR CONSTANT RATE TEST
2-Dec-05	20:00:00	180	5.690	4.350	864	40	3.03	0.70	-	-	-	
2-Dec-05	21:00:00	240	6.160	4.820	-	40	3.03	0.63	8.69	817	3.2	
2-Dec-05	22:00:00	300	6.460	5.120	-	40	3.03	0.59	8.48	780	2.8	
2-Dec-05	23:00:00	360	6.660	5.320	-	40	3.03	0.57	8.46	700	2.2	
3-Dec-05	0:00:00	420	6.810	5.470	-	40	3.03	0.55	8.65	795	1.9	
3-Dec-05	1:00:00	480	6.920	5.580	-	40	3.03	0.54	8.39	774	2.4	
3-Dec-05	2:00:00	540	7.020	5.680	-	40	3.03	0.53	8.48	791	4.4	
3-Dec-05	3:00:00	600	7.120	5.780	-	40	3.03	0.52	8.44	826	3.9	
3-Dec-05	4:00:00	660	7.190	5.850	-	40	3.03	0.52	8.53	789	3	
3-Dec-05	5:00:00	720	7.250	5.910	-	40	3.03	0.51	8.63	801	1.5	
3-Dec-05	6:00:00	780	7.315	5.975	-	40	3.03	0.51	8.52	714	1.7	
3-Dec-05	7:00:00	840	7.350	6.010	-	40	3.03	0.50	8.47	788	2	
3-Dec-05	8:00:00	900	7.400	6.060	-	40	3.03	0.50	8.52	792	1.8	
3-Dec-05	9:00:00	960	7.436	6.096	-	40	3.03	0.50	-	-	-	
3-Dec-05	10:00:00	1020	7.470	6.130	-	40	3.03	0.49	-	-	-	
3-Dec-05	11:00:00	1080	7.570	6.230	-	40	3.03	0.49	8.42	798	2	
3-Dec-05	12:00:00	1140	7.610	6.270	-	40	3.03	0.48	8.73	793	1.7	
3-Dec-05	13:00:00	1200	7.650	6.310	-	40	3.03	0.48	-	-	-	
3-Dec-05	14:00:00	1260	7.655	6.315	-	40	3.03	0.48	8.71	797	1.7	
3-Dec-05	15:00:00	1320	7.665	6.325	-	40	3.03	0.48	-	-	-	
3-Dec-05	16:00:00	1380	7.710	6.370	-	40	3.03	0.48	8.75	786	1.9	
3-Dec-05	17:00:00	1440	7.723	6.383	8944	40	3.03	0.47	-	-	-	
3-Dec-05	17:00:30	1440.5	6.440	5.100	-	0	0.00	-	-	-	-	
3-Dec-05	17:01:00	1441	5.950	4.610	-	0	0.00	-	-	-	-	
3-Dec-05	17:01:30	1441.5	5.835	4.495	-	0	0.00	-	-	-	-	
3-Dec-05	17:02:00	1442	5.730	4.390	-	0	0.00	-	-	-	-	

### APPENDIX B PUMPING TEST DATA

WELL NAME: 3186-C  
 STATIC WATER LEVEL (m): 1.340  
 DATUM: Top of Casing  
 DATUM STICK-UP(m): 1.000  
 WELL DIAMETER (mm): 152 mm (6")

PUMP INTAKE DEPTH (m): 27.13  
 SCREEN INTERVAL: 29.5 - 30.8 m-bgl  
 SLOT SIZE ("): 0.040 (40 Slot)  
 AVAILABLE DRAWDOWN(m): 25.79  
 SCREEN DIAMETER (mm): 6" Nominal

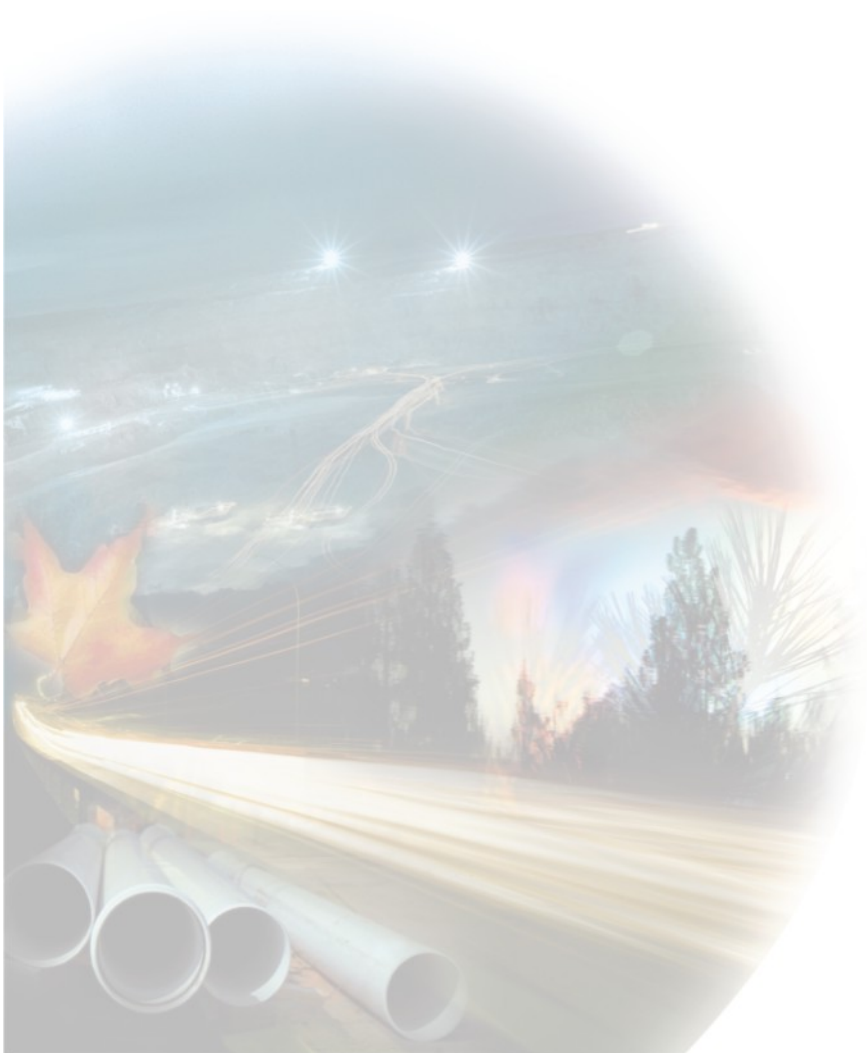
DATE	TIME	ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (m)	TOTALIZER (ft <sup>3</sup> )	FLOW RATE (IGPM)	FLOW RATE (L/s)	SPECIFIC CAPACITY (L/s/m)	pH	EC	TEMP	COMMENTS
3-Dec-05	17:02:30	1442.5	5.640	4.300	-	0	0.00	-	-	-	-	
3-Dec-05	17:03:00	1443	5.590	4.250	-	0	0.00	-	-	-	-	
3-Dec-05	17:03:30	1443.5	5.530	4.190	-	0	0.00	-	-	-	-	
3-Dec-05	17:04:00	1444	5.450	4.110	-	0	0.00	-	-	-	-	
3-Dec-05	17:04:30	1444.5	5.420	4.080	-	0	0.00	-	-	-	-	
3-Dec-05	17:05:00	1445	5.380	4.040	-	0	0.00	-	-	-	-	
3-Dec-05	17:06:00	1446	5.295	3.955	-	0	0.00	-	-	-	-	
3-Dec-05	17:07:00	1447	5.220	3.880	-	0	0.00	-	-	-	-	
3-Dec-05	17:08:00	1448	5.155	3.815	-	0	0.00	-	-	-	-	
3-Dec-05	17:09:00	1449	5.090	3.750	-	0	0.00	-	-	-	-	
3-Dec-05	17:10:00	1450	5.035	3.695	-	0	0.00	-	-	-	-	
3-Dec-05	17:12:00	1452	4.930	3.590	-	0	0.00	-	-	-	-	
3-Dec-05	17:14:00	1454	4.832	3.492	-	0	0.00	-	-	-	-	
3-Dec-05	17:16:00	1456	4.744	3.404	-	0	0.00	-	-	-	-	
3-Dec-05	17:18:00	1458	4.663	3.323	-	0	0.00	-	-	-	-	
3-Dec-05	17:20:00	1460	4.591	3.251	-	0	0.00	-	-	-	-	
3-Dec-05	17:25:00	1465	4.419	3.079	-	0	0.00	-	-	-	-	
3-Dec-05	17:30:00	1470	4.255	2.915	-	0	0.00	-	-	-	-	
3-Dec-05	17:45:00	1485	3.915	2.575	-	0	0.00	-	-	-	-	
3-Dec-05	18:00:00	1500	3.637	2.297	-	0	0.00	-	-	-	-	
3-Dec-05	18:30:00	1530	3.214	1.874	-	0	0.00	-	-	-	-	
3-Dec-05	19:00:00	1560	2.895	1.555	-	0	0.00	-	-	-	-	
3-Dec-05	19:30:00	1590	2.625	1.285	-	0	0.00	-	-	-	-	
3-Dec-05	20:00:00	1620	2.402	1.062	-	0	0.00	-	-	-	-	
3-Dec-05	21:00:00	1680	2.050	0.710	-	0	0.00	-	-	-	-	





# APPENDIX C

LABORATORY REPORTS AND CERTIFICATES





# CERTIFICATE OF ANALYSIS

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**Date:** December 21, 2005

**ALS File No.** W8652

**Report On:** 1260008 Water Analysis

**Report To:** **EBA Engineering Consultants Ltd.**  
Calcite Business Centre  
Unit 6 - 151 Industrial Road  
Whitehorse, YT  
Y1A 2V3

**Attention:** **Ms. Katherine Johnston**

**Received:** December 9, 2005

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**ALS ENVIRONMENTAL**

per:

Natasha Markovic-Mirovic, B.Sc. - Project Chemist  
Sime Buric, B.Sc. - Client Services

File No. W8652

**REMARKS**



Please note that the certain Metals detection limits have been increased for some of the samples due to the matrix interferences encountered during the analysis.

**RESULTS OF ANALYSIS - Water**

Sample ID	Burwash Airport	D.Bay Grades Stn.
Sample Date	05-12-07	05-12-03
Sample Time	11:00	17:00
ALS ID	1	2

**Physical Tests**

Colour	(CU)	<5.0	6.1
Conductivity	(uS/cm)	436	781
Total Dissolved Solids		261	548
Hardness	CaCO3	179	384
pH		8.21	8.18
Turbidity	(NTU)	0.83	0.85
UV Absorbance		0.0380	0.0800

**Dissolved Anions**

Alkalinity-Total		CaCO3	235	265
Chloride	Cl		1.15	0.62
Fluoride	F		0.313	0.280
Sulphate	SO4		34.6	213

**Nutrients**

Nitrate Nitrogen		N	<0.10	<0.10
Nitrite Nitrogen		N	<0.10	<0.10

Remarks regarding the analyses appear at the beginning of this report.  
 Results are expressed as milligrams per litre except for pH, Colour (CU),  
 Conductivity (umhos/cm), and Turbidity (NTU).  
 < = Less than the detection limit indicated.

**RESULTS OF ANALYSIS - Water**

Sample ID	Burwash Airport	D.Bay Grades Stn.
Sample Date	05-12-07	05-12-03
Sample Time	11:00	17:00
ALS ID	1	2

**Total Metals**

Aluminum	T-Al	<0.020	<0.020
Antimony	T-Sb	<0.0010	<0.0010
Arsenic	T-As	0.00357	0.0111
Barium	T-Ba	<0.040	0.061
Boron	T-B	0.35	1.31
Cadmium	T-Cd	<0.00040	<0.00040
Calcium	T-Ca	26.3	57.3
Chromium	T-Cr	<0.0040	<0.0040
Copper	T-Cu	<0.0020	<0.0020
Iron	T-Fe	<0.030	0.173
Lead	T-Pb	<0.0020	<0.0020
Magnesium	T-Mg	27.5	58.5
Manganese	T-Mn	0.149	0.0677
Mercury	T-Hg	<0.00020	<0.00020
Potassium	T-K	4.86	4.88
Selenium	T-Se	<0.0020	<0.0020
Sodium	T-Na	26.5	26.9
Uranium	T-U	0.00078	0.00098
Zinc	T-Zn	<0.10	<0.10

**Organic Parameters**

Total Organic Carbon	C	1.99	5.68
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Remarks regarding the analyses appear at the beginning of this report.  
 Results are expressed as milligrams per litre except for pH, Colour (CU),  
 Conductivity (umhos/cm), and Turbidity (NTU).  
 < = Less than the detection limit indicated.



## Appendix 1 - REGULATORY CRITERIA

### Health Canada

Summary of Guidelines for Canadian Drinking Water Quality, April 2003. Please see the guidelines for further details. All limits are Maximum Acceptable Concentration (MAC) unless otherwise indicated. Limits are expressed as mg/L except for pH, Turbidity, Colour and Bacteriological Tests.

		Lower Limit	Upper Limit		Notes
<b>Physical Tests</b>					
Colour	(CU)	-	15	CU	1
Total Dissolved Solids		-	500	mg/L	1
pH		6.5	8.5		1
Turbidity	(NTU)	-	5	NTU	1, 2
<b>Dissolved Anions</b>					
Chloride	Cl	-	250	mg/L	1
Fluoride	F	-	1.5	mg/L	
Sulphate	SO <sub>4</sub>	-	500	mg/L	1, 3
<b>Nutrients</b>					
Nitrate Nitrogen		N	-	10	mg/L
Nitrite Nitrogen		N	-	1	mg/L
<b>Total Metals</b>					
Antimony	T-Sb	-	0.006	mg/L	4, 5
Arsenic	T-As	-	0.025	mg/L	4
Barium	T-Ba	-	1	mg/L	
Boron	T-B	-	5	mg/L	4
Cadmium	T-Cd	-	0.005	mg/L	
Chromium	T-Cr	-	0.05	mg/L	
Copper	T-Cu	-	1	mg/L	1, 6
Iron	T-Fe	-	0.3	mg/L	1
Lead	T-Pb	-	0.01	mg/L	6, 5
Manganese	T-Mn	-	0.05	mg/L	1
Mercury	T-Hg	-	0.001	mg/L	
Selenium	T-Se	-	0.01	mg/L	
Sodium	T-Na	-	200	mg/L	1
Uranium	T-U	-	0.02	mg/L	4
Zinc	T-Zn	-	5	mg/L	1, 6

1 Aesthetic Objective (AO) (taste, odour, appearance, etc.)

2 1 NTU maximum allowed for water entering distribution systems.

3 There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.

4 Interim Maximum Acceptable Concentration (IMAC)

5 First drawn water may be high, flush system before sampling.

6 At point of consumption.

## Appendix 2 - METHODOLOGY



Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

### Colour in Water

This analysis is carried out using procedures adapted from APHA Method 2120 "Color". Colour (true colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method. The analysis is carried out without pH adjustment.

Recommended Holding Time:  
Sample: 2 days  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

### Conductivity in Water

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

Recommended Holding Time:  
Sample: 28 days  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

### Solids in Water

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) and total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius, TSS is determined by drying the filter at 104 degrees celsius. Total solids are determined by evaporating a sample to dryness at 104 degrees celsius. Fixed and volatile solids are determined by igniting a dried sample residue at 550 degrees celsius.

Recommended Holding Time:  
Sample: 7 days  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

### pH in Water

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

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## Appendix 2 - METHODOLOGY - Continued



Recommended Holding Time:  
Sample: 2 hours  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

### **Turbidity of Water**

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

Recommended Holding Time:  
Sample: 2 days  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

### **UV Absorbance/% Transmittance**

This analysis is carried out using procedures adapted from APHA Method 5910B "Ultraviolet Absorption Method" and Method 415.3 "Determination of Total Organic Carbon and Specific UV Absorbance at 254nm in Source Water and Drinking Water", published by the United States Environmental Protection Agency (EPA). The sample is filtered through a 0.45um filter and measured for absorbance in a quartz cell at 254nm and reported as absorbance per cm (i.e. cm<sup>-1</sup>). The analysis is carried out without pH adjustment. Alternatively, results can be reported as % Transmittance (over one cm) where the absorbance result is converted to % Transmittance by the following calculation: %T = 100(10 to the power of -A).

Recommended Holding Time:  
Sample: 2 days  
Reference: APHA and EPA

Laboratory Location: ALS Environmental, Vancouver

### **Alkalinity in Water by Colourimetry**

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

Recommended Holding Time:  
Sample: 14 days  
Reference: APHA

Laboratory Location: ALS Environmental, Vancouver



### **Dissolved Anions in Water by Ion Chromatography**

This analysis is carried out using procedures adapted from APHA Method 4110 "Determination of Anions by Ion Chromatography" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions are determined by filtering the sample through a 0.45 micron membrane filter and injecting the filtrate onto a Dionex IonPac AG17 anion exchange column with a hydroxide eluent stream. Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

Recommended Holding Time:

Sample: 28 days (bromide, chloride, fluoride, sulphate)

Sample: 2 days (nitrate, nitrite)

Reference: APHA and EPA

Laboratory Location: ALS Environmental, Vancouver

### **Metals in Water**

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample: 6 months

Reference: EPA

Laboratory Location: ALS Environmental, Vancouver

### **Mercury in Water**

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

Recommended Holding Time:

Sample: 28 days

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**Appendix 2 - METHODOLOGY - Continued**



Reference: EPA

Laboratory Location: ALS Environmental, Vancouver

**Carbon in Water**

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". All fractions of carbon are determined by the combustion-infrared method. Total carbon includes organic carbon (covalently bonded in organic molecules) and inorganic carbon (carbonate, bicarbonate and dissolved carbon dioxide). Total organic carbon is the calculated difference between the total carbon and the inorganic carbon determination. Dissolved carbon fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

Recommended Holding Time:

Sample: 28 days

Reference: APHA

Laboratory Location: ALS Environmental, Vancouver

**Results contained within this certificate relate only to the samples as submitted.**

**This Certificate Of Analysis shall only be reproduced in full, except with the written approval of ALS Environmental.**

**End of Report**