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PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EUREKA CIVIL CONSULTING SERVICES
PROJECT NO.: R.015466.001

Eureka Civil Consulting Services

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Any questions concerning the information or its interpretation should be directed to Carlos Cancino or Richard MacDonald.

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1. INTRODUCTION

1.1 General

WorleyParsons was retained by Public Works and Government Services Canada (PWGSC) to carry out a conceptual engineering study to assess potential upgrades to the water reservoir, sewage lagoon, airstrip and fuel storage facilities at the Eureka Weather Station (the Station) located in Nunavut, Canada.

Eureka, Nunavut is a small outpost located on Slidre Fjord, midway up Ellesmere Island in the Canadian High Arctic (Figure 1 through Figure 10). The Station has been continuously occupied since 1946 and is the second most northern permanently inhabited site on the globe. Mainly in use as part of Environment Canada's High Arctic Weather Station (HAWS) network. The station is also currently supports ongoing atmospheric research as well as Canadian Forces activities. The primary facilities at the station include the main weather station complex, a water reservoir, sewage lagoon and airstrip.

1.2 Project Objectives

The primary project objective of this project was to complete a study to define the scope and cost associated with several infrastructure upgrades to the Eureka Weather Station. This includes assessing technologies and options to mitigate issues associated with source water for human consumption, water supply and treatment system, fuel storage containment and runway surface degradation. In addition to the engineering studies associated with this work, a geotechnical survey and hydrological program were completed to provide the necessary input into the design parameters.

1.3 Scope of Work

The proposed scope of work for this project was outlined in PWGSC Terms of Reference R. 015446.001 (ET025-110131) and WorleyParsons' Proposal No: CPR 10-039, dated July 21, 2010. The scope of work was divided into the following major components

- Water Supply and Distribution Study;
- Wastewater Treatment Options Review Study;
- Fuel Drum Storage Area Study;
- Geotechnical Investigation Report; and
- Digital Topographic Survey.

1.4 Site Reconnaissance

During the week of August 16, 2010, WorleyParsons conducted an inspection of the Station and surrounding area. Activities completed during the site visit are summarized below:

- a review of topographical, soil, and hydrological information for the area;
- a review of the water storage and distribution system, including sampling for water quality;
- a review of the waste water disposal system, including the waste water lagoon;
- a review of historical information, including available third party information, for the area;
- an evaluation of potential sources of drinking water, including water quality analysis:
  - potential sources included Station Creek, Black Top Creek, and the Slidre Fiord.
- completion of 16 Test Pits (TP) using a backhoe-loader;
- an evaluation of potential sources of suitable sand and gravel;
- an interview with the Station Program Manager (André Bouchard 2010) about the history of the Station; and
- a topographic field survey of the Station and surrounding area

2. WATER SUPPLY AND DISTRIBUTION STUDY

The purpose of this study is to evaluate all aspects of the water supply for the Station, including the existing water source, storage, treatment, and distribution, and develop and assess various options for meeting the potential future water demand of increased station occupancy for the next 15 years. Available information related to water sources, storage, treatment, and distribution was assessed in order to determine the best option for the Eureka Station for the next 15 years. The engineering study was conducted following the Canadian drinking water guidelines requirements.

2.1 Scope of Work

The scope of work of this portion of the work included completing the following assessments for the Station:

- station Water demand assessment;
- station Creek assessment;
- alternate water source assessment;
- reservoir assessment;
- water treatment assessment;
- development and evaluation of feasible options; and
- water distribution system assessment.

2.2 Main Findings

The following are the main findings of the Water Supply and Distribution Study. The complete study can be found in Appendix 1.

The Station has capacity for 60 persons. Future water supply options have been developed to provide a water system that meets the demand of this population (design demand). The average daily demand for the Station was estimated to be 335 L/person/day.

The existing water supply system was reviewed to determine if it could meet the potential future demand. The reservoir has an over winter capacity for about 17 persons and is therefore undersized to meet the design demand. The water treatment system is able to supply up to 170 L/day of drinking water and is undersized to meet the design demand.

Three alternative water sources were reviewed (Station Creek, Black Top Creek and seawater from the Slidre Fjord). It was concluded that Station Creek is the preferred water source for the Station based on

a quantitative and qualitative analysis of following parameters: water quantity, water quality, potential for contamination, storage requirements and intake pump house and pipeline concerns.

Options for provision of an earthworks reservoir were developed and assessed. These options included modifying the existing reservoir and constructing a new reservoir. It was determined that modifying the existing reservoir would not provide the full design capacity, but would provide increased stability of the reservoir and add some additional capacity.

Three options of constructing a new full capacity reservoir were developed for a comparative analysis. The construction cost estimates for the options were in the range of $12,500,000 to $12,800,000. The ranking of each option in the comparative analysis was sufficiently close to warrant further investigation and refinement of analysis.

Table A summarizes the construction cost for all the options considered to upgrade the Station reservoir.

Table A Reservoir Options Construction Cost Estimate

Reservoir Option	Estimated Construction Cost
Option 1 – Increase Stability of Existing Reservoir	$2,165,072
Option 2 – Raise Existing Reservoir Berms	$8,991,211
Option 3 – Construct New Reservoir North of Existing Reservoir	$12,779,794
Option 4 – Construct New Reservoir West of Station Creek	$12,582,757
Option 5 – Construct New Reservoir East of the Station	$12,482,731

Water treatment systems were evaluated to meet the design demand by treating surface water or saline water. The assessment concluded that treating surface water (i.e. Station Creek as the water source) in conjunction to the current practice at the Station, in which only the drinking water portion of the demand (i.e. 2 m^3/day) is to be treated to obtain drinking water quality and non-potable utility water to be used after softening and multimedia filtration (i.e. 18 m^3/day) was the preferred option.

The cost of treating water is considerably less than the construction cost of a new earthworks reservoir. Therefore, further consideration of treating sea water is warranted. In order to use sea water, a permanent year round intake structure and pipeline would need to be constructed. If such a structure is not practical, then some form of water storage would still need to be provided during the winter months and surface water (Station Creek) would, again be the preferred source.

3. WASTEWATER TREATMENT OPTIONS REVIEW STUDY

The purpose of this study was to provide engineering for the evaluation of options for the ultimate selection of the most viable wastewater treatment system for implementation at the Station over the next 15 years.

3.1 Scope of Work

The primary task was to review Golder Associates' report on Wastewater Treatment System Options and confirm the constructability at the proposed sites. This included an analysis of all potential challenges related to technology, operations and maintenance.

The second task was to conduct an analysis to determine size and capacity of force main, pumps and other components of the wastewater treatment systems that would meet the future demands.

3.2 Main Findings

The following are the main findings of the Wastewater Treatment Options Review Study. The complete study can be found in Appendix 2.

The Golder Associates' report evaluates several wastewater treatment options and ranks them based on treatment performance, ease of operation, upset risk/impact, mechanical failure risk/impact, energy consumption, solids handing requirements and capital cost. The resulting short-listed treatment technologies recommended are two kinds of attached growth systems (media-based trickling filters or submerged fixed film bioreactors) or a new facultative pond lagoon.

Since, secondary quality effluent is not required at this site and sludge/solids handling is expected to be difficult at this location, mechanical type systems including attached growth systems are not recommended for this facility. Lagoons have several advantages over the other two recommended systems. In northern climates, lagoons offer a reliable and easy-to-operate process. The recommendation to proceed with lagoon treatment is based on the assumption that past performance of the existing lagoon meets the current and future Nunavut Water Board (NWB) licence effluent requirements, and also meets the Station's operational and performance requirements. Preliminary design information and recommendations are presented for the recommended wastewater treatment option.

4. FUEL DRUM STORAGE AREA STUDY

The purpose of this portion of the work was to outline the key design aspects of the proposed fuel drum storage area at the Station, including preparation of preliminary engineering drawings and consideration of the technical challenges of construction in the arctic.

This study included a review of existing information, a summary of the field work and preparation of the design basis.

4.1 Scope of Work

The scope of work for the fuel drum storage area study included the following:

- a review of existing background information;
- coordinate with and support of the geotechnical and topographic investigations for the proposed footprint area;
- review of geotechnical and topographical survey results, as it pertains to the fuel drum storage area; and
- preparation of a design basis.

4.2 Main Findings

The following are the main findings of the Fuel Drum storage area study. The complete study can be found in Appendix 3.

The geometric design basis of the fuel drum storage maximizes the fuel drum storage capacity while minimizing the area footprint. The proposed layout inside the fuel drum storage area is “U-shaped”. This allows the front-end loader a maximum amount of manoeuvrability while maintaining the smallest footprint. This layout can be modified going forward, for operational reasons, if necessary. However, the proposed footprint of the fuel drum storage area is based on this arrangement.

A secondary containment structure is to be constructed on a pad of granular fill with a minimum thickness of 1.0 m. The crushed gravel fill should be placed near the end of the summer season when the annual depth of thaw has been achieved. Constructing a stable crushed gravel fill during the poorest annual subgrade conditions should ensure stable crushed gravel fill in all seasons. To protect the synthetic linear, two layers of sand are proposed. One sand layer will be placed under the liner and the other sand layer will be placed on top of the liner. Two layers of woven geotextile are also proposed to be used as separation barriers to prevent the sand mixing with the gravel. The first woven geotextile will be placed on top of the gravel fill, with the sand placed on top of the geotextile. The second woven

geotextile will be placed on top of the upper sand layer with the gravel surface placed on top. For a trafficable surface, crushed gravel will be placed on the fuel drum storage footprint. The fuel drum storage footprint includes the area the drums are stored in and the area required for the front-end loader to manoeuvre.

Two locations were identified as potential sites for the fuel drum storage area (Drawing 19). Location Option 1, was identified in the Terms of Reference (PWGSC 2010) and Location Option 2, was identified by WorleyParsons geotechnical engineers. Location Option 1 is proposed to the north of the existing bulk fuel storage site at the airfield. Location Option 1 was deemed less desirable by the WorleyParsons' field team due to its proximity to the Rose Rock Creek slope. Location Option 2 is situated slightly south and east of Option 1 moving it away from the potentially unstable slope of Rose Rock Creek. The soil conditions in the area of Option 1 consist of relatively undisturbed tundra (silty clay till) with permafrost located approximately 0.5 meters (m) below grade. The soil conditions in Option 2 are presumed to be similar to Option 1.

In terms of the proposed construction schedule, the compacted crushed gravel fill would ideally be placed and left in place over a full winter season. The following summer, the crushed gravel fill would be re-graded, as needed, and the subsequent secondary containment structure can be placed. However, if necessary, the entire structure can be placed in one construction season, although this is less desirable.

5. GEOTECHNICAL INVESTIGATION REPORT

The objective of the geotechnical investigation at the Station was to support the overall conceptual engineering study. The geotechnical investigation comprised a site reconnaissance, a subsurface investigation (at the existing airstrip and in the proposed sewage lagoon sites) and a granular material borrow source search. In addition, the geotechnical investigation included a review of the Stantec report (prepared for the proposed fuel drum storage area) and the Golder report (on the proposed sewage lagoons).

5.1 Scope of Work

The scope of work of the geotechnical investigation report includes:

- a review of the available geotechnical and geological information for the Eureka area;
- a geotechnical investigation, including site reconnaissance, test pitting and sampling of potential granular material borrow sources;
- laboratory testing of selected soil samples recovered from the site; and
- preparation of a geotechnical report, which summarizes the results of the study and provides suitable comments and recommendations.

5.2 Main Findings

The following are the main findings of the Geotechnical investigation report. The complete report can be found in Appendix 4.

The existing runway at Eureka consists of a thin layer (approx 150 mm) of granular material directly overlying native silty clay till. The entire site is underlain by permafrost which presumably extends to great depth. The seasonal thaw at the time of the site visit ranged from 1.0 to 1.4 metres below existing grade; in winter the entire soil profile will be frozen. The runway is poorly drained in some areas and placement of additional gravel fill is proposed to promote adequate drainage and improve the structural strength.

A new fuel drum storage area is proposed to the north of the Canadian Forces bulk fuel storage site at the airfield. This site was deemed unsuitable by the WorleyParsons field team due to its proximity to the Rose Rock Creek slope and an alternative location has been suggested. Soil conditions in the area consist of relatively undisturbed tundra (silty clay till) with permafrost located approximately 0.5 m below grade. The fuel drum storage area should be constructed on a thick gravel pad placed directly on the tundra. The pad should be placed in summer at the time of maximum thaw depth, to replicate

worst-case conditions, and constructed to sufficient thickness to adequately support a front-end loader even when the underlying till is in a partially thawed state.

Two new sewage lagoon locations have been proposed by others. Soil conditions in these locations consists of various depths of granular fill overlying silty clay colluvium, with permafrost at a depth of approximately 1.0 m below grade. Based on the site topography, the southern location (Option 1) is deemed more suitable for construction of the lagoon.

The existing water reservoir is understood to be undersized for the potential Station population. As well, during the site reconnaissance, signs of instability were noted in the existing reservoir berms. Several options were examined for upgrading or expanding the existing reservoir and for construction of a new reservoir. Any new reservoir should have a geosynthetic liner with an underdrain system to prevent uncontrolled seepage during the thaw season and influxes of contaminated and/or brackish groundwater. Any new reservoir should also have appropriately graded side slopes; slopes of 3H:1V for berms formed out of good quality granular fill and slopes of 4H:1V for berms formed out of the native fine grained soils.

Sources of suitable sand and gravel to serve as feedstock for a screening and crushing operation were identified along the Station Creek, Blacktop Creek and Remus Creek watercourses. Of the three, Blacktop Creek was identified as the most practical location for a screening and crushing plant.

It should be noted that this report presents the results only of a site reconnaissance and shallow test pitting investigation conducted using the available equipment on site. Prior to the detailed design of the sewage lagoon or water reservoir, a detailed geotechnical investigation should be conducted using suitable drilling equipment.

6. DIGITAL TOPOGRAPHIC SURVEY

WorleyParsons engaged Inukshuk Nunasi Geomatics (ING) to complete a topographic survey of the Station during the site reconnaissance. The topographic survey of the Station and surrounding areas included the airstrip, the water reservoir, the proposed lagoon locations and buildings, as requested by WorleyParsons (refer to Drawing 1 and Drawing 2). The purpose of the survey was to derive elevations of the existing surfaces.

The topographic survey was performed with Real Time Kinematic (RTK) GPS using Leica 1200 Systems; Total Station survey using Lieca Robotic TPS 1201; and scanning using Lieca C10 3D Scanner.

Surveyed co-ordinates and elevations were based on published values for GSD Monument 749167A and confirmed by means of check ties to NRCan Geodetic Survey Division (GSD) Monument 749167 along with post process to Canadian Active Control System (CACS) Station M059000 as well as using the NRCan Precise Point Positioning (PPP) Web site. A complete Topographic survey report can be found in Appendix 5. All files provided by ING are included in a CD attached to this document.

7. RECOMMENDATIONS

The following additional assessments and analysis are recommended to ensure a safe and reliable execution of the proposed infrastructure upgrades to the Station.

7.1 Water Supply and Distribution

- refine the design basis water demand by determining future population projections and water use;
- consider implementing water conserving practices at the Station to reduce water demand and storage requirements;
- recommend to the Water Survey of Canada (Environment Canada) that they provide a hydrometric gauging station at Station Creek to confirm available flow estimates and track the changes to flow in the future due to climate change;
- implement interim reservoir rehabilitation (Option 1) to increase reliability of existing reservoir;
- refine the reservoir option analysis including:
  - additional geotechnical assessment to confirm the subsurface materials;
  - assessment of conflicts with existing and potential Station infrastructure;
  - additional topographic survey (Option 4 only);
  - perform an investigation to address how to best manage the contamination located immediately west of the Station;
  - assess the impacts of snow drift formation around the Station; and
  - investigate potential of intentionally accumulating snow above reservoir to limit ice formation and increase active storage depths.
- although not considered in this study, it appears that it might be feasible to replace the earthen reservoir with above ground, heated, and insulated water tanks. The tanks could be assembled onsite with minimal equipment and man-power. Further assessment of this option is recommended;
- perform a feasibility study and cost estimate for the provision of a permanent sea water intake that could operate throughout the winter. Re-evaluate the analysis presented in this Study;
- if desalination is further pursued as a potential treatment option, a detailed assessment will be required to determine power supply for the treatment system; and

- during the next design phase, consideration should be given to relocating the chlorine dosing point to downstream of the treatment process. Current operation of the facility includes pre-chlorination, which can lead to the formation of disinfection by-products (DBP) such as halo acetic acids (HAA) and trihalomethanes (THM) in the treated water.

7.2 Wastewater Treatment Options Review

- complete the technology selection between the two types of attached growth systems and wastewater lagoons options such that further design refinement can be completed, including:
  - selection and sizing of key components of the system including the new wastewater transfer pipeline and pumps, wastewater treatment system and effluent discharge; and
- it is recommended that major components of the design be modeled to determine sizing and predict performance.

7.3 Fuel Drum Storage Area

It is recommended that the fuel drum storage area be moved from the original proposed location (Option 1) to the area east of the bulk fuel storage on the east end of the north apron (Option 2).

7.4 Geotechnical Investigation Report

- it should be noted that the geotechnical investigation report presents the results only of a site reconnaissance and shallow test pitting investigation conducted using the available equipment on site. Prior to the detailed design of the sewage lagoon or water reservoir, a detailed geotechnical investigation using suitable drilling equipment should be conducted;
- conduct an airport feasibility study to rehabilitate the existing runway and apron granular surfaces and to upgrade the runway shoulder areas to provide proper drainage; and
- complete a high level construction cost estimate of the proposed upgrades to the runway and the apron.

8. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

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Figures

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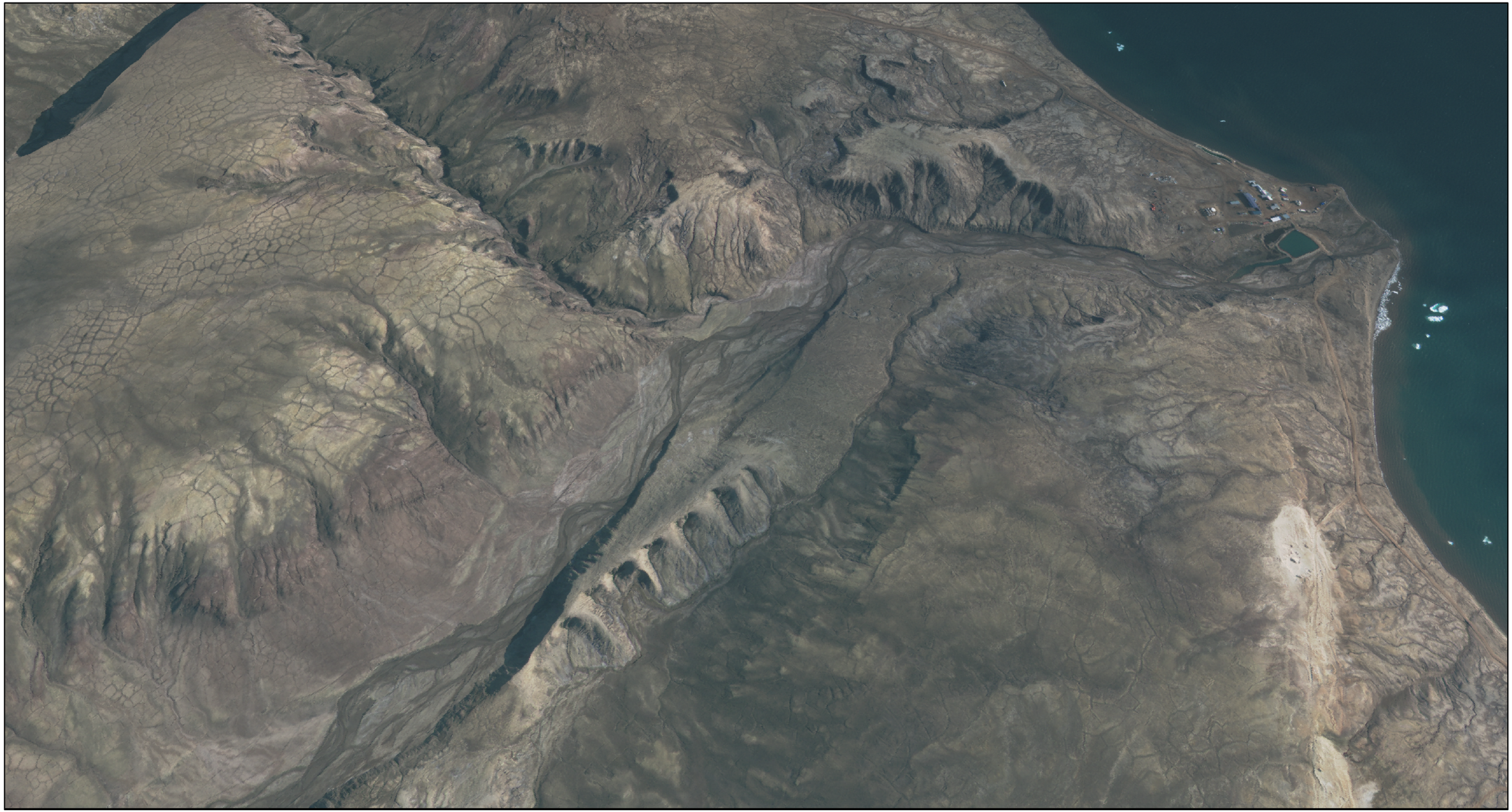
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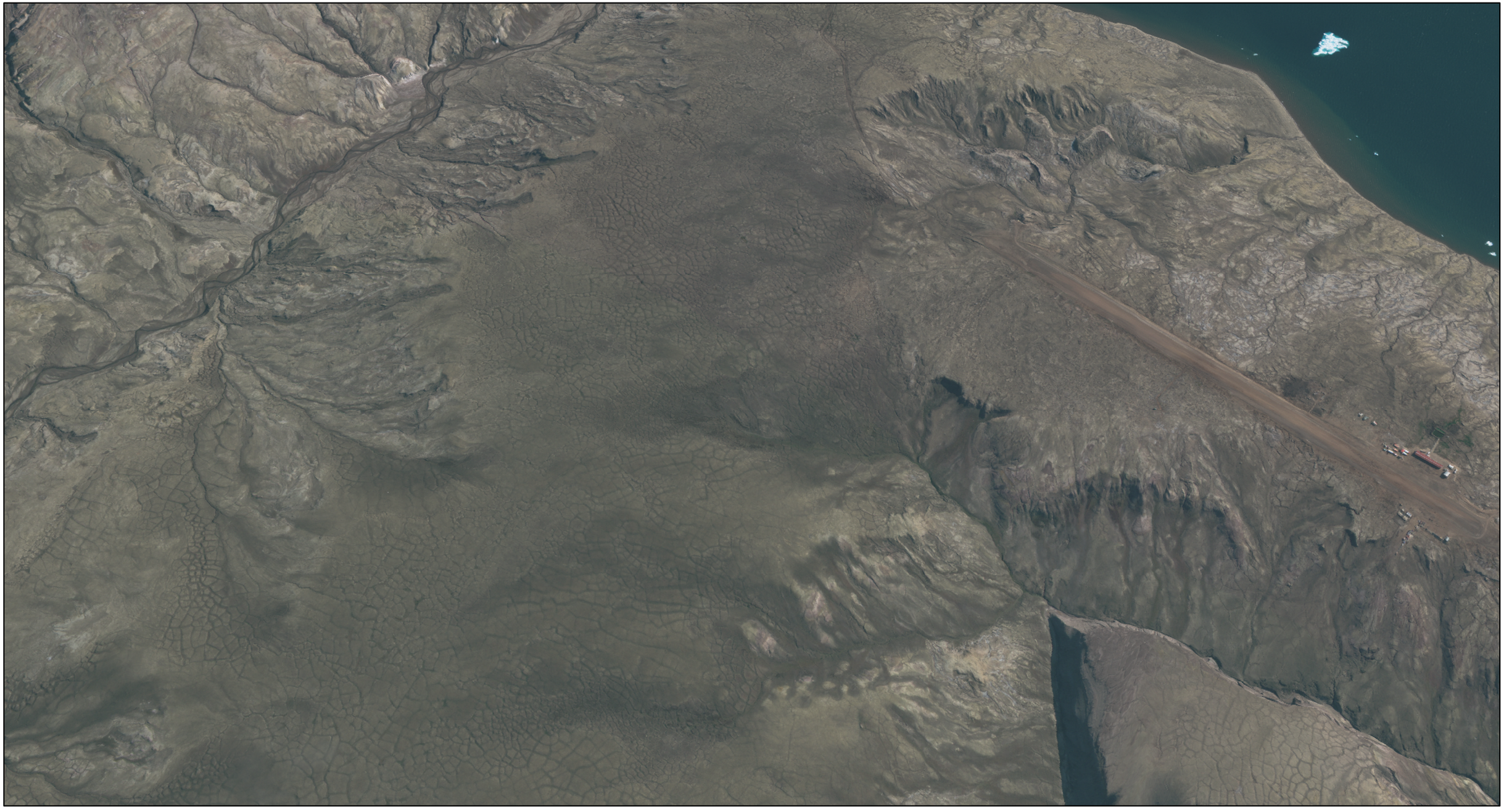
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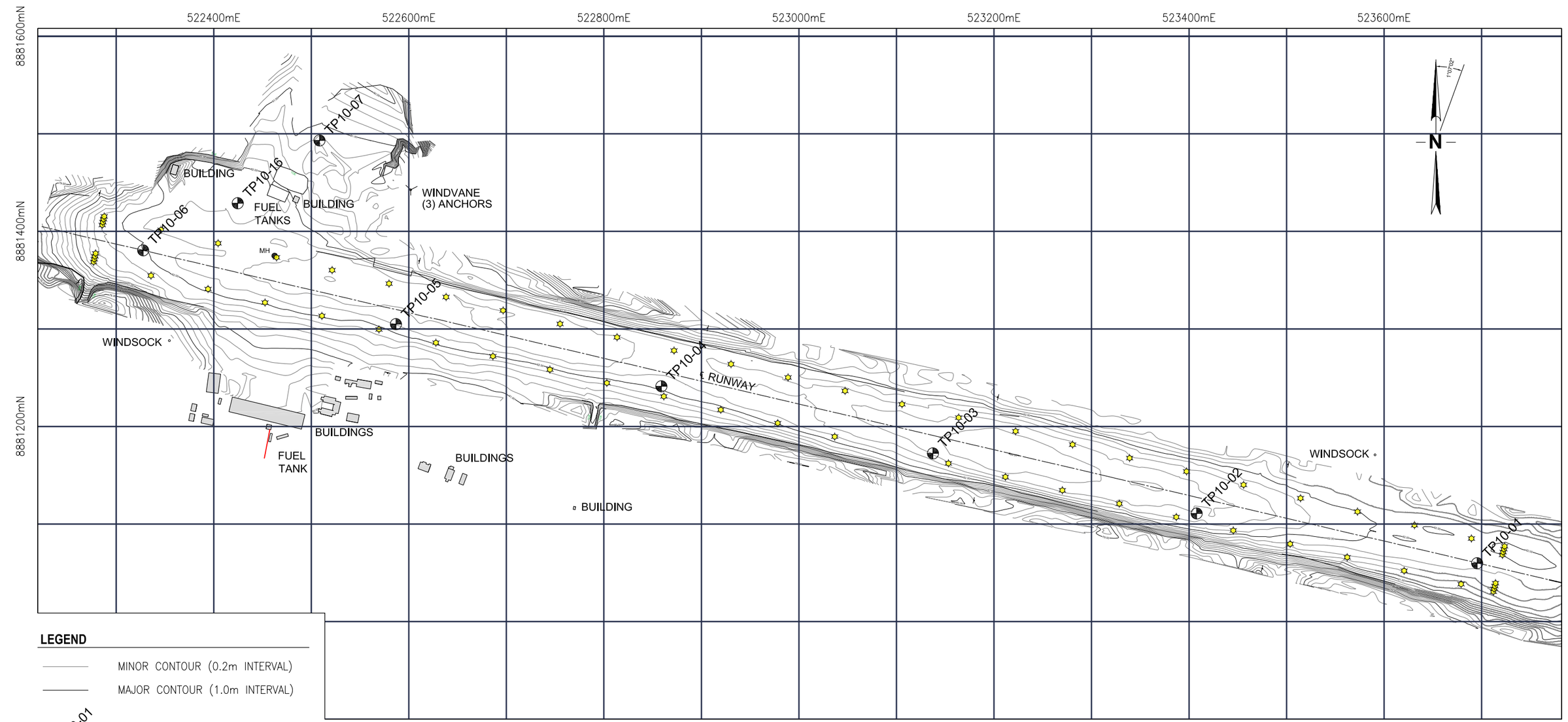
Drawings

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REAL PROPERTY SERVICES / SERVICES IMMOBILIERS

Western Region / Région de l'ouest



LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- TP10-01 — TEST PIT LOCATION
- MH — MANHOLE
- RUNWAY LIGHT

0 50 100 150 200m

SCALE 1 : 4,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

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			Designed by/Concept par: **L.M.**	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille: **1** **OF 27** — Revision/ Revision
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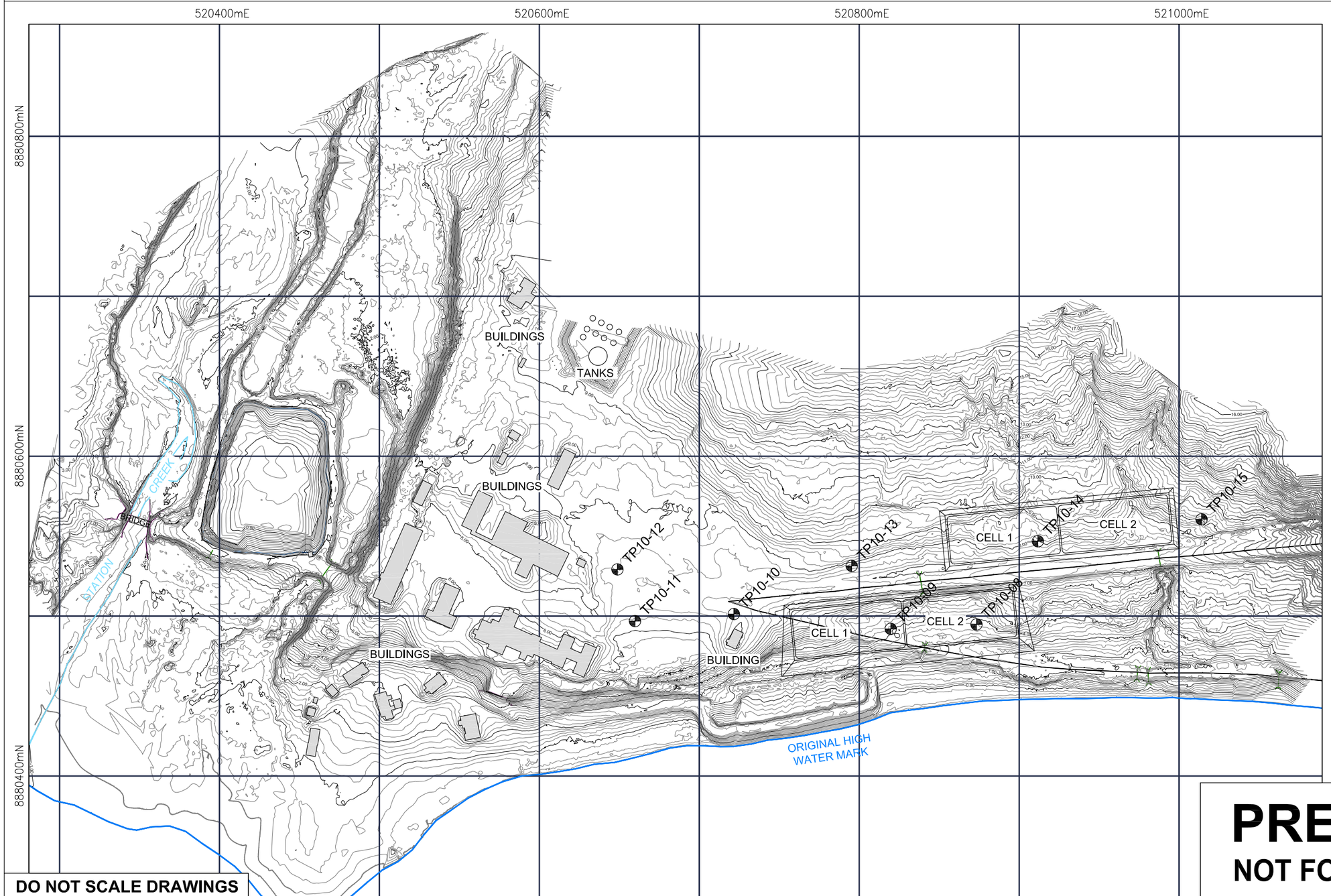
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REAL PROPERTY SERVICES
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SERVICES IMMOBILIERS
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N

1°07'02"

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
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Appendices

Appendix 1 Water Supply and Distribution Study

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EcoNomics

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Eureka Civil Consulting Services

Water Supply and Distribution Study

C71130000 – Document No: C71130000-WW-REP-0002

15 December 2010

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FILE LOC.: CALGARY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
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0	Issued as Final	H. Anaya / R. Wirtz	M. Shome	M. Shome	15-Dec-10		

EcoNomics™

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EXECUTIVE SUMMARY

This study evaluates all aspects of the water supply system for the High Arctic Weather Station, in Eureka, Nunavut. The existing water supply system was reviewed and various options were developed to meet the potential future water demand, due to increased station occupancy, for the next 15 years.

The Station has capacity for 60 persons. Future water supply options have been developed to provide a water system that meets the demand of this population (design demand). The average daily demand for the Station was estimated to be 335 L/person/day.

The existing water supply system was reviewed to determine if it could meet the potential future demand. The reservoir has an over winter capacity for about 17 persons and is therefore undersized to meet the design demand. The water treatment system is able to supply up to 170 L/day of drinking water and is undersized to meet the design demand.

Three alternative water sources were reviewed (Station Creek, Black Top Creek and seawater from the Slidre Fjord). It was concluded that Station Creek is the preferred water source for the Station based on a quantitative and qualitative analysis of following parameters: water quantity, water quality, potential for contamination, storage requirements and intake pump house and pipeline concerns.

Options for provision of an earthworks reservoir were developed and assessed. These options included modifying the existing reservoir and constructing a new reservoir. It was determined that modifying the existing reservoir would not provide the full design capacity, but would provide increased stability of the reservoir and add some additional capacity.

Three options of constructing a new full capacity reservoir were developed for a comparative analysis. The construction cost estimates for the options were in the range of $12,500,000. The ranking of each option in the comparative analysis was sufficiently close to warrant further investigation and refinement of analysis.

Water treatment systems were evaluated to meet the design demand by treating surface water or saline water. The assessment concluded that treating surface water (i.e. Station Creek as the water source) in conjunction to the current practice at the station in which only the drinking water portion of the demand (i.e. 2 m^3/day) is to be treated to obtain drinking water quality and non-potable utility water to be used after softening and multimedia filtration (i.e. 18 m^3/day) was the preferred option.

The cost of treating water is considerably less than the construction cost of a new earthworks reservoir. Therefore, further consideration of treating sea water is warranted. In order to use sea water, a permanent year round intake structure and pipeline would need to be constructed. If such a structure is not practical, then some form of water storage would still need to be provided during the winter months and surface water (Station Creek) would, again be the preferred source.

The main recommendations of this study are provided below and should be considered to ensure a safe and reliable water supply for the Station.

- consider implementing water conservation practices at the Station to reduce water demand and storage requirements;
- refine the design basis water demand by refining future population projections and water usage;
- implement interim reservoir rehabilitation Option 1 to increase the reliability of the existing reservoir;
- if an earthworks reservoir is desired then the analysis should be refined based on the following additional assessments:
  - additional geotechnical investigations to confirm the subsurface materials;
  - assessment of conflicts with existing and potential Station infrastructure;
  - additional topographic survey (Option 4 only);
  - evaluate options to manage the contamination located immediately west of the existing water reservoir;
  - maintaining surface drainage around the proposed and existing reservoirs;
  - provision of a new pump house and pipeline routes and feasibility of trucking water or providing a pipeline to convey water from the reservoir to the treatment plant;
  - assess impacts of snow drift formation around the Station; and
  - investigate the potential of intentionally accumulating snow above the reservoir to limit ice formation and increase active storage depths;
- perform a feasibility study and cost estimate for the provision of a permanent sea water intake that could operate throughout the winter;
- if desalination is further pursued as a potential treatment option, a detailed assessment will be required to determine the most suitable method to supply power to the treatment system; and
- although not considered in this study, it appears that it might be feasible to replace the existing earthworks reservoir with above ground, heated, and insulated water tanks. The tanks could be assembled onsite with minimal equipment and manpower. Further information and cost estimates for these tanks are included in Appendix 1.6. It is important to note that these cost estimates do not include the preparation of a suitable foundation for the tanks. The foundation for such a tank would require considerable earthwork.

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DRAWING 18 – 26 NOT INCLUDED IN THIS REPORT (INCLUDED IN THE FUEL DRUM STORAGE AREA STUDY AND THE GEOTECHNICAL REPORT)

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1. INTRODUCTION

1.1 Background and Purpose

Public Works and Government Services Canada (PWGSC) has commissioned WorleyParsons Infrastructure and Environmental to carry out the engineering studies required to assess the water supply for the Eureka High Arctic Weather Station (the Station) for the next 15 years. The Station is located on the north side of Slidre Fjord at the north-western tip of the Fosheum Peninsula on Ellesmere Island at 80°0'N and 85°56'W. Figure 1.1 shows a satellite image of the Station.

The purpose of this study is to evaluate all aspects of the water supply for the Station, including the existing water source, storage, treatment, and distribution, and develop and assess various options for meeting the potential future water demand of increased station occupancy for the next 15 years. Available information related to water sources, storage, treatment, and distribution was assessed in order to determine the best option for the Eureka Station for the next 15 years. The engineering study has been conducted following the Canadian drinking water quality guidelines (CDWQG) requirements (Health Canada 2008).

1.2 Presentation of Findings

This section describes the structure of this report.

Section 2 provides an overview of the methodology used to collect and process information as well as the methodology for developing and evaluating future design options.

Section 3 provides a detailed description of the existing system.

Section 4 provides the design basis for the study and includes the evaluation of the water demand for the Station and additional design requirements for the water supply study.

Section 5 provides an evaluation of ability of the existing system to meet the design basis developed in Section 4.

Section 6 provides a discussion of the development and assessment of potential water sources for the Station.

Section 7 provides a discussion of the development and assessment of potential water reservoir options for the Station.

Section 8 provides a discussion of the development and assessment of potential water treatment options for the Station.

Section 9 summarizes the study and provides recommendations for further work.

2. METHODOLOGY

2.1 Field Work

During the week of August 16, 2010, WorleyParsons conducted an inspection of the Station and surrounding area. Activities completed during the site visit are summarized below:

- a review of topographical, soil, and hydrological information for the area;
- a review of the water storage and distribution system, including sampling for water quality;
- a review of the waste water disposal system, including the waste water lagoon;
- a review of historical information, including available third party information, for the area;
- an evaluation of potential sources of drinking water, including water quality analysis:
  - potential sources included Station Creek, Black Top Creek, and the Slidre Fjord;
- an interview with the Station Program Manager (André Bouchard 2010) about the history of the Station; and
- a field survey of the Station and surrounding area.

Select photographs taken during the site visit are presented in Appendix 1.1.

2.2 Development of Design Basis

The design basis for the water system has been developed using available guidelines, standards, and best management practices. The design basis is required to define the water demand of the Station and determine the requirements, considerations and constraints related to the storage, treatment and distribution of water for the Station.

2.3 Review of Existing System

Available information on the existing system was collected, reviewed, and summarized. This information includes:

- information collected during the site visit;
- field survey information; and
- water quality data.

2.4 Assessment of Existing System

The assessment of the existing system was carried out by comparing the existing system to the design basis. Inadequacies of the existing system to meet potential future demand were identified. This

assessment forms the basis of the future water supply system option development. The future water supply system options will be developed and assessed to address inadequacies with the existing system.

2.5 Water Quality Assessment

A water quality assessment was carried out based on existing information and water quality monitoring activities performed during the site visit.

The available water quality information was reviewed and a data gap analysis was performed. It was determined that the existing water quality data needed to be supplemented by performing additional water quality analysis based on Canadian Water Quality Guidelines (CWQG). Samples were collected from the optional water sources, the existing water reservoir, and the treated water. Details on the sampling schedule are provided in the following section. Microbiological water quality data was assessed based on the existing information and the disinfection processes that will be implemented. All water quality analytical results are presented in Tables 1 to 9.

2.5.1 Water Sampling

The analytical schedule for each sampling location is summarized in Table A. Water samples from each location were analysed for all or a portion of the following:

- major ions/routine potability;
- dissolved and total metals;
- dissolved and total organic carbon (DOC and TOC);
- pesticides;
- volatile organic compounds (VOCs) and trihalomethanes (THM);
- petroleum hydrocarbons (PHC, benzene, toluene, ethylbenzene, xylenes, PHC fraction (F) 1 and 2);
- asbestos;
- polycyclic aromatic hydrocarbons (PAH); and
- radiological parameters.

In addition to the above analytical parameters, field-measured parameters (i.e. temperature, pH, and electrical conductivity) were measured at each location at the time of sampling.

Table A 2010 Analytical Schedule

Sample Site	Indicator / Misc. Parameters	BTEX F1-F4	Dissolved Metals	Total Metals	VOCs	THM	Pesticides	Radiological Parameters	Asbestos
Black Top Creek	✓		✓	✓					
Slidre Fjord	✓		✓	✓					
Water Reservoir	✓	✓		✓	✓	✓	✓	✓	✓
Final Tap Drinking Water	✓	✓		✓	✓	✓	✓	✓	✓
Final Tap Non-Drinking Water	✓	✓		✓	✓	✓	✓		
Field Blank	✓	✓		✓	✓	✓			
Trip Blank	✓	✓		✓	✓	✓			

Water sampling was conducted according to standard WorleyParsons sampling protocols (Appendix 1.2). All samples were analysed by an accredited laboratory in accordance with the quality assurance/quality control (QA/QC) requirements of the Canadian Council of Ministers of the Environment (CCME 1993a and 1993b).

2.5.2 Assessment Criteria

Laboratory analytical results were compared to the following guidelines, where applicable:

- Health Canada 2008: Guidelines for Canadian Drinking Water Quality.

2.5.3 QA/QC

Laboratory QA/QC measures, including laboratory matrix spikes, duplicates, blanks, control samples, and surrogate recovery, for the August sampling event are provided in Appendix 1.3.

Field duplicate samples were submitted for laboratory analysis of one or more of the following analyses:

- major ions/routine potability;
- total metals;
- TOC;
- THM; and
- VOCs.

All parameters concentrations were similar (i.e. RPD values less than 2% for inorganics and 40% for organics) between original and duplicate samples with the exception of TDS.

In August, field and trip blank samples were collected for laboratory analysis of one or more of the following analyses:

- major ions/routine potability;
- total metals;
- TOC;
- THM; and
- VOCs.

The results of the QA/QC program are not expected to affect the interpretation water quality.

2.6 Hydrology Assessment (Water Quantity)

The objective of the hydrology assessment is to estimate the quantity of water that could be withdrawn from either Station Creek (current source for the Station) or Black Top Creek (potential future source for the Station). Figure 1.2 shows the watersheds of these two watercourse relative to the location of the Station. In order to assess the quantity of available water in the creeks, an estimate of the flow rates of the watercourses is required.

Historical flow data is not available for either Station Creek or Black Top Creek; therefore, a regional stream flow analysis was completed to estimate the potential range in flow of these creeks. A regional analysis involves calculating the flow per unit drainage area for a gauged watercourse and applying this ratio to an ungauged watercourse, assuming that the flow per area of the gauged watercourse is similar to that of the ungauged watercourse. This is known as the direct drainage area ratio method.

When data from several regional watercourses are available, a regression analysis can be performed to develop an equation relating flow to drainage area.

The Water Survey of Canada (WSC) operates a stream flow gauging network throughout Canada that provides historical stream flow data. Historical flow data was collected from seven hydrometric gauging stations and used to characterize the flow in Station and Black Top Creeks. These stations were selected based on the location relative to the Station. These stations represent all available WSC stream flow gauging data north of latitude 72^{o}. Table B summarized the pertinent information for these stations. Figure 1.3 shows the locations of the stations relative to the Station.

Generally, flow within the watercourses listed in Table B begins in mid June and ends in late August or Early September. This is similar to Station Creek. The following steps were undertaken to assess the available volume of water within these creeks:

- the mean seasonal flow (from June 15 to August 30) for each watercourse for each year of available data was calculated;
- the average mean seasonal flow over the period of record for each station was determined;
- the flow per unit drainage area for each station was calculated;
- a regression analysis for the average mean seasonal flow and drainage area was performed;
- mean seasonal flows in the ungauged watercourses were estimated using the direct drainage area ratio method and the regression equation; and
- the annual volume of the creeks was then calculated to allow comparison with the required withdrawal volumes.

The results of the hydrologic analysis are presented in the Water Source Assessment Section 6.

Table B Summary of Hydrometric Station Information

Station Number	Station Name	Latitude	Longitude	Drainage Area (km^2)	Record Length (Years)	Period of Record	Operational Schedule
10TA001	Big River Above Egg River	72°29'2" N	123°24'14" W	3,640	7 6 4	1975 – 1981 1983 – 1988 2007 – 2010	Continuous Seasonal Continuous
10UB001	Marcil Creek Near Arctic Bay	72°59'37" N	84°59'16" W	139	6	1978 – 1983	Seasonal
10VC002	Mecham River Near Resolute	74°41'28" N	94°48'13" W	86.8	5 2 1 4	1971 – 1975 1977 – 1978 1979 – 1979 2007 – 2010	Seasonal Continuous Miscellaneous Continuous
10VC001	Allen River Near The Mouth	74°50'48" N	95°3'31" W	448	1 15	1970 – 1970 1971 – 1985	Miscellaneous Seasonal
10VC013	Snowbird Creek Near Bradford Island	75°37'52" N	101°19'2" W	87.0	1	1976 – 1976	Seasonal
10VC014	White Bear Creek Near Bradford Island	75°39'2" N	101°19'2" W	14.2	1	1976 – 1976	Seasonal
10VH001	Falls River Near D'iberville Fjord	80°36'8" N	79°24'40" W	32.6	3	1973 – 1975	Seasonal

Source: WSC 2010

2.7 Options Assessment

In order to assess the different options for the components of the water supply system at the Station (water source, reservoir, and treatment system) an assessment matrix was develop based on importance and value. Each option for the different components was scored against predefined criteria. Each criterion was given a weighting to account for the importance of the criterion and a value depending on how well the option meets a given criterion. Weighting was determined based on client requirements, constraints of the location, and professional judgement of the project team. The scoring values rationale for each component is described below.

2.7.1 Water Source

Each option for water source was assessed based on the following factors:

- water quality;
- adequate supply volume and duration of supply availability;
- vulnerability to contamination; and
- storage requirements based on supply availability.

Scoring values and weighting for the source assessment are presented in Table C.

Table C Scoring Values and Weighting for Source of Water Assessment

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
Water Quantity	If quantity is not sufficient the source option is discarded and no more assessment is warranted.		Sufficient	Enough flow to provide the full volume of the reservoir in a period of 1 month without allocating more than 5% of the waterbody flow or volume.
			Not Sufficient	Not enough flow to provide the full volume of the reservoir in a period of 1 month without allocating more than 5% of the waterbody flow or volume.
Water Quality	2	10	Good	Meets drinking water criteria with minimum treatment requirements. Dissolve solids, inorganic and organic parameters within drinking water guidelines.
		5	Fair	Meets drinking water criteria by providing treatment for hardness and TDS. point of use / point of entry type of treatment are possible.
		0	Poor	Extensive treatment requirements to meet drinking water guidelines due to high content of either organic or inorganic parameters.
Potential For Contamination	2	10	Very Low	No pollution sources were identified within the water body drainage area.
		5	Low	Pollution sources identified within the water body area, and contamination prevention is achievable y minor intervention of the pollution sources.

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
		0	High	Pollution sources identified within the water body area, and contamination prevention is achievable by a strong intervention of the pollution sources.
Storage Required	3	10	Operational	Volume of storage required based on year round supply availability.
		5	12 Months	Volume of storage required based on seasonal supply availability.
Intake, Pump house, and pipeline concerns	3	10	Good	Power available near, pipeline feasible, no intake concerns.
		5	Fair	Power available near, trucking needed or intake concerns.
		0	Poor	No power available at the source, pipeline is not feasible (trucking needed) or intake concerns.

Total score = Σ (weight x value). Maximum score value is 100, higher score means better performance of the system against the predefined criteria.

2.7.2 Reservoir

Each option for the water reservoir was assessed based on the following factors:

- active storage volume;
- potential for contamination;
- earthwork required;
- construction cost;
- conflict of reservoir footprint with existing Station infrastructure; and
- proximity to source and water treatment facility.

Scoring values and weighting for the reservoir assessment are presented in Table D.

Table D Scoring Values and Weighting for Reservoir Assessment

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
Active Storage	If active storage is not sufficient the option is discarded.		Sufficient	Enough active storage volume to meet design basis
			Not Sufficient	Not enough active storage volume to meet design basis
Potential For Contamination	1	10	Very Low	No pollution sources were identified within the location of the pond
		5	Low	Pollution sources identified within or near the location the pond, and contamination prevention is achievable by minor intervention of the pollution sources.
		0	High	Pollution sources identified within or near the location the pond, and contamination prevention is achievable by a strong intervention of the pollution sources.
Earth Work Required	3	Maximum Value 10		Value = Lowest “Earthwork” / “Earthwork” * 10
Construction Cost	3	Maximum Value 10		Value = Lowest Cost / Cost * 10

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
Conflict of Footprint with Existing Station Infrastructure	1	10	Good	No conflict
		5	Fair	Minor conflict. (relocation of road)
		0	Poor	Major conflict (relocation of infrastructure)
Proximity to Source and Treatment Facilities	2	10	Good	Near source and treatment -simple pipeline
		5	Fair	Extensive piping or logistical constraints between only source or treatment (trucking of water may be required)
		0	Poor	Extensive piping or logistical constraints between both source and treatment (trucking of water may be required)

Total score = Σ (weight x value). Maximum score value is 100, higher score means better performance of the system against the predefined criteria.

2.7.3 Water Treatment System

Each option for water treatment was assessed based on the following factors:

- meets required flow rate;
- product water quality
- capital and operation costs;
- footprint (treatment plant and operation supplies);
- reliability (known issues of the technology [e.g. stand by issues]), risk and impact of process upset, and Risk and impact of mechanical failure;
- ease of operation; and
- power requirements.

Scoring values and weighting for the water treatment options are presented in Table E.

Table E Scoring Values and Weighting for the Water Treatment Options

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
Product Water Quality	If quality is not sufficient the treatment option is discarded and no more assessment is warranted.		Sufficient	Supplies drinking water that complies with CWQG
			Not Sufficient	Does not supply drinking water that complies with CWQG
Capital Expenditure	1	Maximum 10	Value=10*Lowest Cost / Cost	
Operational Expenditure	1	Maximum 10	Value=10*Lowest Cost / Cost	
Power Requirements	3	Maximum 10	Value= 10*Lowest Power Requirement / Power Requirement	

Characteristic	Weighting	Scoring		
		Value	Ranking	Rationale
Footprint	2	Maximum 10	Value=10*Smallest Footprint / Footprint	
Ease of Operation	3	10	Easy	Operation similar or easier than current water treatment system.
		5	Fair	Operation more complex than current treatment system. Technology is proven and well understood.

Total score = Σ (weight x value). Maximum score value is 100, higher score means better performance of the system against the predefined criteria.

3. SUMMARY OF EXISTING WATER SYSTEM

3.1 Source

The existing water source for the Station is Station Creek is located immediately west of the existing water reservoir. Figure 1.1 shows the location of Station Creek relative to the Station. Figure 1.2 shows the watershed of Station Creek at the point of water diversion. Station Creek generally flows from (mid June to early September). Water is typically diverted from Station Creek between mid July and late August, when the turbidity of the water in the creek is reduced (André Bouchard 2010). There is no development in the watershed other than a portion of the Station's air strip. Further details on the water quality and quantity of Station Creek are presented in Section 6.

3.2 Storage

The water reservoir for the station is currently located in the Station Creek valley, immediately adjacent to Station Creek at an elevation approximately 8 m below the main station buildings, which are located on the colluvial slope above the Fjord (Figure 1.1). Water is pumped into the reservoir from Station Creek using a 2/3 HP pump through a 2" pipe. The water is pumped from the reservoir to storage tanks prior to being treated for use in the Station.

Drawing 3 shows the topographic contours in the area of the Station and the bathymetry of the reservoir, based on the survey conducted during the site visit. The lowest crest elevation (top of berm) of the reservoir is approximately 2.8 m. An overflow pipe is located on the south berm of the reservoir and has an outlet invert elevation of 2.6 m. This elevation has been assumed to be the high water level of the reservoir. During the site visit the water elevation in the reservoir was 2.54 m. The lowest elevation of the reservoir is at elevation -0.6 m.

Historically the reservoir was filled by gravity through the fill channel located north of the reservoir. During the thaw season, water would flow by gravity from the creek into the water reservoir, through two culvert inlets located on the north side of the reservoir. Several years ago, this practise was discontinued as a condition of the Station's water license (Nunavut Water Board 2006), and the entrance from the Creek into the fill channel was blocked. The culverts connecting the fill channel to the reservoir were not blocked. The inverts of the inlet culverts that connect the reservoir to the fill channel are at an elevation of approximately 2.3 to 2.4 m. The water level in the pond and the channel to the north are equalized by these culverts. The berms of the fill channel show signs of seepage (WorleyParsons 2010). If the berms of the fill channel failed, water would flow from the reservoir into Station Creek through these culverts. When estimating the capacity of the existing reservoir the storage volume, the fill channel was neglected because it was assumed that, shortly following freeze-up, the culverts would be blocked with ice and the reservoir would be hydraulically isolated from the channel.

Given the design constraints discussed in Section 4.3, the existing reservoir has an active storage capacity of approximately 2,100 m^3; with a freeboard of 0.2 m, ice allowance of 2 m and a dead

storage depth of 0.5 m. Drawing 3 presents a table showing the depth storage relationship for the reservoir.

Seepage through the berms of the lagoon and the fill channel was noted at the time of the site reconnaissance. Signs of slumping and instability were also noticeable in the berms at the time of the inspection. Additional information on the assumed construction of the reservoir and the instability of the slopes is provided in the geotechnical report (WorleyParsons 2010).

3.3 Water Treatment

The water distribution system in the station is separated by drinking water and non-drinking water uses. Consequently, the treatment system is configured to produce two different water qualities. Non-drinking water is chlorinated, filtered and softened. Drinking water, additionally to the previous processes, is treated with additional filters, granular activated carbon (GAC), a Reverse Osmosis (RO) unit, and disinfected using Ultraviolet Disinfection (UV). A block diagram showing the existing treatment system is presented in Drawing 4. The water quality is monitored and results indicate that the drinking water system provides good quality of water to the station (Environment Canada 2010). The maximum output from the drinking water treatment unit is 170 L/day, and the drinking water storage is 432 L. During the site visit, the station manager indicated that the system has performed reliably and has not had any significant problems. The only problem was due a human error as indicated in the water quality results taken on May 2009, when the waste stream from the RO unit was used as the drinking water, testing was done and the problem was corrected.

3.4 Water Conveyance Systems

3.4.1 Source to Storage

There are currently two pumps onsite that are used to pump water from Station Creek to the reservoir. Typically only one pump is used; however, both pumps are occasionally operated when filling the reservoir. The 2/3 HP pumps are rated at 0.23 m^3/min maximum and 12 m head maximum (note these are maximum values - not 0.23 m^3/min at 12 m of head). The head for pumping to the reservoir is about 3 m. It is estimated that the flow of the pump from Station Creek into the existing reservoir is roughly 0.19 m^3/min assuming 4 meters of total head. This would provide approximately 8,200 m^3 over a month of continuous pumping.

3.4.2 Reservoir to Treatment

The existing system used to transfer water from the reservoir to the treatment system consists of a 3 HP pump discharging water through a 150 mm diameter, 47 m long pipelines. Currently, water is pumped intermittently to internal storage tanks. Pump curve information for this pump was not available at this time; therefore, the pump capacity was assessed based on the maximum monthly water use on record (June 2009). The maximum monthly volume was 438.7 m^3. Assuming the pump ran

continuously for this month, the flow rate would be approximately 15 m^3/day. This has been assumed as the maximum flow rate for the system.

3.4.3 Treatment to Use

Two pipelines transfer water from the treatment system to the point of use – a potable water pipeline and a utility water pipeline. Hydro pneumatic pumps are used to maintain pressure in the distribution pipelines.

3.4.4 Fire System

The existing fire system has a storage capacity of approximately 52 m^3 (half of the two 15,000 gal tanks).

4. DESIGN BASIS

The following sections provide the design basis used to evaluate the existing water system and potential future water system options. The purpose of the design basis is to define the water demand of the Station and determine any requirements, considerations and constraints related to the storage, treatment and distribution of water for the Station.

4.1 Water Demand Assessment

The objective of the water demand assessment is to define the historical water demand and determine the design water demand. The design water demand will be used to evaluate the adequacy of the existing system and will form the basis for the option analyses. The demand can be defined in terms of volume (supply requirements) and flow (pumping/distribution requirements). Water is primarily used by the station occupants for domestic purposes. Some water is also provided to the Department of National Defence (DND) during the summer months.

4.1.1 Existing Demand

The existing water demand was characterized based on historical water consumption and population data at the station. Monthly consumption data and average monthly station occupants, from February 2005 to July 2010, were used to estimate the demand per person. Table F summarizes the minimum, maximum, and mean volume, population, and usage rate for the period of available data.

Table F Summary Water Demand Statistics

Statistic	Monthly Consumption (m^3)	Monthly Average Population	Usage Rate (L/person/day)
Minimum	22.0	8.0	78.9
Mean	150.6	18.5	335.3
Maximum	335.6	45.0	645.8

The mean usage rate of 335 L/person/day was adopted as the design water demand for this study. This usage rate is very similar to the Canadian domestic water use which was 343 L/person/day, in 1999 and 335 L/person/day in 2001 (Shrubsole and Draper 2007). It should be noted that Canadian domestic water use rates are relatively high compared to other nations and can be 1.5 to 3 times higher than many European nations (Lepsoe 2004). Consideration should be given to implementing water conserving practices at the Station to reduce the water demand.

The usage by DND has also been recorded from February 2005 to July 2010. The annual volume of water provided to the DND over this time period has ranged from 440 m^3 to 720 m^3, with an average of 570 m^3.

4.1.2 Design Demand

The Station currently has capacity for a maximum of 60 persons; however, over the past five years the average population has been approximately 18 persons. In order to allow contingency on the system, a design population of 60 persons based on full occupancy of the station has been adopted for evaluating the existing system and optional scenarios; however, the station might operate at lower occupancy levels.

Fire flow and storage requirements were based on the National Fire Protection Association Standards for the Installation of Sprinkler Systems (NFPA 2010). Assuming a light hazard occupancy (light hazard occupancies are defined as occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected). The volume for the fire water system to supply flow for 30 min is 43.7 m^3.

The following design basis for the treated water supply volume has been developed based on 60 persons and the average daily demand of 335 L/person/day. The DND storage allowance was approximated by taking 1.5 times the maximum recorded annual volume provided to DND. The above fire flow and storage requirements were also adopted. These estimates were made to provide a conservative design given the remote location of the Station and the importance of maintaining an adequate water supply:

- annual volume for Station Use - 60 persons X 355 L/person/day = 7,337 m^3;
- annual volume for DND – 720 m^3 X 1.5 = 1,080 m^3;
- annual volume for Fire Flow – 103 m^3 X 2 = 43.7 m^3; and
- total annual volume requirement = 8,460 m^3.

The estimated treated water demand in terms of flow rate is summarized in Table G and is based on the average daily demand. It was assumed that raw water requirements are 30% higher than treated water requirements since some of the raw water is wasted as part of the treatment. As described in Section 3 the existing water use at the facility is separated into potable (i.e. water for drinking and cooking) and utility water (i.e. non-drinking water uses).

Table G Estimated Raw and Treated Water Demand

Units	Raw Water	Treated Water Demand	
		Potable Water	Utility Water
L/person/day	437	34	302
m^3/day	26	2	18

4.2 Source

The water source needs to meet the criteria outlined in Section 2.7.1.

4.3 Storage

As per the terms of reference of the study, it has been assumed that water storage would be achieved using a traditional earthworks reservoir. The following sections describe the design considerations of such a reservoir.

4.3.1 Reservoir Volume

The volume of an Arctic water supply reservoir can be divided into four components - freeboard, ice storage, active storage, dead storage. A description of each component is provided below along with the adopted design depth for each component:

Freeboard

Freeboard is required to prevent overtopping of the reservoir caused by rainfall, overfilling or wave action. An overflow route, often in the form of a pipe, is provided at the base of the freeboard to prevent the water level increasing significantly above the base of freeboard. The top of freeboard is taken to be the lowest elevation of the crest (top of berm) of the reservoir. For this study a depth of freeboard of 1.0 m was adopted as the design basis. This should be reviewed during detailed design based on wave calculations, potential inflows, and overflow route capacity.

Ice Allowance

Ice allowance is required to prevent the reservoir from freezing to the bottom near the end of the winter season. The amount of ice formation is a function of temperatures, snow cover and water flow beneath the ice cover. Based on the available climate data for the Station, the most severe winter in the past 30 years at the station was 1986/1987. The temperature data from this winter season was used to calculate the potential thickness of ice on the reservoir. Using the modified Stefan Equation (USACE 2002) the design-freezing index value of 8180ºC-days was calculated for a freezing season of

276 days. Considering the reservoir as a still body of water, the design ice depth could range from 1.5 m with maximum snow cover to 2.5 m with no snow cover. A design ice depth of 2.0 m was adopted. The design ice thickness should be re evaluated during the next design stages based on expected snow cover at the selected reservoir location.

Dead Storage

Dead storage is provided at the base of the reservoir to prevent uptake of sediment during pumping and provide depth to allow pumping. For this study a dead storage depth of 0.5 m was adopted.

Active Storage

The active storage is the component of the reservoir that is available for use and is contained above the dead storage and below the allowable ice storage. The active storage volume is the quantity of water required for the period of time from start of freeze-up to thaw which is approximately 280 days. The active storage needs to be sized to provide water for this time period because; non-saline surface water sources are only available to supply the reservoir during the open water season. A deep reservoir with a small foot print is desirable to maximize the depth of active storage relative to the amount of ice storage.

The active storage volume was determined based on providing treated water for 280 days with a maximum station capacity of 60 persons and the average daily demand of 335 L/person/day. Raw water requirements were assumed to be 1.3 times greater than the treated water volume requirement. The required fire storage volumes were included in the active storage volume. The DND storage allowance was not considered because they withdraw water only during the open season period. A 15% safety factor was added to the storage volume to account for potential losses or unforeseen additional demand. The above design basis was adopted to provide a conservative design given the remote location of the Station and the importance of maintaining an adequate water supply. The active storage volume calculation is summarized below:

- volume of treated water - 60 persons X 355 L/person/day X 280 days = 5,600 m^3;
- raw water volume – 5,600 m^3 * 1.3 = 7,300 m^3;
- fire flow volume – 43.7 m^3;
- 15% safety factor – 7,300 m^3 * 0.15 = 1,100 m^3; and
- **total volume = 8,500 m^3.**

4.3.2 Reservoir Design Considerations

Additional considerations for the reservoir are discussed below.

- construction of the reservoir is difficult in the Arctic due to permafrost conditions. Reservoir berms typically cannot be compacted sufficiently and are often constructed using granular

material. Potential seepage through reservoir berms; therefore, needs to be prevented by lining the reservoir (typically synthetic geomembrane liner (WorleyParsons 2010);

- an underdrain system is required below the liner to reduce groundwater pressure below the liner and prevent heaving of the geomembrane system. The underdrain should be designed to cope with any inflows from Station Creek or Slidre Fjord under high water level conditions. It was assumed that the underdrain system would be pumped and not gravity drained, due to site constraints (WorleyParsons 2010);
- side slopes formed out of processed gravel or good sand and gravel pit run may use a gradient of 3H:1V. Side slopes formed out of the native colluvial soils or out of a silt, sand and gravel mix should use a gradient of 4H:1V (WorleyParsons 2010);
- proximity of the reservoir to the water source and the treatment and distribution system is also a key consideration. This will affect the pumping and piping requirements. Pumping and piping in the Arctic conditions is challenging due to the extreme temperatures;
- potential for contamination is another consideration. Available information on the existing contamination on site was reviewed to allow input into the further information regarding the implications of the contamination in the area of the Station to the reservoir are provided in Appendix 1.4;
- construction and operation costs are key considerations; and
- modifications or rehabilitation of the existing reservoir requires an alternative water source to be provided during the construction season. The construction season also corresponds to the open water season when surface water is collected in the reservoir for the following winter. Therefore, a large temporary water supply may be required if the existing reservoir is taken out of service for an extended period of time.

4.4 Water Treatment System

The treatment plant must be capable of treating the raw water to meet CDWQ Guidelines (Health Canada 2008). The capacity of the treatment system must provide 2 m^3/day of potable water and 18 m^3/day of utility water. Additional considerations for the water treatment system are outlined in the options assessment criteria in the Section 2.7.3.

4.5 Water Conveyance Systems

There are three components of the water conveyance system required for Station:

- source to the storage (reservoir);
- storage to the treatment system; and
- treatment system to the point of use.

The design requirements and considerations for each of these components are discussed individually below.

4.5.1 Source to Storage

The design basis for pumping from the water source has been based on providing sufficient capacity to fill the selected reservoir (dead/ice storage included) within one month, to correspond with open water season of Station Creek. Typically only the active storage volume would need to be replaced in addition to any net losses from the reservoir (precipitation – evaporation – seepage loss). It is expected that this volume would not be greater than 10,000 m^3; however, this could vary depending on the selected reservoir option.

4.5.2 Reservoir to Treatment

As described in Section 4.1.2 the raw water demand is approximately 26 m^3/day. The design basis for pumping from storage is to fill the internal storage tanks, upstream of the treatment system, over 18 hrs of pumping; therefore, the required pumping flow rate would be 40 m^3/day. This would meet the daily demand for the station at full occupancy. This value will need to be confirmed during subsequent design phases.

4.5.3 Treatment to Use

Unless buildings are added or the existing buildings are renovated with additional water consuming devices, there is no requirement to develop a design basis for the distribution system from the treatment plant to the point of use.

5. ASSESSMENT OF EXISTING SYSTEM

This section provides an assessment of the ability of the existing water system to meet the design requirements developed in Section 4.

5.1 Source

The suitability of Station Creek as a water source is described in the options assessment for water sources – Section 6.

5.2 Storage

Table H provides a summary of the comparison of existing reservoir parameters to the design basis requirements.

Table H Comparison of Existing Reservoir Parameters to Design Basis Requirements

Parameter	Design Basis Requirement	Existing Reservoir	Meets Requirements (Y/N)
Dead Storage	0.5 m	0.5 m	Y
Active Storage	8,500 m^3	2,100 m^3	N
Ice Allowance	2 m	2 m	Y
Freeboard	1 m	0.2 m	N

As shown in Table H the existing reservoir is currently undersized and has capacity for approximately 17 persons assuming 280 days, 335 L/person/day, and 30% of stored water being rejected during treatment. The Station requires options for additional reservoir storage.

5.3 Treatment

Based on the historical water quality data and the additional data collected during the site visit, the drinking water treatment system meets water quality guidelines. Water quality data for drinking water at the station is presented in Tables 1 to 9.

Since the maximum output of the system is 0.17 m^3/day, the system does not have adequate treatment capacity to meet the design basis demand of 2 m^3/day.

Current operation of the facility includes pre-chlorination, which can lead to the formation of disinfection by-products (DBP) such as halo acetic acids (HAA) and trihalomethanes (THM) in the treated water. During the next design phase, consideration should be given to relocating the chlorine dosing point to

downstream of the treatment process. This could also eliminate the need for using granular activated carbon upstream of the membrane system.

5.4 Water Conveyance Systems

5.4.1 Source to Storage

The existing reservoir is undersized; therefore, a new reservoir will be required to meet the design basis. The capacity of the existing pumping system may not be adequate to fill the larger reservoir if the elevation or volume of the reservoir is greater than the existing reservoir. A new pumping system would be required for all of the reservoir options that meet the design basis capacity.

5.4.2 Reservoir to Treatment

The design daily demand of raw water is approximately 40 m^3/day. The existing system capacity is approximately 15 m^3/day. Therefore, additional pumping will likely be required to convey water to the treatment system. This capacity needs to be confirmed during subsequent design phases.

5.4.3 Treatment to Use

Unless buildings are added to the Station or the existing buildings are renovated with additional water consuming devices, there is no requirement to increase the capacity of the distribution system from the treatment plant to the point of use. If the Station operates at full capacity in the future, the adequacy of the existing system from a usability point of view may become an issue (i.e. there are only 13 showers for 60 persons).

5.4.4 Fire System

Based on the National Fire Protection Association (NFPA) requirements (NFPA 2010), the volume of fire water required is 43.7 m^3. The existing fire system has a storage capacity of approximately 52 m^3 (half of the volume from two 15,000 gal tanks) and therefore exceeds the volume requirement. Further investigation is required to determine if the fire distribution system meets the NFPA regulations for flow rate requirements. This assessment is beyond the scope of this study.

6. WATER SOURCE ASSESSMENT

The objective of the water source assessment is to characterize the suitability of various water sources to meet the Station demands. Sources were evaluated as described in the Section 2 Methodology.

6.1 Station Creek

The location of Station Creek is shown on Figure 1.1. This section describes the quality and volume of the creek as well as the treatment and storage requirements related to the creek water. Potential for contamination within the watershed is also considered.

6.1.1 Water Quality

The water quality of Station Creek was assessed by collecting and analysing water samples from the reservoir.

At the time of sampling the Water Reservoir had a temperature of 5.9ºC, an Electrical Conductivity (EC) of 797 µS/cm, and a pH of 7.49. Water quality of Station Creek and CDWQG are presented in Tables 1 to 9. All parameters were generally below the CDWQG with the exception of the following:

- turbidity exceeded the Aesthetic Objective (AO) with a value of 3.27 Nephelometric Turbidity Unit (NTU) (Table 2);
- Total Dissolved Solids (TDS) was measured at a concentration of 544 mg/L, exceeding the AO of 500 mg/L in August 2010 (Table 2);
- historically, dissolved sodium has almost doubled the AO ranging from 333 to 507 mg/L (Table 2); and
- aluminum exceeded the AO for the first time since sampling began with a concentration of 0.215 mg/L (Table 4b).

CDWQG suggest an AO guideline of less than or equal to 0.1 NTU. It is recommended turbidity be controlled due to the potential for suspended matter to contain heavy metals, biocides, and potentially protecting microorganisms from disinfection (Health Canada 2003).

Health Canada (2008) suggests an AO of less than or equal to 500 mg/L for TDS to minimize hardness, unpalatability, mineral deposition and corrosion (Health Canada 1978). Recent data on health affects associated with the ingestion of TDS in drinking water is limited, and the data that are available are unclear; however, some individual components of TDS can affect human health (Health Canada 1978b; as updated 1991). Components of TDS which are known to affect human health have been provided individual guidelines by Health Canada (2008).

Health Canada (2008) suggests an AO of less than or equal to 200 mg/L for sodium. Because the body has very effective mechanisms to control sodium levels, sodium is not acutely toxic in the normal range of environmental or dietary concentrations (Health Canada 1979a). However, there is a relationship in

the human body between fluid volume and sodium retention, and changes in sodium intake can result in hypertension, congestive cardiac failure, renal disease, cirrhosis, toxaemia of pregnancy, and Meniere's disease (Health Canada 1979a).

There are no known adverse health effects to ingesting aluminum and no known effects on water distribution systems (Health Canada 1998). However, as a precautionary measure, Health Canada (2008) suggests an AO of 0.1 mg/L.

6.1.2 Volume

Station Creek flows were estimated using the methodology described in Section 2.3. The drainage area of Station Creek at the Station is approximately 109.6 km^2 and is shown on Figure 1.2. Based on the direct drainage area ratio method the mean seasonal flow in Station Creek could range from 0.9 m^3/s to 5.1 m^3/s. Based on the regional analysis the mean seasonal flow was estimated to be 3.0 m^3/s. The estimated volume passing the Station over a period of 30 days would therefore, range between 2.4 and 13.3 million m^3. The annual demand for a station population of 60 persons was estimated to be 8,500 m^3 (Section 3). This demand represents a withdrawal of 0.4% of the lowest estimated annual volume. Therefore, estimates suggest that Station Creek has adequate volume to supply the Station with water.

6.1.3 Water Treatment Required

The main concern is the relatively high turbidity and high concentration of dissolved solids, hardness, sodium and aluminum. The current technologies used at Station (e.g. Chlorination, IX, RO, UV) are able to adequately treat the water from station creek for the separated uses system. Consequently, the same technologies with a few upgrades to reduce the formation of trihalomethanes (THM's) and with continuous TDS monitoring of the RO product water, would be sufficient to treat the water from station creek. A detailed description and assessment on the treatment options for treatment using station creek as a source is presented on Section 8.

6.1.4 Potential for Contamination

Watershed for the station creek was determined based on the basin elevations, as shown on Figure 1.2. The only potential source of anthropogenic contamination is the runoff from the abandoned dump site that is located west of the runway (Environment Canada 2010). Water quality results in the reservoir indicated that there was no measurable anthropogenic contamination; therefore, the potential for contamination is considered to be very low.

6.1.5 Storage Required

Station Creek runs seasonally from mid-June to late August or mid-September. Pumping from the creek can only take place during this time; therefore, a large quantity of storage is required when using this source. An assessment on storage is provided in Section 7.

6.2 Black Top Creek

The location of Black Top Creek is shown on Figure 1.2. This section describes the quality and volume of the creek as well as the treatment and storage requirements related to the creek water. Potential for contamination within the watershed is also considered.

6.2.1 Water Quality

The Black Top Creek was analysed as a potential alternate source of water. At the time of sampling the temperature of the creek was 9.2ºC, the EC was 1,083 µS/cm, and the pH was measured at 7.38. Several parameters exceeded the CDWQG in 2010 including turbidity, dissolved manganese, TDS, and total aluminum, iron, and manganese. Water quality of Black Top Creek and CDWQG are presented in Tables 1 to 9.

The AO suggested by Health Canada (2008) for iron in drinking water is less than or equal to 0.3 mg/L. This objective is aimed to minimize objectionable taste and appearance, as well as inefficiency in the distribution system which can result from the precipitation of insoluble hydroxides and the development of slime produced by iron oxidizing bacteria.

Manganese is most often present as a dioxide, carbonate or silicate mineral (Health Canada 1979b), and many igneous and metamorphic minerals contain manganese as a minor constituent. The presence of dissolved manganese in water is dependent on both redox and pH conditions, although it is somewhat more stable toward oxidation than ferrous iron.

Health Canada (2008) suggests an AO guideline for manganese of less than or equal to 0.05 mg/L to minimize staining and undesirable tastes in beverages, as well as the accumulation of microbial growths in distribution systems (black precipitates; Health Canada 1979b).

6.2.2 Volume

Black Top Creek flows were estimated using the methodology described in Section 2.3. The drainage area of Black Top Creek near its mouth is approximately 103.3 km^2 and is shown Figure 1.2. Based on the direct drainage area ratio method the mean seasonal flow in Station Creek could range from 0.9 m^3/s to 4.8 m^3/s. Based on the regional analysis the mean seasonal flow was estimated to be 2.8 m^3/s. The flow volume over a period of 30 days would therefore range between 2.3 and 12.5 million m^3. The annual demand for a station population of 60 persons was estimated to be 8,500 m^3 (Section 4). This demand represents a withdrawal of 0.4% of the lowest estimated annual volume. Therefore, estimates suggest that Black Top Creek has adequate volume to supply the Station with water.

6.2.3 Water Treatment Required

Black Top creek water quality is similar to the Station Creek water quality, the main concern is the relatively high concentration of minerals. The same water treatment technologies used at the Station

with a few upgrades to reduce the formation of THM's and with continuous TDS monitoring of the RO product water, would be necessary to treat the water from Black Top creek. A detailed description and assessment on the options for treatment using Black Top creek as a source is presented in Section 8.

6.2.4 Potential for Contamination

Watershed for the creek was determined based on the basin elevations, as shown in Map 01-003-001. No potential source of anthropogenic contamination was identified within the watershed. The potential for contamination is considered to be very low.

6.2.5 Storage Required

Black Top Creek runs seasonally from mid-June to late August or mid-September. Pumping from the creek can only take place during this time; therefore, a large quantity of storage is required when using this source.

6.2.6 Other Considerations

Due to the long distance (over 5 km) between the station and the creek, a pipeline would be expensive to construct and difficult to maintain from freezing. Therefore, a pipeline would be a poor option to convey the water to the station; alternatively, water could be trucked-in. Trucking would require permanent maintenance of the road from the creek to the station.

There is no power available near the station; therefore, on-site generation or a new power line from the station would be required.

6.3 Slidre Fjord

The location of Slidre Fjord, relative to the Station, is shown on Figure 1.1. This section describes the quality and volume of the water in the Fjord as well as the treatment and storage requirements related to using the Fjord water as a water supply. Potential for contamination of the Fjord is also considered.

6.3.1 Water Quality

Slidre Fjord provides another potential source option for providing the Station with water. Field-measured parameters at this location provided the lowest temperature at 4.3ºC, the highest EC at 41,400 µS/cm, and a mid-range pH of 7.85. Water quality of Slidre Fjord and CDWQG are presented in tables 1 to 9. The Slidre Fjord had the most parameters that exceeded the CDWQG. These parameters include:

- turbidity (2.36 NTU);
- chloride (15,500 mg/L);
- sulphate (2,070 mg/L);

- TDS (27,300 mg/L);
- sodium (7,820 mg/L);
- dissolved arsenic (0.0461 mg/L); and
- total aluminum (0.43 mg/L), and iron (0.41 mg/L).

Health Canada (2008) suggests an AO guideline of less than or equal to 250 mg/L for chloride to minimize undesirable tastes in beverages. At higher concentrations chloride may cause corrosion in distribution systems as well (Health Canada 1979c).

The CDWQG for sulphate suggested by Health Canada (2008) is less than or equal to 500 mg/L. This value is an AO based on taste considerations, although there is the possibility of adverse physiological effects at higher concentrations.

6.3.2 Volume

The available volume of water from Slidre Fjord is virtually unlimited in terms of meeting the Station's demand.

6.3.3 Water Treatment Required

Seawater from the Slidre Fjord is characterized by a high concentration of minerals (i.e. sodium, sulphates, chloride) and relatively high arsenic, aluminum, and iron concentrations.

If seawater were used as a source, the existing separated treatment system (potable and non potable) will not work since all the demand flow will need to be treated by a desalinization plant since seawater is not suitable for non-drinking water use. Due to the amount of water to be treated, the desalinization plant for the Station will need to be based on Reverse Osmosis (RO) technology. A detailed description and assessment on the treatment options for treatment using seawater as a source is presented on Section 8.

6.3.4 Potential for Contamination

The only identified source of anthropogenic contamination is the discharge from the Station's sewage lagoon. However, dilution combined with the salinity of the water would reduce the potential for contamination to impact the water treatment system (e.g. microbiological and organic matter contamination) and the treatment required to desalinate the water would remove those contaminants from the water. The potential for contamination is therefore considered to be low.

6.3.5 Storage Required

If a permanent intake and pumping system were constructed in the Fjord and maintained during the winter months, a small amount of operation storage would be required within the Station. Alternatively, if the construction of an intake structure that would remain ice free during the winter and be adequately

protecting against ice loading is deemed impractical, saline water could be stored in a reservoir for use during the winter months. This would allow pumping to be completed during open water season.

6.3.6 Other Considerations

Pipes and storage tanks that will handle sea water need to be adequate protected against corrosion.

The desalinization plant would need to treat all the water supplied to the station. The water supplied to the DND would also need to be treated.

6.4 Option Ranking

Table I presents the summary of the option assessment for the source of water. A detailed description of the scoring methodology is presented in Section 2.4.1.

Table I Source Water Option Assessment

Option	Water Quantity	Water Quality (2)	Potential For Contamination (2)	Storage Required (3)	Intake, Pump house, and pipeline concerns (3)	Score
Station Creek	Sufficient	5	10	5	10	75
Black Top Creek	Sufficient	5	10	5	0	45
Seawater (Slidre Fjord)	Sufficient	0	5	5	5	40

Maximum score value is 100, higher score means better performance of the system against the predefined criteria.

The preferred source of water based on the pre-defined criteria is Station Creek.

7. RESERVOIR ASSESSMENT

Based on the Water Source Assessment, Station Creek is the preferred water source to supply the Station; therefore, the reservoir assessment that the water source is Station Creek.

The existing reservoir has an over-winter capacity for approximately 17 people; therefore, a preliminary option review was conducting to identify potential solutions for providing additional storage to meet the design demand (60 persons). Following the preliminary option review, five feasible options were selected for further analysis and ranking.

7.1 Preliminary Options Review

The following preliminary options were considered for providing additional water storage:

- dredging the existing reservoir;
- raising the berms or deepening the floor of the existing reservoir;
- laterally expanding the footprint of the existing reservoir;
- constructing a second reservoir; and
- decommissioning existing reservoir and constructing a new reservoir.

Each of the above options is discussed in the sections below.

7.1.1 Dredging the Existing Reservoir

Dredging the existing reservoir is not feasible due to the instability of the internal reservoir slopes. Furthermore, the depth of sediment accumulation on the base of the reservoir is anticipated to be minimal. A comparison of the survey data to historical reservoir depths showed almost no difference.

7.1.2 Raising the Berms or Deepening the Floor of the Existing Reservoir

Consideration has been given to increasing the storage capacity of the existing reservoir by increasing the water depth inside the reservoir. This could be accomplished by lowering the elevation of the floor of the reservoir or by increasing the height of the containment berms.

Lowering the floor of the reservoir is not possible, because the floor is currently within 1 m of the high water mark in the Fjord. If the floor elevation is further reduced, there is a risk that unfrozen zones (taliks) will be encountered. Such taliks contain super cooled brine, which may be hydraulically connected to the ocean and could potentially contaminate the reservoir with sea water.

Alternatively, capacity could be increased by raising the elevation of containment berms. This option is limited by the proximity of the reservoir to Station Creek and the properties of the existing berms;

however, this option is worthy of further consideration and has been carried forward for further analysis.

7.1.3 Laterally Expanding the Existing Reservoir

Consideration was given to laterally expanding the existing reservoir. This option is considered feasible; however, the depth of active storage in the existing reservoir is only 0.6 m. The ice allowance depth is 2 m. Therefore, simply expanding the existing footprint of the reservoir would result in a reservoir that has poor geometry and requires a large volume of water to reach the full supply level because most of the stored water would become unusable ice storage. The berms could be raised in addition to laterally expanding the reservoir, but this option has several disadvantages. The reservoir would be out of service for an extended period of time. The level of effort required to complete this construction would be similar to the level of effort required to construct a completely new reservoir. Furthermore reconstruction of this reservoir would be complicated by working with the existing berms, which are of unknown quality. Based on these factors laterally expanding the existing reservoir has not been carried forward for further analysis.

7.1.4 Constructing a Second Reservoir

The concept of constructing a second reservoir to augment the storage of the existing reservoir was qualitatively considered. This option was quickly ruled out due the magnitude of the additional storage volume (6,000 m^3) that is required and the poor condition of the existing reservoir. It was felt that the level of effort to construct a reservoir with 6,000 m^3 would be similar to the level of effort to construct a reservoir with the full design capacity (8,500 m^3). Having multiple reservoirs would be beneficial from a redundancy perspective, but this would also require operation and maintenance systems (reservoir and pumping/piping systems). Although this option was not considered further in this study, if a staged approach is taken, whereby the existing reservoir capacity is marginally increased and the reservoir is made more robust. It might make sense to provide a supplemental storage facility in the future.

7.1.5 Decommissioning Existing Reservoir and Constructing a New Reservoir

This option would provide the ultimate solution for water storage at the Station. A new water reservoir would be built to provide an adequate volume of water, while having dimension that minimize the volume of water wasted in ice storage allowance. An ideal location could be selected and the construction quality could be controlled to ensure stability of the berms. The existing reservoir and pumping system could be maintained to supply water during construction, then decommissioned once the new reservoir was in operation. A single reservoir would simplify operation and maintenance. This option has been carried forward for more detailed analysis.

7.2 Detailed Option Review

The options that were identified as being feasible during the preliminary option review have been developed into conceptual designs for further consideration. Five options were developed as shown on Drawing 7:

- Option 1 – Increase stability of existing reservoir;
- Option 2 - Raise existing reservoir berms;
- Option 3 – Construct new reservoir north of existing;
- Option 4 - Construct new reservoir west of Station Creek; and
- Option 5 – Construct new reservoir east of the Station.

This section provides a description of these options. Conceptual plan and section drawings along with high level earthwork quantities are provided in Drawings 8 – 17.

7.2.1 Option 1 – Increase Stability of Existing Reservoir

The plan and sections of Option 1 are shown on Drawings 8 and 9. This option consists of upgrading the existing reservoir by flattening the outside slopes of the reservoir to 4 horizontal to 1 vertical, by placing fill material around the reservoir. The crest of the reservoir would be raised by approximately 0.7 m to an elevation of 3.5 m to increase the amount of freeboard from 0.2 m to 0.9 m. The fill channel on the north side of the reservoir would be filled in and the inlet culverts on the north side of the reservoir would be removed. The existing overflow culvert would be maintained to prevent an increase in the high water level. If the high water level were increased without lining the reservoir, increased seepage might occur through the berms and lead to internal slope failure.

These upgrades would not increase the under-ice storage capacity of the reservoir; however, they may reduce seepage losses through the reservoir. In addition, the upgrades would reduce the risk of a slope failure on the outside slopes of the reservoir, which would prolong the useful life of the facility by several years.

The major advantage of this option is that it could be undertaken with the construction equipment currently available at the Station, possibly over one or two thaw seasons, so that the cost would be minimal. In addition, the reservoir upgrades could be completed with no significant interruption in reservoir operations.

The existing pumping and piping arrangement would be adequate to convey water to and from the reservoir, however the floor of the pump house might be impacted by raising the berms.

Consideration could also be given to flattening the inside slopes of the reservoir as part of the upgrades. However, this would reduce the under-ice capacity of the reservoir and require that the reservoir be taken out of service during construction.

This option does not provide any additional protection against contamination of the water supply by the contaminate plume to the east.

Further analysis and consideration is required to determine the effect of raising the berm on:

- Station Creek;
- the bridge across Station Creek,
- the road south of the reservoir;
- the drainage route between the reservoir and the east bank of Station Creek; and
- the pumphouse on the southeast corner of the reservoir.

This option is not carried forward into the options assessment ranking because it does not meet the design volume.

The estimated cost of constructing this option is $2,165,000. Detailed information on the cost estimate is provided in Appendix 1.5.

7.2.2 Option 2 – Raise Existing Reservoir Berms

The plan and sections for Option 2 are shown on Drawings 10 and 11. This option consists of taking the reservoir out of service and upgrading the interior and exterior reservoir slopes by flattening them to 4 horizontal to 1 vertical. Steeper side slopes may be possible (e.g. 3H:1V); however, this depends on the material properties of the existing berms.

The crest of the reservoir would be raised by approximately 1.7 m to an elevation of 4.5 m. This would increase the storage depth and freeboard. This option would provide approximately 3,600 m^3 of storage (capacity for approximately 29 persons). The fill channel on the north side of the reservoir would be filled in and the inlet culverts on the north side of the reservoir would be removed. The existing overflow culvert would also be removed and replaced with an overflow culvert with invert elevation at 3.5 m. The high water level would therefore, be increased to this level.

A membrane liner would need to be installed over the inside slopes and floor of the reservoir. The liner is required to minimize seepage losses from the reservoir and to ensure that the outside slopes do not become unstable. Consideration will need to be given to protect the liner from ice action. A sub-drainage system will need to be installed below the membrane liner to prevent liner uplift from water pressure and air pockets that will collect below the liner.

Based on preliminary analysis, the existing pumping and piping arrangement may not be adequate to fill the reconstructed reservoir. The best solution to meeting the additional flow requirements would need to be further assessed during subsequent design phases; however, increasing the pipe size or adding an additional pump may be sufficient. The existing pumping arrangement from the reservoir to the treatment system is likely adequate; however, the floor of the pump house will likely be impacted by raising the berms.

The advantage of raising the containment berms is that it minimizes the volume of earthworks required to increase storage capacity. The primary disadvantage is that it requires that the reservoir be taken out of service while construction proceeds. The timing and schedule for the work would therefore, be very critical and an alternate temporary source of water would be required during construction and for the winter following construction. During the thaw season, water could be pumped from Station Creek directly to the indoor storage tanks. During the winter, alternative sources and treatment of water would need to determined (snow melt, extreme water rationing, minimal population, etc).

Further analysis and consideration is required to determine the effect of raising the berm on:

- Station Creek;
- the bridge across Station Creek;
- the road south of the reservoir;
- the drainage route between the reservoir and the east bank of Station Creek;
- additional pumping capacity to fill the reservoir; and
- the requirement to raise the floor of the pump house on the southeast corner of the reservoir.

The maximum elevation of the berms is limited by the proximity of the existing reservoir to channel of Station Creek, to the west, and the bank of Station Creek, to the east. The conceptual design represents a perceived maximum berm elevation and only results in an active storage volume of 3,600 m^3. This option is not carried forward into the options assessment ranking because it does not meet the design volume.

The estimated construction cost for this option is $8,991,000. Detailed information on the cost estimate is provided in Appendix 1.5.

7.2.3 Option 3 – Construct New Reservoir North of Existing Reservoir

The plan and sections of Option 3 are shown on Drawings 12 and 13. This option involves constructing a new reservoir north of the existing reservoir. The reservoir would be constructed with 4 m of active storage depth which would maximize the ratio of active storage to ice allowance.

With this option, the new reservoir could be constructed while maintaining operations in the existing reservoir. Unforeseen delays in constructing the new reservoir would therefore not affect the water supply to the weather station.

The proposed reservoir is located between Station Creek and the water treatment facility and therefore, minimize pumping and piping requirements for water handling.

It has been assumed that berm construction for this reservoir would be completed using imported, manufactured granular material. For conceptual design, using these materials, the inside and outside reservoir slopes can be graded to 3H:1V. If unprocessed granular material is used, 4H:1V side slopes would be required.

The reservoir would be lined with a membrane liner to prevent seepage losses and to prevent instability of the outside slopes. A sub-drainage system will be required below the membrane liner to prevent uplift. Based on the conceptual elevations, the sub-drainage system would need to be pumped.

The existing pumping and piping arrangement may not be adequate to fill the reconstructed reservoir. Based on a preliminary analysis, a 100 mm diameter, 125 m long pipeline would be required to convey water from Station Creek to the reservoir. Also three 2 HP pumps (two operational and one standby) would be required to fill the reservoir. A new pump house and conveyance system between the reservoir and the treatment system would also be required. It is anticipated that this pipeline would have a diameter of 150 mm and a length of approximately 100 m. This pipeline would need to be heat traced, insulated, and self-draining. The pipeline route may be in conflict with the fuelling line. The existing pump house pump is not adequate to supply the required volume and three 3 HP pumps (two operational and one standby) would be required. The best solution to meeting the additional flow requirements should be further assessed during subsequent design phases.

One of the main disadvantages of locating the reservoir here is the contaminant plume located immediately west of the proposed location, which originates at the tank farm located north of the Station. A review of the potential impact of the contamination on the water supply is presented in Appendix 1.4, along with potential options for managing the contamination. Locating the reservoir here also increases the potential for future spills from the tank farm to contaminate the reservoir.

Further analysis and consideration is required for the reservoir at this location:

- how to manage the contamination located immediately west of the reservoir site;
- potential impact to the fuelling line immediately adjacent to the reservoir;
- selection of a route for hauling material during construction;
- maintaining surface drainage around the proposed and existing reservoirs;
- the drainage route between the reservoir and the east wall of Station Creek Valley; and
- provision of new pump house and pipeline routes.

This option meets all the requirements of the design basis and is therefore carried forward into the options assessment ranking.

The estimated construction cost for this option is $12,780,000. Detailed information on the cost estimate is provided in Appendix 1.5.

7.2.4 Option 4 – Construct New Reservoir West of Station Creek

The plan and sections of Option 4 are shown on Drawings 14 and 15. This option consists of construction of a new reservoir on the west side of Station Creek. The reservoir would be constructed with 4 m of active storage depth which would maximize the ratio of active storage to ice allowance.

The advantage of locating the reservoir in this area is that it may be possible to construct the reservoir by excavating below the existing ground surface and using the excavated material to construct the berms as the soil in this area appears to consist largely of sands and gravels. This approach would reduce the requirement to import material from a borrow source. Test holes would have to be drilled on the proposed site to confirm the feasibility of this method of construction. However, for the purposes of this study it has been assumed that imported, manufactured granular material would be used for construction of the berms. For conceptual design, using these materials, the inside and outside reservoir slopes can be graded to 3H:1V. If unprocessed granular material is used, 4H:1V side slopes would be required.

The reservoir would be lined with a membrane liner to prevent seepage losses and to prevent instability of the outside slopes. A sub-drainage system will be required below the membrane liner to prevent uplift. Based on the conceptual elevations, the sub-drainage system would need to be pumped.

The existing pumping and piping arrangement would not be adequate to fill the reconstructed reservoir. Based on a preliminary analysis, a 150 mm diameter, 80 m long pipeline would be required to convey water from Station Creek to the reservoir. Three 4 HP pumps (two operational and one standby) would be required to fill the reservoir. A new pump house and conveyance system between the reservoir and the treatment system would also be required. It is anticipated that, if a pipeline is feasible, it would have a diameter of 150 mm and a length of 300 m. This pipeline would need to be heat traced, insulated, and self-draining. Additionally this pipeline would need to cross Station Creek. The existing pump house pumps would likely need to be replaced with three 3 HP pumps (two operational and one standby). The best solution to meeting the additional flow requirements would need to be further assessed during subsequent design phases.

An alternative to pumping the water from the reservoir to the treatment system would be to haul water by truck. Although this is a method which is commonly used in many northern communities, it may require additional station staff and/or equipment. If this option is selected, consideration should also be given to upgrading the existing bridge crossing at Station Creek as this bridge would be critical to accessing the water supply.

Another advantage of this option is that the new reservoir could be constructed while maintaining operations in the existing reservoir. Unforeseen delays in constructing the new reservoir would therefore not affect the water supply to the weather station.

There is no known contamination in this location; however, the presence of contamination should be investigated as part of the geotechnical assessment.

Further analysis and consideration is required for the reservoir at this location:

- feasibility of trucking water or providing a pipeline to convey water from the reservoir to the treatment plant;
- additional geotechnical investigations to confirm subsurface materials;
- topographic survey of the area; and

- reconstruction or rehabilitation of the existing bridge.

This option meets all the requirements of the design basis and is therefore, carried forward into the options assessment ranking.

The estimated construction cost for this option is $12,583,000. Detailed information on the cost estimate is provided in Appendix 1.5.

7.2.5 Option 5 – Construct New Reservoir East of the Station

The plan and sections for Option 5 are shown on Drawings 16 and 17. This option consists of constructing a new reservoir east of the Station. The reservoir would be constructed with 4 m active storage depth which would maximize the ratio of active storage to ice allowance.

At this location, it has been assumed that the water reservoir could be constructed by excavating below the existing ground surface by blasting and by using the blasted material to construct the berms at a slope of 4:1. The feasibility of this method of construction will depend on the water (ice) content and gradation of the soil that underlies the Station as discussed in the geotechnical report (WorleyParsons 2010). Additional geotechnical investigations will be required to assess the soils at this location. Based on the material properties at this location, there might be potential to steepen the side slopes to 3:1.

The reservoir would be lined with a membrane liner to prevent seepage losses and to prevent instability of the outside slopes. A sub-drainage system will be required below the membrane liner to prevent uplift. Based on the conceptual elevations, the sub-drainage system would need to be pumped.

The existing pumping and piping arrangement is not adequate to fill the reconstructed reservoir. Based on a preliminary analysis, a 100 mm diameter, 375 m long pipeline would be required to convey water from Station Creek to the reservoir. It is anticipated that three (two operational and one standby) 3 HP pumps would be required would be required to fill the reservoir. A new pump house and conveyance system between the reservoir and the treatment system would also be required. It is anticipated that a 150 mm diameter, 225 m long pipeline would be required. This pipeline would need to be heat traced, insulated, and self-draining. The pipeline route may be in conflict with the existing infrastructure around the Station. The existing pump house pumps are not adequate to supply the required volume to the treatment system and three new 3 HP pumps would be required (two operational and one standby). The best solution to meeting the additional flow requirements needs to be further assessed during subsequent design phases.

An alternative to pumping the water from the reservoir to the treatment system would be to haul water by truck. This method may require additional station staff and/or equipment. If this option is selected, consideration should also be given to upgrading the existing bridge crossing at Station Creek as this bridge would be critical to accessing the water supply.

An advantage of this option is that the new reservoir could be constructed while maintaining operations in the existing reservoir. Unforeseen delays in constructing the new reservoir would therefore not affect the water supply of the weather station.

There is some contamination at this location; however, it is considered localized and could be removed and placed with the contaminated soils area near the airstrip. The main concern is the proximity of the reservoir to the tank farm and the potential for future spills contaminating the reservoir. Additional information is provided in Appendix 1.4.

A disadvantage of this location is that it would require a relatively long fill line from Station Creek to the reservoir, a distance of 200 or 300 m. In addition, it might be necessary to construct an access road up the Station Creek Valley to a new filling point on Station Creek.

Locating the reservoir here would greatly inhibit further expansion of other facilities in the vicinity of the weather station buildings and would require relocation of the meteorological compound.

The presence of the reservoir at this location may also cause significant snow drifting around the existing station and other buildings. If this site is preferred, we recommend that a snow drifting study be undertaken to assess this potential concern.

Further analysis and consideration is required for the reservoir at this location:

- feasibility of providing a pipeline to convey water from the reservoir to the treatment plant;
- additional geotechnical investigations to confirm the subsurface materials;
- feasibility of relocating the meteorological station;
- potential impacts to future Station expansion plans;
- conflict of reservoir with future sewage facility;
- managing contamination and potential for future spills; and
- impacts on snow drift formation around the Station.

This option meets all the requirements of the design basis and is therefore, carried forward into the options assessment ranking.

The estimated construction cost for this option is $12,483,000. Detailed information on the cost estimate is provided in Appendix 1.5.

7.3 Option Ranking

Options 3 through 5 meet the design basis requirements and are ranked using the methodology described in Section 2.7.2.

The rankings were developed for the following criteria and are described in the sections below:

- potential for contamination;
- earthwork required;
- construction cost;

- conflicts with existing Station infrastructure; and
- proximity to source and treatment facilities.

7.3.1 Comparison of Options

Potential for Contamination

As described in the Section 7.2, Option 3 has the most potential to be affected by contamination and was ranked as a 0. Option 4 has no known source of contamination and was ranked as a 10. Option 5 has a medium risk of contamination and was ranked as a 5.

Earthwork Required

The earth work required for Option 3 involved a cut of 1,300 m^3 and a fill of 35,000 m^3. It has been assumed that the cut material would be wasted and imported material would be imported to construct the berms at a 3:1 slope. Based on this the total earthwork for Option 3 was calculation by adding the cut and fill volumes obtaining a total of 36,300 m^3.

The assumptions made regarding the construction of Option 3 were also applied to Option 4. Cut and fill volumes were added to obtain a total earthwork volume of 32,800 m^3.

For Option 5, the assumption was made that the cut material would be used to construct the berms at a slope of 4:1. Therefore, the total earth work volume was determined by subtracting the cut volume from the fill volume. The total earth work for Option 5 was determined to be 14,600 m^3.

The rankings were obtained by taking the total earthwork of each option and dividing it by the option with the lowest earth work volume. This yielded values of 4.0 for Option 3, 4.5 for Option 4 and 1 for Option 5.

Construction Cost

Appendix 1.5 provides summarized information on the cost estimates for reservoir Options 3, 4, and 5. The estimated construction cost of each reservoir is provided below.

- Option 3: $12,780,000;
- Option 4: $12,583,000; and
- Option 5: $12,483,000.

Given the level of detail in this study, the construction costs of these three options can be considered to be equal. Therefore, a ranking of 10 was given to each option.

Conflicts with Existing Station Infrastructure

As described in the Section 7.2 Option 3 has a medium level of conflict with existing infrastructure (fuelling line) and was ranked as a 5. Option 4 has virtually no conflict with the existing infrastructure and was ranked as a 10. Option 5 has the most conflict with the existing infrastructure as was ranked as a 0.

Proximity to Source and Treatment Facilities

As described in the Section 7.2 Option 3 is located in the most ideal location in terms of pumping water to and from the reservoir and received a ranking 10. Option 4 has the most constraints in terms of conveying the water from the reservoir to the station (crossing Station Creek) and was ranked as a 0. Option 5 has a medium level of difficulty for conveying water to and from the reservoir and was ranked as a 5.

Summary of Ranking

Table J presents the summary of the option assessment for the water reservoir. A detailed description of the scoring methodology is presented in Section 2.7.2.

Table J Reservoir Option Assessment

Option	Potential For Contamination (1)	Earth Work Required (3)	Cost (3)	Conflict of Footprint with Existing Station Infrastructure (2)	Proximity to Source and Treatment Facilities (2)	Score
Option 3	0	4	10	5	10	72
Option 4	10	4.5	10	10	0	73.5
Option 5	5	10	10	0	5	75

The maximum score value is 100, a higher score means better performance of the system against the predefined criteria. Options 1 and 2 had insufficient storage volumes and were not ranked.

While the preferred reservoir option is Option 5, locating the reservoir to the east of the Station, the rankings are sufficiently close to warrant further investigation and refinement of all three options.

8. DEVELOPMENT OF WATER TREATMENT OPTIONS AND RANKING

8.1 Water Treatment Options

The capacity of the existing water treatment system is not sufficient to supply the future demand; therefore, water treatment options were developed based on the assessment performed on available sources of water (see Section 2.7.1). Two distinct sources were identified: seawater from the Slidre Fjord and surface water from Station Creek.

A review of the raw water quality from the Station Creek indicates that the main concern is the relatively high turbidity, high concentration of dissolved solids, hardness, sodium and aluminum. Seawater from the Slidre Fjord is characterized by a high concentration of minerals (i.e. sodium, sulphates, chloride) and relatively high turbidity, arsenic, aluminum, and iron.

A combination of softening, multimedia filtration, membranes and disinfection was chosen as the appropriate technologies to treat the water from the selected sources. The selection of these technologies is based on the water quality of the selected sources. The various technologies are similar to the ones used in the current system, which deliver adequate water quality. See Section 3.3 for a description on the existing system.

Two options were developed based on the source and the design flow rate. Option 1 was developed to treat water from the Slidre Fjord (seawater) and Option 2 developed to treat water from Station Creek (surface water).

8.1.1 Treatment Standards

Each system is designed to produce potable water meeting all requirements in the CDWQG. Currently, the utility water (i.e. non-drinking water uses) is treated to remove hardness and disinfected with chlorine. These same utility water treatment standards have been assumed for developing the options below.

8.1.2 Water Treatment Options Description

Option 1 – Seawater from Slidre Fjord Treatment Using Reverse Osmosis Membrane Filtration (RO)

Option 1 involves using sea water as a raw water source for both potable and utility water. The proposed technology for sea water treatment would include:

- pre-treatment with water softener;
- granular Activated Carbon filter;
- cartridge filtration (5 µm);

- reverse osmosis (RO) membrane filtration; and
- disinfection using sodium hypochlorite.

Option 1 would not be split into utility water and potable water applications, as all of the required flow (i.e. 20 m^3/day) would need to be treated to remove salinity before being used. A block diagram showing the treatment sequence of Option 1 is presented in Drawing 5.

Option 2 – Surface Water Treatment using Mixed Media Filtration (MMF)

Option 2 involves using surface water from Station Creek as a raw water source. The proposed technology for surface water treatment would include:

- chemical pre-treatment and aeration;
- ion exchange softening;
- multimedia filtration;
- reverse osmosis membrane filtration; and
- disinfection using sodium hypochlorite.

Option 2 was considered for two different flow rates to obtain drinking water quality standards:

- Following the current practice at the station, only the drinking water portion of the demand (i.e. 2 m^3/day) would be treated to meet drinking water quality and non-potable utility water would be treated by softening and multimedia filtration only (i.e. 18 m^3/day); and
- Both drinking and utility water would be treated to meet drinking water quality (i.e. 20 m^3/day).

A block diagram showing the treatment sequence of Option 2 is presented in Drawing 6.

8.1.3 Comparison of Costs for Water Treatment Options

The costs in Table K are high level cost estimates for process equipment only (freight on board Calgary), and do not include the costs associated with engineering, installation, the building envelope or ancillary equipment such as chemical storage, raw and treated water storage, pumping and distribution. The cost estimates presented in Table K could be multiplied by a factor of 3 to account for engineering, supply and installation of the units at the Station; however, this factor was not applied because these cost estimates were only used for comparison purposes.

Table K Comparison of Water Treatment Options

	Option 1 (Sea Raw Water Source)	Option 2 (Surface Water Source)	
	All water potable	Utility Separate	All water potable
Capital Cost	$170,000	$67,000	$74,000
Operational Cost (yearly)	$34,000	$6,700	$7,400
Area required (m)	Unit consists in two skids: One 1.2 m by 6.1 m, and another 1.8 m by 0.9 m. Total 2.1 m by 6 m (skids placed side by side) or 7.8 m by 1.2 m (skids placed lengthwise). Total height is 3 m.	2.5 x 2.5 x 3 (height)	6 x 2.5 x 3 (height)

The difference in costs between treating sea water and surface water is in the material of construction. Desalination RO (Reverse Osmosis) systems must be constructed of material that will minimize the potential for corrosion due to the elevated salt concentration in the feed water. In addition, the feed pumps are bigger, as high pressure is required to push the water through the membranes compared to surface water, again adding to the costs. The salinity rejection rate for desalination RO is higher than the salinity rejection rate for surface water RO. To get higher salt rejections from the membranes, the manner in which the membranes are constructed is slightly different for sea water than surface water. The membrane material is the same, but the type, thickness and placement of the spacers in the spiral wound unit is different making desalination membranes more expensive. As indicated in Table K, there is a significant price different between the two systems.

8.1.4 Reliability

Both treatment options are based on the same technologies. Generally, reverse osmosis based water treatment systems are automated and therefore, inherently more reliable and consistent than systems requiring more operator supervision. The quality of the source water is the most significant factor that can affect the performance of the water treatment system. Adequate on-line monitoring is recommended to ensure the system operates well.

Reliability issues associated with an automated system are typically related to the instrumentation and controls of the system; therefore, it is important that the operators either have a good understanding of these issues, or have easy access to technical support.

In particular for desalinization plants, there are some additional concerns associated with the use of seawater including the potential for corrosion due to leakage of seawater. This can be mitigated by selecting construction material appropriate for the application and by ensuring the system is properly

constructed. Continuous operation and/or flushing of the system with fresh water before a shutdown are good practices to help mitigate these concerns.

Redundancy should be built into the system to ensure that the treated water supply is not impacted when regular maintenance or servicing is required. This redundancy can be provided in a number of different ways, including providing significant treated water storage as well as providing standby units. Alternatively, shelf spares can be provided to allow operators to quickly change out equipment that fails or requires servicing.

Electrical supply will be important to ensure continuous operation of the system, and a back-up generator is recommended if continuous supply of treated water is required.

8.1.5 Risk and Impact of Process Upset

The risk of a process upset is dependent on the raw water quality. To mitigate the risk, adequate raw water quality monitoring is recommended, with the ability to divert raw water away from the process in the event of an unexpected change in the raw water quality.

For the proposed systems it is believed that surface water (Option 2) would be more susceptible to changes in the raw water solids concentration since water quality is dependant on seasonal changes. However, since water is to be diverted to the water reservoir before it is treated the impact of a process upset is not significant due to the storage provided upstream of the treatment system. Solids levels could be monitored indirectly using an on-line turbidity meter, and if a turbidity level exceeding the capabilities of the system is reached, the raw water could be diverted to avoid a process upset.

In the case of the seawater treatment system (Option 1) a continuous supply of treated water is required with no storage upstream of the treatment system; therefore, redundancy should be provided as part of the operational equipment. The proposed processes are well understood and have a proven track record.

8.1.6 Risk and Impact of Mechanical Failure

The risk of a mechanical failure is dependent on the amount of redundancy in the system. Most single points of failure would be the piping leading to and from the treatment process, and the risk of these failing is low, as long as they are installed correctly. The impact of one of these failures would be significant as it would shut down the system until the failure is repaired. Providing on-line standby units would minimize the risk and impact of a mechanical failure of the proposed treatment processes.

It is believed that the desalinization unit (Option 1) would be more susceptible to mechanical failure due to the corrosive nature of the seawater.

8.1.7 Ease of Operation

Both treatment system options should be relatively easy to operate. They require monitoring to ensure that the membranes are not fouling and will require a manually operated clean-in-place performed

every 1 to 2 months. Option 1 would require more stringent maintenance due to the corrosive nature of the seawater. The multimedia filter identified in Option 2 (surface raw water source) requires monitoring to ensure that coagulant dosing is effective and outlet turbidity meets the criteria to ensure the filter is operating properly after backwash cycles.

8.1.8 Electrical Consumption

Table L provides estimates on the potential electrical load difference between using surface water and sea water. These numbers are provided as order of magnitude numbers for comparison and may not include all of the electrical loads for the two treatment options. The Option 2 load was established for treating all the demand flow up to drinking water quality.

Table L Power Requirements for Treatment Options

Units	Option 1 (Sea Water)	Option 2 (Surface Water)
Kilowatts/ day	320	80

Power consumption is a critical criterion on the selection of the treatment system. Special care has to be given to power requirements during detailed engineering.

8.2 Option Ranking

Table M presents the summary of the option assessment for the water treatment system.

Table M Treatment Options Assessment

	Product Water Quality	Capital Expenditure (1)	Operational Expenditure (1)	Power Requirements (3)	Footprint (2)	Ease of Operation (3)	Score
Option 1 (Desalinization Plant)	Sufficient	0	5	0	0	5	20
Option 2 (Surface water Plant)	Sufficient	10	5	5	10	10	80

The maximum score value is 100. A higher score means better performance of the system against the predefined criteria.

The preferred option for water treatment based on pre-defined criteria is Option 2, using surface water (i.e. Station Creek) as a source.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The following conclusions summarize the findings of water supply study.

9.1.1 Design Basis

- the Station has capacity for 60 persons. Future water supply options have been developed to provide a water system that meets the demand of this population (design demand);
- based on historical population and water use data, the average daily demand for the Station is 335 L/person/day. This demand is similar to typical Canadian domestic water demand; and
- the water treatment system must meet CDWQG.

9.1.2 Existing System Assessment

- Station Creek is an adequate water source to meet the design demand and is considered treatable;
- the reservoir has an over winter capacity for about 17 persons and is therefore undersized to meet the design demand;
- the water treatment system is able to supply up to 170 L/day of drinking water;
- the existing water conveyance system is adequate for the existing reservoir, but will need to be upgraded to meet the design demand; and
- the existing fire water storage system has adequate storage to meet the NFPA requirements.

9.1.3 Options Assessment

Source

Alternative water sources (Black Top Creek and seawater from the Slidre Fjord) were assessed and compared to Station Creek. It was concluded that Station Creek is the preferred water source for the Station.

Storage

Options for provision of a traditional earthworks reservoir were developed and assessed.

The following preliminary options were considered for providing additional water storage:

- dredging the existing reservoir;

- raising the berms or deepening the floor of the existing reservoir;
- laterally expanding the footprint of the existing reservoir;
- constructing a second reservoir; and
- decommissioning the existing reservoir and constructing a new reservoir.

Of the above options only raising the berms of the existing reservoir and construction a new reservoir were considered feasible for further analysis.

Raising the berms for the existing reservoir would increase the reservoir capacity but would not provide the design storage. Therefore, two interim reservoir rehabilitation options were developed for consideration.

- Option 1 - Increase the stability of the existing reservoir berm; and
- Option 2 - Raise existing reservoir berms.

Option 1 only increases the stability of the reservoir, but does not provide additional capacity. The estimated construction cost for this option is $2,165,000. Option 2 would increase stability of the reservoir berms and increase the over winter capacity to meet the demand of approximately 29 persons. The construction cost estimate for this option is $8,991,000.

Three options for constructing a new full capacity reservoir were developed for analysis. These options include:

- Option 3 – Construct a new reservoir north of the existing reservoir;
- Option 4 – Construct a new reservoir west of Station Creek; and
- Option 5 – Construct a new reservoir east of the Station.

There are many considerations and constraints related to the construction of a new reservoir. The construction cost estimates were all in the range of $12,500,000. Based on this assessment, Option 5 was considered to be the preferred reservoir option; however, the rankings are sufficiently close that all 3 Options should be investigated further.

Treatment

Water treatment systems were evaluated to meet the design demand by treating surface water or saline water. The assessment concluded that Station Creek is the preferred water source. The preferred treatment option is to treat only the drinking water portion of the demand (i.e. 2 m^3/day) to meet drinking water quality criteria and treat water for use as non-potable utility water using softening and multimedia filtration only (i.e. 18 m^3/day).

9.1.4 Overall Preferred System

The study concluded that the overall preferred water supply system for the Station is to use Station Creek as a source and ion exchange, multimedia filtration, membranes and chlorination as the technologies for the water treatment system. The preferred storage reservoir appears to be Option 5, but the rankings were sufficiently close to warrant further investigation of Option 3 and 4.

It should be noted that the cost of treating water is considerably less than the construction cost of a new earthworks reservoir. Therefore, further consideration of treating sea water is warranted. The largest disadvantage to using sea water as a source is the feasibility of constructing an intake structure that would remain ice free during the winter and be adequately protected against ice. If a permanent intake structure is not practical, then some form of water storage would still need to be provided during the winter months and surface water (Station Creek) would, again be the preferred option.

9.2 Recommendations

The following additional assessments and analysis are recommended to ensure a safe and reliable water supply system for the Station.

- refine the design basis water demand by refining future population projections and water use;
- consider implementing water conservation practices at the Station to reduce water demand and storage requirements;
- recommend to the Water Survey of Canada (Environment Canada) that they provide a hydrometric gauging station at Station Creek to confirm available flow estimates and track the trends in flow;
- implement interim reservoir rehabilitation Option 1 to increase the reliability of existing reservoir;
- refine the reservoir option analysis including:
  - additional geotechnical investigations to confirm the subsurface materials;
  - assessment of conflicts with existing and potential Station infrastructure;
  - additional topographic survey (Option 4 only);
  - evaluate methods of managing the contamination located immediately west of the existing reservoir;
  - maintaining surface drainage around the proposed and existing reservoirs;
  - provision of new pump house and pipeline routes and feasibility of trucking water or providing a pipeline to convey water from the reservoir to the treatment plant;
  - assess impacts of snow drift formation around the Station; and

  - investigate the potential of intentionally accumulating snow above the reservoir to limit ice formation and increase active storage depths.

- although not considered in this study, it appears that it may be feasible to replace the existing earthworks reservoir with above ground, heated, and insulated water tanks. The tanks could be assembled onsite with minimal equipment and man-power. Further information and cost estimates for these tanks are included in Appendix 1.6. It is important to note that these cost estimates do not include the preparation of a suitable foundation for the tanks. The foundation for such a tank would require considerable earthwork.
- perform a feasibility study and cost estimate for the provision of a permanent sea water intake that could operate throughout the winter.
- if desalination is further pursued as a potential treatment option, a detailed assessment will be required to provide an adequate electrical supply power to the treatment system.
- current operation of the facility includes pre-chlorination, which can lead to the formation of disinfection by-products (DBP) such as halo acetic acids (HAA) and trihalomethanes (THM) in the treated water. During the next design phase, consideration should be given to relocating the chlorine dosing point to a location downstream of the treatment process.

10. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

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Tables

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Table 1

Water Quality Analytical Results: Field-Measured Parameters

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	Temperature (°C)	Electrical Conductivity (at 25°C) (µS/cm)	pH (units)	Comments
WATER RESERVOIR	18-Aug-10	5.9	797	7.49	
F TAP DRINKING WATER	18-Aug-10	21.0	14	7.75	
F TAP NON-DRINKING WATER	18-Aug-10	21.8	863	8.14	
BLACKTOP CREEK	17-Aug-10	9.2	1,083	7.38	
SLIDRE FIORD	17-Aug-10	4.3	41,400	7.85	

NOTES:

1. ***Electrical conductivity values standardized to 25°C (within the limitations of the equipment).***
2. ***--- Denotes parameter not measured.***

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Table 2

Water Quality Analytical Results: Indicator Parameters

PROJECT NO.: C71130000

		PHYSICAL					INDICATORS						CATIONS, ANIONS & ION BALANCE											ORGANIC	NITROGEN PARAMETERS				PHENOLS
Monitoring Station	Date (d-m-y)	EC (µS/cm)	pH (units)	Turbidity (NTU)	Tot Hard as $CaCO_3$ (mg/L)	Tot Alk as $CaCO_3$ (mg/L)	Chloride:D (mg/L)	Sulphate:D (mg/L)	Iron:D (mg/L)	Manganese:D (mg/L)	TDS (mg/L)	TDS-calculated (mg/L)	Calcium:D (mg/L)	Magnesium:D (mg/L)	Potassium:D (mg/L)	Potassium:T (mg/L)	Sodium:D (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Hydroxide (mg/L)	Fluoride:D (mg/L)	Ion Balance (%)	Ion Balance % (%)	DOC (mg/L)	NO_2 as N (mg/L)	NO_3 as N (mg/L)	NO_2+NO_3 as N (mg/L)	Tot Amm N (mg/L)	Phenols (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	6 - 8.5	0.1	---	---	250	500	0.3	0.05	500	500	---	---	---	---	200	---	---	---	---	---	---	---	---	---	---	---	---
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	---	5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.5	---	---	---	1	10	10	---	---
WATER RESERVOIR	15-May-07	---	---	---	1,300	---	---	---	---	---	---	---	334	114	18.5	---	333 [1]	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-09	---	---	---	2,350	---	---	---	---	---	---	---	637	183	26	---	507 [1]	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	292	---	---	---	---	---	482	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	17-Aug-10	792	8.08	3.27 [1]	306	79.3	80.3	207	---	---	544 [1]	---	---	---	---	3.74	---	96.7	<5.0	<5.0	0.118	---	109	2.9	<0.050	<0.050	<0.071	<0.050	<0.0010
F TAP DRINKING WATER	15-May-07	---	---	---	1.7	---	---	---	---	---	---	---	0.4	0.2	0.3	---	12.9	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-09	---	---	---	1,650	---	---	---	---	---	---	---	354	185	25.9	---	817 [1]	---	---	---	---	---	---	---	---	---	---	---	---
	9-Jul-09	---	---	---	112	---	---	---	---	---	524 [1]	---	27.3	10.6	1.7	---	145	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	2.1	---	---	---	---	---	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	18-Aug-10	9.76	7.08	0.1	<1.0	<5.0	1.37	0.8	---	---	23	4.1	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	Low	Low	---	<0.050	<0.050	<0.071	<0.050	<0.0010
(Duplicate)	18-Aug-10	9.97	6.88	0.11 [1]	<1.0	<5.0	1.35	0.78	---	---	18.5	4.2	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	---	Low	---	<0.050	<0.050	<0.071	<0.050	<0.0010
F TAP NON-DRINKING WATER	15-May-07	---	---	---	22.3	---	---	---	---	---	---	---	4.8	2.5	15.8	---	870 [1]	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-09	---	---	---	1,420	---	---	---	---	---	---	---	300	162	24.8	---	909 [1]	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	26.7	---	---	---	---	---	1,510 [1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	18-Aug-10	851	8.19	1.25 [1]	<1.0	76.2	91.3	195	---	---	511 [1]	496	---	---	---	0.63	---	92.9	<5.0	<5.0	0.124	86.2	86.2	---	<0.050	0.357	0.357	---	---
BLACKTOP CREEK	17-Aug-10	1,060	7.88	32.1 [1,2]	468	62.5	75.8	398	<0.050	0.29 [1]	774 [1]	717 [1]	117	42.6	2.6	3.55	42.1	76.3	<5.0	<5.0	0.258	96.1	96.1	<1.0	<0.050	0.196	0.196	---	---
FRESHWATER #1	9-Jul-09	---	---	---	132	---	---	---	---	---	256	---	32.2	12.5	1.7	---	30.1	---	---	---	---	---	---	---	---	---	---	---	---
FRESHWATER #2	9-Jul-09	---	---	---	11.1	---	---	---	---	---	208	---	2.9	0.9	0.2	---	62	---	---	---	---	---	---	---	---	---	---	---	---
SLIDRE FIORD	17-Aug-10	39,300	7.85	2.36 [1]	4,600	93.6	15,500 [1]	2,070 [1]	0.145	<0.010	27,300 [1]	27,000 [1]	303	933	289	332	7,820 [1]	114	<5.0	<5.0	<5.0	91.1	91.1	1.3	<5.0	<5.0	<7.1	---	---
WATER TANK	9-Jul-09	---	---	---	275	---	---	---	---	---	432	---	66.6	26.4	3.4	---	69.2	---	---	---	---	---	---	---	---	---	---	---	---
FIELD BLANK	18-Aug-10	0.5	5.94 [1]	<0.10	---	<5.0	<0.50	<0.50	---	---	<5.0	---	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	---	---	---	<0.050	<0.050	<0.071	---	---
TRIP BLANK	18-Aug-10	0.62	5.8 [1]	<0.10	---	<5.0	<0.50	<0.50	---	---	<5.0	---	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	---	---	---	<0.050	<0.050	<0.071	---	---
Relative Percent Difference (RPD) Report																													
F TAP DRINKING WATER	18-Aug-10	9.76	7.08	0.1	<1.0	<5.0	1.37	0.8	---	---	23	4.1	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	Low	Low	---	<0.050	<0.050	<0.071	<0.050	<0.0010
(Duplicate)	18-Aug-10	9.97	6.88	0.11 [1]	<1.0	<5.0	1.35	0.78	---	---	18.5	4.2	---	---	---	<0.50	---	<5.0	<5.0	<5.0	<0.050	---	Low	---	<0.050	<0.050	<0.071	<0.050	<0.0010
RPD(%)		2.13%	2.87%	9.52%	---	---	1.47%	2.53%	---	---	21.69%	2.41%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)
4. *Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)

Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.

Turbidity

The turbidity MAC guidelines presented in HC (2008) are for waterworks systems that use a surface water source or a groundwater. source under the direct influence of surface water. HC (2003) provides guidance for secure groundwater sources. Secure groundwater sources are those not under the direct influence of surface water where turbidity is likely. non-organic and should not pose a health threat or hinder disinfection. HC (2003) also states that turbidity at 5.0 NTU or greater becomes visually apparent and is likely unacceptable to consumers. WorleyParsons has thus adopted a MAC of 5.0 NTU for individual residential water supply wells.

NO_2 as N

The CDWQ guideline for NO_2 (10 mg/L) was converted to NO2 as N (1 mg/L).

NO_3 as N

The CDWQ guideline for NO_3 (45 mg/L) was converted to NO3 as N (10 mg/L).

NO_2+NO_3 as N

The CDWQ guideline for NO_2+NO_3 (45 mg/L) was converted to NO2+NO3 as N (10 mg/L).

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Table 3

Water Quality Analytical Results: Hydrocarbon Parameters

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	BTEX						SELECT HYDROCARBONS				
		Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylene-m&p (mg/L)	Xylene-o (mg/L)	Xylenes-Total (mg/L)	PHC F1 (C_6-C_{10}) (mg/L)	PHC F1 (C_6-C_{10})-BTEX (mg/L)	PHC F2 ($C_{>10}$-C_{16}) (mg/L)	PHC F3 ($C_{>16}$-C_{34}) (mg/L)	PHC F4 ($C_{>34}$-C_{50+}) (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	0.024	0.0024	---	---	0.3	---	---	---	---	---
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		0.005	---	---	---	---	---	---	---	---	---	---
WATER RESERVOIR	15-May-07	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
	10-Apr-08	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
	17-Aug-10	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00010	<0.10	<0.10	<0.25	<0.25	<0.25
F TAP DRINKING WATER	15-May-07	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
	10-Apr-08	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00071	<0.10	<0.10	<0.25	<0.25	<0.25
(Duplicate)	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00010	---	<0.00010	---	---	---	---	---
F TAP NON-DRINKING WATER	15-May-07	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
	10-Apr-08	<0.001	<0.001	<0.001	---	---	<0.001	---	---	---	---	---
FIELD BLANK	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00010	---	<0.00010	---	---	---	---	---
TRIP BLANK	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00010	---	<0.00010	---	---	---	---	---
Relative Percent Difference (RPD) Report												
F TAP DRINKING WATER	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00071	<0.10	<0.10	<0.25	<0.25	<0.25
(Duplicate)	18-Aug-10	<0.00010	<0.00010	<0.00010	<0.00010	---	<0.00010	---	---	---	---	---
RPD(%)		---	---	---	---	---	---	---	---	---	---	---

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)
4. *Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)

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Table 4a

Water Quality Analytical Results: Dissolved Metals Parameters

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	DISSOLVED METALS AND TRACE ELEMENTS													
		Aluminum:D (mg/L)	Antimony:D (mg/L)	Arsenic:D (mg/L)	Barium:D (mg/L)	Boron:D (mg/L)	Cadmium:D (mg/L)	Chromium:D (mg/L)	Copper:D (mg/L)	Lead:D (mg/L)	Mercury:D (mg/L)	Selenium:D (mg/L)	Silver:D (mg/L)	Uranium:D (mg/L)	Zinc:D (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		**0.1**	**---**	**---**	**---**	**---**	**---**	**---**	**1**	**---**	**---**	**---**	**---**	**---**	**5**
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		**---**	**0.006**	**0.01**	**1**	**5**	**0.005**	**0.05**	**---**	**0.01**	**0.001**	**0.01**	**---**	**0.02**	**---**
BLACKTOP CREEK	17-Aug-10	0.1	<0.00050	<0.00050	0.0267	<0.050	<0.00020	<0.0050	0.0012	<0.00010	<0.00010	<0.0020	<0.0050	<0.00050	<0.050
SLIDRE FIORD	17-Aug-10	<0.10	<0.0080	**0.0461** [2]	0.0118	3.13	<0.0010	0.028	0.016	<0.0020	<0.00010	<0.040	<0.0050	0.0023	0.07

NOTES:

1. *--- in guideline row(s) denotes no criteria for that parameter.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal -Provincial-Territorial Committee on Health and the Environment. May 2008.)
4. *Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal -Provincial-Territorial Committee on Health and the Environment. May 2008.)

Aluminum:D

This is an operational guideline, designed to apply only to drinking water treatment plants using aluminum-based coagulates.
The operational guideline value of 0.1 mg/L applies to conventional treatment plants.
The operational guideline value of 0.2 mg/L applies to other types of treatment systems.

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Table 4b

Water Quality Analytical Results: Total Metals Parameters

PROJECT NO.: C71130000

TOTAL METALS AND TRACE ELEMENTS

Monitoring Station	Date (d-m-y)	Aluminum:T (mg/L)	Antimony:T (mg/L)	Arsenic:T (mg/L)	Barium:T (mg/L)	Beryllium:T (mg/L)	Bismuth:T (mg/L)	Boron:T (mg/L)	Cadmium:T (mg/L)	Calcium:T (mg/L)	Chromium:T (mg/L)	Cobalt:T (mg/L)	Copper:T (mg/L)	Iron:T (mg/L)	Lead:T (mg/L)	Lithium:T (mg/L)	Magnesium:T (mg/L)	Manganese:T (mg/L)	Mercury:T (mg/L)	Molybdenum:T (mg/L)	Nickel:T (mg/L)	Selenium:T (mg/L)	Silicon:T (mg/L)	Silver:T (mg/L)	Sodium:T (mg/L)	Strontium:T (mg/L)	Thallium:T (mg/L)	Tin:T (mg/L)	Titanium:T (mg/L)	Uranium:T (mg/L)	Vanadium:T (mg/L)	Zinc:T (mg/L)	Cesium:T (mg/L)	Rubidium:T (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		**0.1**	---	---	---	---	---	---	---	---	---	---	**1**	**0.3**	---	---	---	**0.05**	---	---	---	---	---	---	**200**	---	---	---	---	---	---	**5**	---	---
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	**0.006**	**0.01**	**1**	---	---	**5**	**0.005**	---	**0.05**	---	---	---	**0.01**	---	---	---	**0.001**	---	---	**0.01**	---	---	---	---	---	---	---	---	**0.02**	---	---	---	---
WATER RESERVOIR	15-May-07	<0.03	---	---	0.0781	<0.0001	---	0.233	0.0003	---	0.0003	0.0006	0.0016	0.0536	0.0002	---	---	0.0182	---	0.0006	0.0035	---	2.51	<0.0001	---	1.34	<0.0001	---	0.0014	---	0.0003	<0.01	---	---
	10-Apr-08	0.0092	---	---	0.0657	<0.0001	---	0.103	<0.00005	---	0.0002	0.0004	0.022	<0.05	0.0001	---	---	0.0347	---	0.0006	0.003	---	2.27	<0.0001	---	1.18	<0.0001	---	0.001	---	<0.0001	0.0039	---	---
	7-May-09	0.03	0.0002	0.0007	0.105	<0.0001	---	0.218	<0.0001	---	0.0003	0.0008	0.0142	0.036	0.0001	0.057	---	0.0175	---	0.0008	0.0057	0.0045	---	<0.0001	---	2.12	<0.0001	---	0.001	0.0034	0.0003	<0.005	<0.0001	0.0046
	6-May-10	0.0044	<0.0001	<0.0002	0.019	<0.0001	---	---	<0.00005	---	<0.0001	<0.0001	0.0282	<0.005	<0.0001	0.0094	---	0.0071	---	0.0001	0.0007	0.0006	---	<0.0001	---	0.288	<0.0001	---	0.0001	0.0003	<0.0001	0.0019	<0.0001	0.0009
	17-Aug-10	**0.215** [1]	<0.00040	<0.00040	0.0196	<0.0010	<0.00020	0.042	<0.00020	71.6	0.00107	0.00033	0.0012	0.192	0.00015	---	31	0.0095	<0.00010	0.00014	0.00278	0.0021	---	<0.00040	61.9	0.276	<0.00010	<0.00040	0.0066	0.00042	0.00072	0.0084	---	---
F TAP DRINKING WATER	15-May-07	0.0009	---	---	<0.0001	<0.0001	---	0.149	<0.00005	---	<0.0001	<0.0001	0.0101	<0.05	0.0003	---	---	<0.0001	---	<0.0001	0.0034	---	0.07	<0.0001	---	0.0004	<0.0001	---	<0.0001	---	<0.0001	0.413	---	---
	10-Apr-08	0.0019	---	---	0.0027	<0.0001	---	0.092	<0.00005	---	0.001	<0.0001	0.0297	<0.05	0.0057	---	---	<0.0001	---	0.0003	0.0013	---	0.05	0.0001	---	0.0007	<0.0001	---	<0.0001	---	<0.0001	0.819	---	---
	7-May-09	0.0161	0.0002	0.0009	0.058	<0.0001	---	0.222	<0.00005	---	0.0003	0.0005	0.415	0.014	0.0001	0.0691	---	0.0147	---	0.001	0.0093	0.0065	---	<0.0001	---	1.12	<0.0001	---	0.0018	0.0033	0.0002	0.648	<0.0001	0.0053
	9-Jul-09	0.046	<0.0002	0.0002	0.0054	<0.0001	---	---	<0.0001	---	0.0002	<0.0001	0.0652	0.101	0.0001	0.0037	---	0.0036	---	0.0002	0.0007	0.0005	---	<0.0001	---	0.0898	<0.0001	---	0.0007	0.0003	0.0002	0.047	<0.0001	0.0004
	6-May-10	0.0012	<0.0001	<0.0002	0.0003	<0.0001	---	---	0.00009	---	0.0001	<0.0001	0.0096	<0.005	0.0007	0.0006	---	0.0002	---	0.0002	0.0005	<0.0003	---	<0.0001	---	0.0022	<0.0001	---	0.0001	<0.0001	0.0001	0.07	<0.0001	<0.0001
	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	0.039	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.00010	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	1.9	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
(Duplicate)	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	0.04	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.00010	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	2.1	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
F TAP NON-DRINKING WATER	15-May-07	0.0114	---	---	0.0013	<0.0001	---	0.206	<0.00005	---	0.0002	<0.0001	0.216	<0.05	0.0004	---	---	0.0016	---	0.0006	0.0019	---	2.24	<0.0001	---	0.0181	<0.0001	---	0.0004	---	<0.0001	0.0131	---	---
	10-Apr-08	0.0053	---	---	0.0165	<0.0001	---	0.0992	<0.00005	---	0.0003	0.0001	0.134	<0.05	0.0012	---	---	0.0092	---	0.0008	0.0015	---	2.04	<0.0001	---	0.28	<0.0001	---	0.0008	---	<0.0001	0.109	---	---
	7-May-09	0.0222	0.0001	0.0007	0.046	<0.0001	---	0.215	<0.00005	---	0.0003	0.0004	0.64	0.024	0.0002	0.0604	---	0.0127	---	0.0007	0.0055	0.0062	---	<0.0001	---	0.87	<0.0001	---	0.0015	0.0032	0.0001	0.33	<0.0001	0.0042
	6-May-10	0.007	<0.0001	0.0003	0.0027	<0.0001	---	---	<0.00005	---	0.0002	<0.0001	0.371	0.012	0.0003	0.0317	---	0.0037	---	0.0003	0.0024	0.0012	---	<0.0001	---	0.0393	<0.0001	---	0.0004	0.0009	<0.0001	0.0656	<0.0001	0.0019
	18-Aug-10	0.066	<0.00040	<0.00040	0.00032	<0.0010	<0.00020	0.043	<0.00020	<0.50	<0.00080	<0.00020	0.0824	0.051	0.0002	---	<0.10	<0.0020	<0.00010	<0.00010	0.00033	<0.0020	---	<0.00040	162	0.00106	<0.00010	<0.00040	<0.0050	0.00029	<0.00050	0.0115	---	---
BLACKTOP CREEK	17-Aug-10	**9.44** [1]	<0.00040	0.00202	0.0394	0.0014	<0.00020	0.031	<0.00020	124	0.00596	0.0204	0.0119	**7.67** [1]	0.00156	---	51.2	**0.408** [1]	<0.00010	0.00019	0.05	0.0032	---	<0.00040	49.2	0.377	<0.00010	<0.00040	0.116	0.00164	0.00562	0.13	---	---
FRESHWATER #1	9-Jul-09	0.064	<0.0002	<0.0002	0.0064	<0.0001	---	---	<0.0001	---	0.0002	<0.0001	0.0066	0.151	<0.0001	0.0041	---	0.0051	---	0.0001	0.0006	<0.0005	---	<0.0001	---	0.112	<0.0001	---	0.0013	0.0002	0.0003	<0.005	<0.0001	0.0005
FRESHWATER #2	9-Jul-09	0.017	<0.0001	<0.0002	0.0022	<0.0001	---	---	<0.00005	---	<0.0001	<0.0001	0.0133	0.01	0.0001	0.0009	---	0.0005	---	<0.0001	0.0016	<0.0003	---	<0.0001	---	0.0072	<0.0001	---	0.0003	<0.0001	<0.0001	0.0558	<0.0001	<0.0001
SLIDRE FIORD	17-Aug-10	**0.43** [1]	<0.0080	<0.080	0.0165	<0.020	<0.0040	3.65	<0.0010	336	0.025	<0.0040	<0.020	**0.41** [1]	<0.0020	---	1,040	<0.040	<0.00010	0.0056	0.0084	<0.40	---	<0.0020	**8,750** [1]	5.91	<0.0020	<0.0080	<0.012	0.0025	<0.10	<0.080	---	---
WATER TANK	9-Jul-09	0.065	<0.0002	0.0002	0.0134	<0.0001	---	---	<0.0001	---	0.0002	<0.0001	0.0098	0.131	0.0001	0.0081	---	0.0048	---	0.0001	0.002	<0.0005	---	<0.0001	---	0.25	<0.0001	---	0.0013	0.0003	0.0003	0.094	<0.0001	0.0007
FIELD BLANK	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	<0.020	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.0001	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	<1.0	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
TRIP BLANK	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	<0.020	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.0001	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	<1.0	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
Relative Percent Difference (RPD) Report																																		
F TAP DRINKING WATER	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	0.039	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.00010	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	1.9	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
(Duplicate)	18-Aug-10	<0.020	<0.00040	<0.00040	<0.00020	<0.0010	<0.00020	0.04	<0.00020	<0.50	<0.00080	<0.00020	<0.0010	<0.010	<0.00010	---	<0.10	<0.0020	<0.00010	<0.00010	<0.00020	<0.00040	---	<0.00040	2.1	<0.00020	<0.00010	<0.00040	<0.0050	<0.00010	<0.00050	<0.0040	---	---
RPD(%)		---	---	---	---	---	---	**2.53%**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**10.00%**	---	---	---	---	---	---	---	---	---

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)
4. *Superscript 2 denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)

Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (CCME, 1999 and Updates, last update v7 2007)

Aluminum:T
- *0.005 mg/L pH<6.5; [Ca2+]<4.0 mg/L; DOC<2.0 mg/L.*
- *0.1 mg/L pH>6.5; [Ca2+]>4.0 mg/L; DOC>2.0 mg/L.*

Cadmium:T
- *10^{0.86[log(hardness)]-3.2}.*

Chromium:T
- *Limit is for Trivalent Chromium.*
- *Limit is for Trivalent Chromium.*

Copper:T
- *0.002 mg/L Hardness($CaCO_3$) = 0-120 mg/L.*
- *0.003 mg/L Hardness($CaCO_3$) = 120-180 mg/L.*
- *0.004 mg/L Hardness($CaCO_3$) = >180 mg/L.*

Lead:T
- *0.001 mg/L Hardness($CaCO_3$) = 0-60 mg/L.*
- *0.002 mg/L Hardness($CaCO_3$) = 60-120 mg/L.*
- *0.004 mg/L Hardness($CaCO_3$) = 120-180 mg/L.*
- *0.007 mg/L Hardness($CaCO_3$) = >180 mg/L.*

Nickel:T
- *0.025 mg/L Hardness($CaCO_3$) = 0-60 mg/L.*
- *0.065 mg/L Hardness($CaCO_3$) = 60-120 mg/L.*
- *0.110 mg/L Hardness($CaCO_3$) = 120-180 mg/L.*
- *0.150 mg/L Hardness($CaCO_3$) = >180 mg/L.*

Mercury:T
- *Measures only inorganic Mercury.*

Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.

Aluminum:T
- *This is an operational guideline, designed to apply only to drinking water treatment plants using aluminum-based coagulates.*
- *The operational guideline value of 0.1 mg/L applies to conventional treatment plants.*
- *The operational guideline value of 0.2 mg/L applies to other types of treatment systems.*

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Table 5

Water Quality Analytical Results: Volatile Organic Compounds

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	VOCS																																				
		1,1,1,2-Tetrachloroethane (mg/L)	1,1,1-Trichloroethane (mg/L)	1,1,2,2-Tetrachloroethane (mg/L)	1,1,2-Trichloroethane (mg/L)	1,1-Dichloroethane (mg/L)	1,1-Dichloroethene (mg/L)	1,1-Dichloropropene (mg/L)	1,2,3-Trichlorobenzene (mg/L)	1,2,3-Trichloropropane (mg/L)	1,2,4-Trichlorobenzene (mg/L)	1,2,4-Trimethylbenzene (mg/L)	1,2-Dibromo-3-Chloropropane (mg/L)	1,2-Dibromoethane (mg/L)	1,2-Dichlorobenzene (mg/L)	1,2-Dichloroethane (mg/L)	1,2-Dichloroethene (mg/L)	1,2-Dichloropropane (mg/L)	1,3,5-Trimethylbenzene (mg/L)	1,3-Dichlorobenzene (mg/L)	1,3-Dichloropropane (mg/L)	1,4-Dichloro-2-Butene (TRANS) (mg/L)	1,4-Dichlorobenzene (mg/L)	2,2-Dichloropropane (mg/L)	2-Butanone (mg/L)	2-Chloroethyl vinyl ether (mg/L)	2-Chlorotoluene (mg/L)	2-Hexanone (mg/L)	4-Chlorotoluene (mg/L)	4-Methyl-2-Pentanone (mg/L)	Acetone (mg/L)	Acetonitrile (mg/L)	Acrylonitrile (mg/L)	Benzene (VOC) (mg/L)	Bromobenzene (mg/L)	Bromochloromethane (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	---	---	---	---	---	---	---	---	---	---	---	---	---	**0.003**	---	---	---	---	---	---	---	**0.001**	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	---	---	---	---	**0.014**	---	---	---	---	---	---	---	**0.2**	**0.005**	---	---	---	---	---	---	**0.005**	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER RESERVOIR	15-May-07	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	10-Apr-08	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	17-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
F TAP DRINKING WATER	15-May-07	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	10-Apr-08	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
(Duplicate)	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
F TAP NON-DRINKING WATER	15-May-07	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	10-Apr-08	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.001	<0.01	<0.025	<0.001	<0.001	<0.025	<0.001	<0.025	<0.025	<0.025	<0.025	---	<0.001	<0.001
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FRESHWATER #1	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FRESHWATER #2	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER TANK	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FIELD BLANK	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
TRIP BLANK	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
Relative Percent Difference (RPD) Report																																						
F TAP DRINKING WATER	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
(Duplicate)	18-Aug-10	---	---	---	---	---	<0.0010	---	---	---	---	---	---	---	<0.00020	<0.0010	---	---	---	---	---	---	<0.00020	---	---	---	---	---	---	---	---	---	---	---	<0.00010	---	---
RPD(%)		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTES:

1. ***--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.***
2. ***Highlighting indicates parameters above applied guideline/criteria.***
3. ***Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)***
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)
4. ***Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)***
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)

Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.
1,2-Dichlorobenzene
In cases where total dichlorobenzenes are measured and concentrations exceed the most stringent.
value (0.005 mg/L), the concentrations of the individual isomers should be established.

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Table 5

Water Quality Analytical Results: Volatile Organic Compounds

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	Bromomethane (mg/L)	Chlorobenzene (mg/L)	Chloroethane (mg/L)	Chloromethane (mg/L)	Cis-1,2-Dichloroethene (mg/L)	Cis-1,3-Dichloropropylene (mg/L)	Cis-1,4-Dichloro-2-Butene (mg/L)	Dibromomethane (mg/L)	Dichlorodifluoromethane (mg/L)	Dichloromethane (mg/L)	Ethyl Methacrylate (mg/L)	Ethylbenzene (VOC) (mg/L)	Hexachlorobutadiene (mg/L)	Hexachloroethane (mg/L)	Iodomethane (mg/L)	iso-Propylbenzene (mg/L)	Methyl-t-Butyl Ether (mg/L)	n-Butylbenzene (mg/L)	n-Propylbenzene (mg/L)	p-Isopropyltoluene (mg/L)	sec-Butylbenzene (mg/L)	Styrene (mg/L)	tert-Butylbenzene (mg/L)	Tetrachloroethene (mg/L)	Toluene (VOC) (mg/L)	Trans-1,2-Dichloroethylene (mg/L)	Trans-1,3-Dichloropropylene (mg/L)	Trichloroethene (mg/L)	Vinyl Chloride (mg/L)	Xylene-o (VOC) (mg/L)	TRIHALOMETHANES: Bromodichloromethane (mg/L)	Chlorodibromomethane (mg/L)	Dibromochloromethane (mg/L)	Tribromomethane (mg/L)	Trichlorofluoromethane (mg/L)	Trichloromethane (mg/L)	Trihalomethanes (mg/L)
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	**0.03**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**0.015**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	**0.08**	---	---	---	---	---	---	---	**0.05**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**0.03**	---	---	---	**0.005**	**0.002**	---	**0.016**	---	---	---	---	---
WATER	15-May-07	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	<0.001	---	<0.001	<0.001	<0.001	<0.001	0.000005
	10-Apr-08	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.001
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	<0.005	<0.005	---	<0.005	<0.005
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	<0.005	<0.005	---	<0.005	<0.005
	17-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	<0.00050	<0.00060	<0.00060	<0.00060	---	<0.00050	<0.0050
F TAP	15-May-07	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	<0.001	---	<0.001	<0.001	<0.001	<0.001	<0.000001
	10-Apr-08	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	0.001	---	0.003	0.004	<0.001	<0.001	0.008
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	<0.005	<0.005	---	<0.005	<0.005
	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.01	---	0.027	0.052	---	<0.005	0.092
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	0.008	0.01	---	<0.005	0.024
	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	0.0131	0.0213	0.0213	0.0145	---	0.0082	0.0571
(Duplicate)	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	0.0135	0.0226	0.0226	0.0144	---	0.008	0.0585
F TAP	15-May-07	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	<0.001	---	<0.001	<0.001	<0.001	<0.001	0.000107
	10-Apr-08	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.025	<0.001	<0.01	<0.005	<0.025	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	<0.001	<0.001	<0.001	<0.002	---	0.003	---	0.018	0.072	<0.001	0.001	0.085
	7-May-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	0.012	0.037	---	<0.005	0.052
	6-May-10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.006	---	0.026	0.068	---	<0.005	0.101
FRESHWATER	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	<0.005	<0.005	---	<0.005	<0.005
FRESHWATER	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.005	---	<0.005	---	---	<0.005	<0.005
WATER	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.011	---	0.032	0.063	---	<0.005	0.111
FIELD	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	<0.0010	<0.00060	<0.0010	<0.0050	---	0.0026	<0.0050
TRIP	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	<0.0010	<0.00060	<0.0010	<0.0050	---	0.0037	<0.0050
(Duplicate)	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	0.0131	0.0213	0.0213	0.0145	---		0.0571
	18-Aug-10	---	<0.00010	---	---	---	---	---	---	---	<0.0010	---	<0.00010	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	<0.0010	<0.00010	---	---	<0.0010	<0.00050	<0.00020	0.0135	0.0226	0.0226	0.0144	---		0.0585
																																								2.42%

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
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Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.

1,2-Dichlorobenzene

In cases where total dichlorobenzenes are measured and concentrations exceed the most stringent.
value (0.005 mg/L), the concentrations of the individual isomers should be established.

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Table 6

Water Quality Analytical Results: Pesticides & Herbicides

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	PESTICIDE																												
		a-Chlordane (mg/L)	Aldicarb (mg/L)	Aldrin (mg/L)	Allyl Chloride (mg/L)	Bendiocarb (mg/L)	Carbaryl (mg/L)	Carbofuran (mg/L)	Chlordane (mg/L)	Chlorpyrifos (mg/L)	DDT-O,P' (mg/L)	Diazinon (mg/L)	Dieldrin (mg/L)	Dimethoate (mg/L)	Diquat (mg/L)	g-Chlordane (mg/L)	Heptachlor (mg/L)	Heptachlor Epoxide (mg/L)	Lindane (mg/L)	Malathion (mg/L)	Methacrylonitrile (mg/L)	Methoxychlor (mg/L)	Methyl Methacrylate (mg/L)	Parathion (mg/L)	Pentachloroethane (mg/L)	Phorate (mg/L)	Prometryn (mg/L)	Propionitrile (mg/L)	Terbufos (mg/L)
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	**0.009**	---	---	**0.04**	**0.09**	**0.09**	---	**0.09**	---	---	---	---	**0.07**	---	---	---	---	---	---	---	**0.9**	---	---	---	---	---	---	---
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER RESERVOIR	15-May-07	---	---	---	<0.025	---			---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	<0.025	---	<0.001	---	---	<0.025	---
	10-Apr-08	---	---	---	<0.025	---			---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	<0.025	---	<0.001	---	---	<0.025	---
	17-Aug-10	<0.00010	<0.00090	<0.000020	---	<0.0070	<0.0090	<0.012	<0.00070	<0.0090	<0.00050	<0.0020	<0.000050	<0.0025	<0.0070	<0.00020	<0.00010	<0.00010	<0.00040	<0.019	---	<0.09	---	<0.0050	---	<0.00050	<0.00025	---	<0.0010
F TAP DRINKING WATER	15-May-07	---	---	---	<0.025	---			---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	<0.025	---	<0.001	---	---	<0.025	---
	10-Apr-08	---	---	---	<0.025	---			---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	<0.025	---	<0.001	---	---	<0.025	---
	18-Aug-10	<0.00010	<0.00090	<0.000020	---	<0.0070	<0.0090	<0.012	<0.00070	<0.0090	<0.00050	<0.0020	<0.000050	<0.0025	<0.0070	<0.00020	<0.00010	<0.00010	<0.00040	<0.019	---	<0.09	---	<0.0050	---	<0.00050	<0.00025	---	<0.0010
F TAP NON-DRINKING WATER	15-May-07	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	---	---	---	---	---
	10-Apr-08	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<0.025	---	---	---	---	---	---

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
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3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
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Table 6

Water Quality Analytical Results: Pesticides & Herbicides

PROJECT NO.: C71130000		HERBICIDE											
Monitoring Station	Date (d-m-y)	Alachlor (mg/L)	Atrazine and metabolites (mg/L)	Cyanazine (mg/L)	Diuron (mg/L)	Glyphosate (mg/L)	Oxychlordane (mg/L)	Metolachlor (mg/L)	Metribuzin (mg/L)	Simazine (mg/L)	Treflan D14 (%)	Triallate (mg/L)	Trifluralin (mg/L)
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		---	**0.005**	**0.01**	**0.15**	**0.28**	---	---	---	**0.01**	---	---	**0.045**
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		---	---	---	---	---	---	---	---	---	---	---	---
WATER RESERVOIR	15-May-07	---	---	---	---	---	---	---	---	---	---	---	---
	10-Apr-08	---	---	---	---	---	---	---	---	---	---	---	---
	17-Aug-10	<0.00050	<0.00050	<0.0010	<0.015	<0.028	<0.00040	<0.0050	<0.0080	<0.0010	60	<0.023	<0.0045
F TAP DRINKING WATER	15-May-07	---	---	---	---	---	---	---	---	---	---	---	---
	10-Apr-08	---	---	---	---	---	---	---	---	---	---	---	---
	18-Aug-10	<0.00050	<0.00050	<0.0010	<0.015	<0.028	<0.00040	<0.0050	<0.0080	<0.0010	80	<0.023	<0.0045
F TAP NON-DRINKING WATER	15-May-07	---	---	---	---	---	---	---	---	---	---	---	---
	10-Apr-08	---	---	---	---	---	---	---	---	---	---	---	---

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
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3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008)*
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4. *Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial -Territorial Committee on Health and the Environment. May 2008.)

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Table 7

Water Quality Analytical Results: Radiological Parameters

PROJECT NO.: C71130000		ARTIFICIAL RADIONUCLIDES							NATURAL RADIONUCLIDES											
Monitoring Station	Date (d-m-y)	Cesium-134 (Bq/L)	Cesium-137 (Bq/L)	Iodine-125 (Bq/L)	Iodine-131 (Bq/L)	Molybdenum-99 (Bq/L)	Strontium-90 (Bq/L)	Tritium (Bq/L)	Lead-210 (Bq/L)	Radium-224 (Bq/L)	Radium-226 (Bq/L)	Radium-228 (Bq/L)	Radon-222 (Bq/L)	Thorium-228 (Bq/L)	Thorium-230 (Bq/L)	Thorium-232 (Bq/L)	Thorium-234 (Bq/L)	Uranium-234 (Bq/L)	Uranium-235 (Bq/L)	Uranium-238 (Bq/L)
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		**7**	**10**	**10**	**6**	**70**	**5**	**7000**	**0.1**	**2**	**0.6**	**0.5**	**---**	**2**	**0.4**	**0.1**	**20**	**4**	**4**	**4**
WATER RESERVOIR	17-Aug-10	<1	<1	<5	<1	<10	<1	<1000	<0.05	<0.01	<0.01	<0.1	<10	<0.01	<0.01	<0.01	<1	<0.02	<0.01	<0.01
F TAP DRINKING WATER	18-Aug-10	<1	<1	<5	<1	<10	<1	<1000	<0.06	<0.01	<0.01	<0.1	<10	<0.01	<0.01	<0.01	<1	<0.01	<0.01	<0.01

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript 1 denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008)*
   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)

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Table 8

Water Quality Analytical Results: Asbestos

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	Asbestos	Asbestos (mf/L)	Chrysotile (mf/L)	Amosite (mf/L)	Crocidolite (mf/L)	Actinolite-Tremolite (mf/L)	Anthophylite (mf/L)
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)			---	---	---	---	---	---
Canadian Drinking Water AO Guidelines (Health Canada, 2008)			---	---	---	---	---	---
WATER RESERVOIR	17-Aug-10		<0.18	0	0	0	0	0
F TAP DRINKING WATER	18-Aug-10		<0.16	0	0	0	0	0

NOTES:

1. *--- in guideline(s) row denotes no criteria, and in data row(s) indicates parameter not analyzed.*
2. *Highlighting indicates parameters above applied guideline/criteria.*
3. *Superscript [1] denotes values exceeding Canadian Drinking Water AO Guidelines (Health Canada, 2008) (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)*
4. *Superscript [2] denotes values exceeding Canadian Drinking Water MAC Guidelines (Health Canada, 2008) (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)*

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Table 9

Water Quality Analytical Results: Miscellaneous Parameters

PROJECT NO.: C71130000

Monitoring Station	Date (d-m-y)	BACTERIA: E. Coli-MF (mpn/100mL)	BACTERIA: Tot Coliforms-MPN (mpn/100mL)	COLOUR: True Colour (units)	ALDEHYDES: Formaldehyde (mg/L)	ALDEHYDES: Acetaldehyde (mg/L)	PHENOLS: 2,3,4,6-Tetrachlorophenol (mg/L)	PHENOLS: 2,4,6-Tribromophenol (%)	PHENOLS: 2,4,6-Trichlorophenol (mg/L)	PHENOLS: 2,4-Dichlorophenol (mg/L)	PHENOLS: 2-Fluorophenol (%)	PHENOLS: Tetrachloromethane (mg/L)	PHENOXY: 2,4,5-T (mg/L)	PHENOXY: 2,4-D (mg/L)	PHENOXY: 2,4-D D5 (%)	PHENOXY: Bromoxynil (mg/L)	PHENOXY: Dicamba (mg/L)	PHENOXY: Dichlofop-methyl (mg/L)	PHENOXY: Dinoseb (mg/L)	PHENOXY: Pentachlorophenol (mg/L)	PHENOXY: Picloram (mg/L)
Canadian Drinking Water MAC Guidelines (Health Canada, 2008)		**1**	**1**	**---**	**---**	**---**	**0.1**	**---**	**0.005**	**0.9**	**---**	**0.005**	**---**	**0.1**	**---**	**0.005**	**0.12**	**0.009**	**0.01**	**0.06**	**0.19**
Canadian Drinking Water AO Guidelines (Health Canada, 2008)		**---**	**---**	**---**	**---**	**---**	**0.001**	**---**	**0.002**	**0.0003**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**0.03**	**---**
WATER RESERVOIR	15-May-07	---	---	---	---	---	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---	---
	10-Apr-08	<1.0	<1.0	---	---	---	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---	---
	7-May-09	<1.0	**4.1** [1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	17-Aug-10	---	---	3	0.012	<0.010	<0.01	99	<0.00050	<0.09	96	<0.00050	<0.028	<0.01	37	<0.00050	<0.012	<0.00090	<0.0010	<0.0060	<0.019
F TAP DRINKING WATER	15-May-07	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	10-Apr-08	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	7-May-09	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	9-Jul-09	<1	<1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	18-Aug-10	---	---	<2	0.052	<0.010	<0.01	102	<0.00010	<0.00010	96	<0.00050	<0.028	<0.01	37	<0.00050	<0.012	<0.00090	<0.0010	<0.0060	<0.019
(Duplicate)	18-Aug-10	---	---	<2	---	---	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	---	---
F TAP NON-DRINKING WATER	15-May-07	---	---	---	---	---	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---	---
	10-Apr-08	<1.0	<1.0	---	---	---	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---	---
	7-May-09	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	6-May-10	<1.0	<1.0	<2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FRESHWATER #1	9-Jul-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FRESHWATER #2	9-Jul-09	<1	<1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BLACKTOP CREEK	17-Aug-10	---	---	<2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SLIDRE FIORD	17-Aug-10	---	---	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WATER TANK	9-Jul-09	<1	<1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FIELD BLANK	18-Aug-10	---	---	<2	---	---	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	---	---
TRIP BLANK	18-Aug-10	---	---	<2	---	---	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	---	---

Relative Percent Difference (RPD) Report																					
F TAP DRINKING WATER	18-Aug-10	---	---	<2	0.052	<0.010	<0.01	102	<0.00010	<0.00010	96	<0.00050	<0.028	<0.01	37	<0.00050	<0.012	<0.00090	<0.0010	<0.0060	<0.019
(Duplicate)	18-Aug-10	---	---	<2	---	---	---	---	---	---	---	<0.00050	---	---	---	---	---	---	---	---	---
RPD(%)		**---**	**---**	**---**	**---**	**---**															

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   (Health Canada, 2008. Guidelines for Canadian Drinking Water Quality. Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.)
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Figures

Z:\cgis\Projects\Eureka\07_ESRI_Projects\MXD\WORKING\00_PROJECT_OVERVIEW\00-002-004.mxd

ANSIB-MAP-L VERSION: A

520,000

520,500

8,880,500



Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution.

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This map must be printed at full scale (100%) in order for the scale to remain correct.

DRAWN	CHECK	DESIGN	APPR.
YW	RW	YW	HA

Water Supply Study
Site Overview

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
05 OCT 2010	Figure 1.1	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
C71130000	1:2,500	UTM 16N	NAD 83	11 X 17

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Z:\gis\Projects\Eureka\07_ESRI_Projects\MXD\WORKING\00_PROJECT_OVERVIEW\01-003-001.mxd

ANSIB-MAP-P VERSION: A

515,000 520,000 525,000 530,000

8,900,000 8,895,000 8,890,000 8,885,000 8,880,000

N

Black Top Creek

Station Creek

SLIDRE FIORD

Eureka HAWS

Air Strip

Legend

- Stream
- Minor Contour (20 m)
- Major Contour (100 m)
- Black Top Creek Watershed (103.3 km^2)
- Station Creek Watershed (109.6 km^2)

2 1 0 2

Kilometres

Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

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This map must be printed at full scale (100%) in order for the scale to remain correct.

DRAWN	CHECK	DESIGN	APPR.
YW	RW	YW	HA

Water Supply Study
Station Creek and Black Top Creek Watersheds

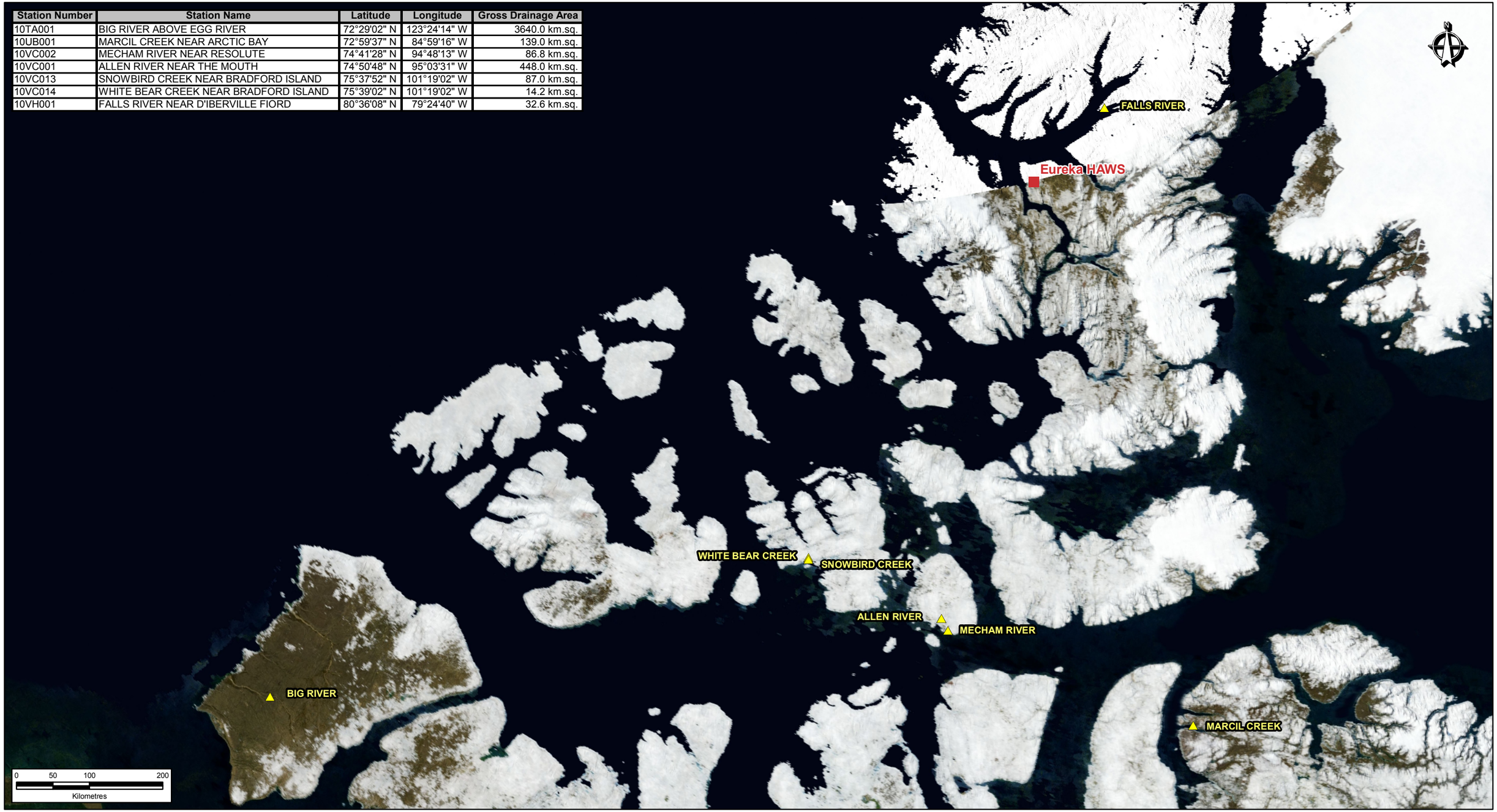
DATE	MAP NUMBER	REV.	CONTRACTOR NAME
05 OCT 2010	Figure 1.2	F	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
C71130000	1:75,000	UTM 16N	NAD 83	11 X 17

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Station Number	Station Name	Latitude	Longitude	Gross Drainage Area
10TA001	BIG RIVER ABOVE EGG RIVER	72°29'02" N	123°24'14" W	3640.0 km.sq.
10UB001	MARCIL CREEK NEAR ARCTIC BAY	72°59'37" N	84°59'16" W	139.0 km.sq.
10VC002	MECHAM RIVER NEAR RESOLUTE	74°41'28" N	94°48'13" W	86.8 km.sq.
10VC001	ALLEN RIVER NEAR THE MOUTH	74°50'48" N	95°03'31" W	448.0 km.sq.
10VC013	SNOWBIRD CREEK NEAR BRADFORD ISLAND	75°37'52" N	101°19'02" W	87.0 km.sq.
10VC014	WHITE BEAR CREEK NEAR BRADFORD ISLAND	75°39'02" N	101°19'02" W	14.2 km.sq.
10VH001	FALLS RIVER NEAR D'IBERVILLE FIORD	80°36'08" N	79°24'40" W	32.6 km.sq.



Z:\cgs\Projects\Eureka\07_ESRI_Projects\MXD\WORKING\01_PROJECT_OVERVIEW\01-003-002.mxd

ANSIB-MAP-L VERSION: A

Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution.

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This map must be printed at full scale (100%) in order for the scale to remain correct.

DRAWN HW
CHECK RW
DESIGN YW
APPR. HA

Water Supply Study
Hydrometric Gauging Station Locations

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
05 OCT 2010	Figure 1.3	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	ORIG. PAGE SIZE
C71130000	1:5,000,000	Lambert Azimuthal Equal Area for North Pole Canada	11 X 17

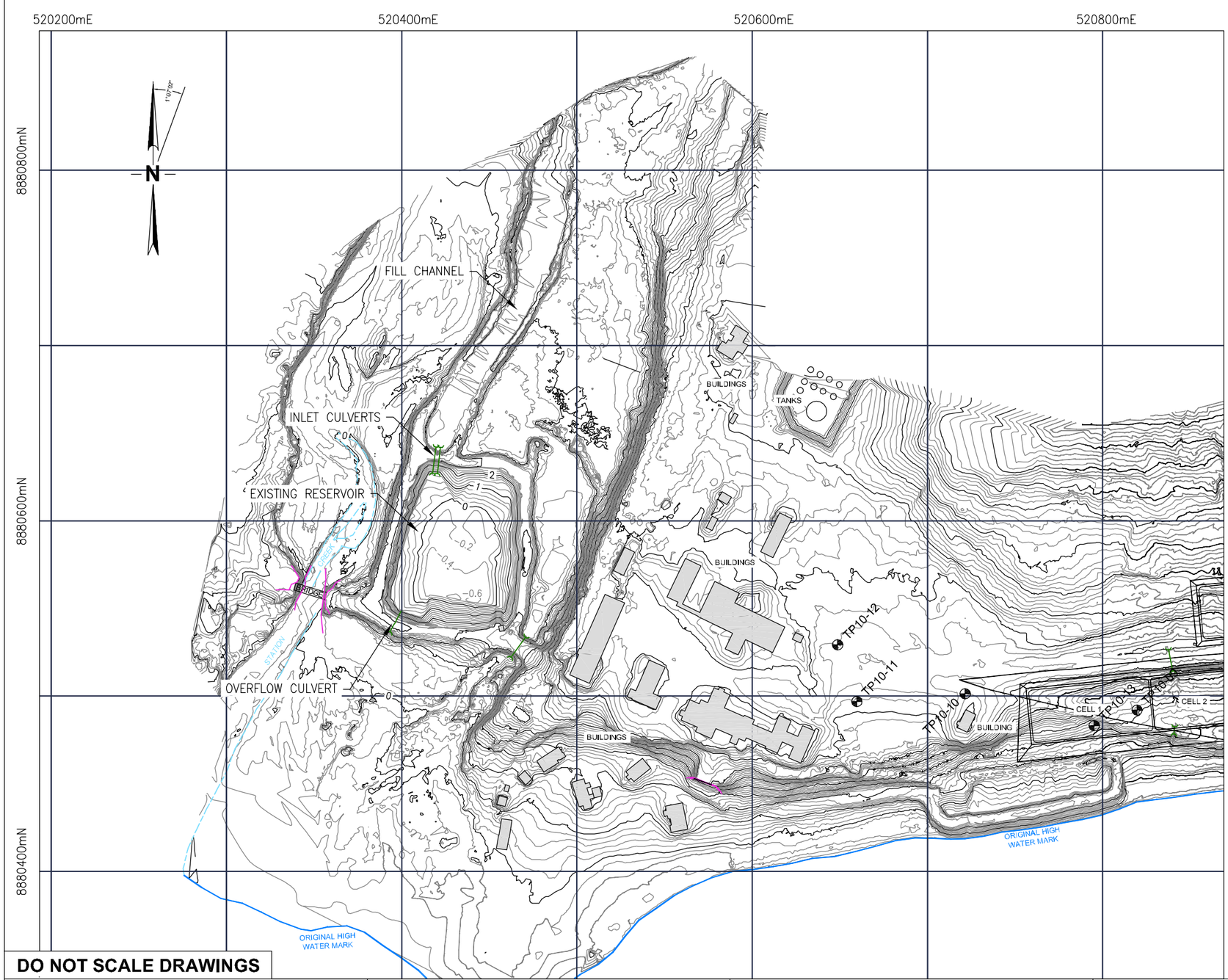
WorleyParsons resources & energy

www.WorleyParsons.com

Drawings

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES / SERVICES IMMOBILIERS
Western Region / Région de l'ouest



Existing Reservoir

DEPTH (m)	ELEV (m)	VOLUME (m^3)	DESCRIPTION
0.0	-0.60	0	DEAD STORAGE (700 m^3)
0.1	-0.50	20	
0.2	-0.40	100	
0.3	-0.30	200	
0.4	-0.20	500	
0.5	-0.10	700	
0.6	0.00	900	ACTIVE STORAGE (2,100 m^3)
0.7	0.10	1,100	
0.8	0.20	1,400	
0.9	0.30	1,700	
1.0	0.40	2,000	
1.1	0.50	2,400	
1.2	0.60	2,800	
1.3	0.70	3,100	ICE ALLOWANCE (10,000 m^3)
1.4	0.80	3,500	
1.5	0.90	4,000	
1.6	1.00	4,400	
1.7	1.10	4,900	
1.8	1.20	5,300	
1.9	1.30	5,800	
2.0	1.40	6,300	
2.1	1.50	6,800	
2.2	1.60	7,300	
2.3	1.70	7,800	
2.4	1.80	8,400	
2.5	1.90	8,900	
2.6	2.00	9,500	
2.7	2.10	10,000	
2.8	2.20	10,600	
2.9	2.30	11,200	
3.0	2.40	11,800	
3.1	2.50	12,200	
3.2	2.60	12,800	
3.3	2.70	13,400	FREEBOARD
3.4	2.80	14,100	

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION

0 25 50 75 100m
SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY
NOT FOR CONSTRUCTION

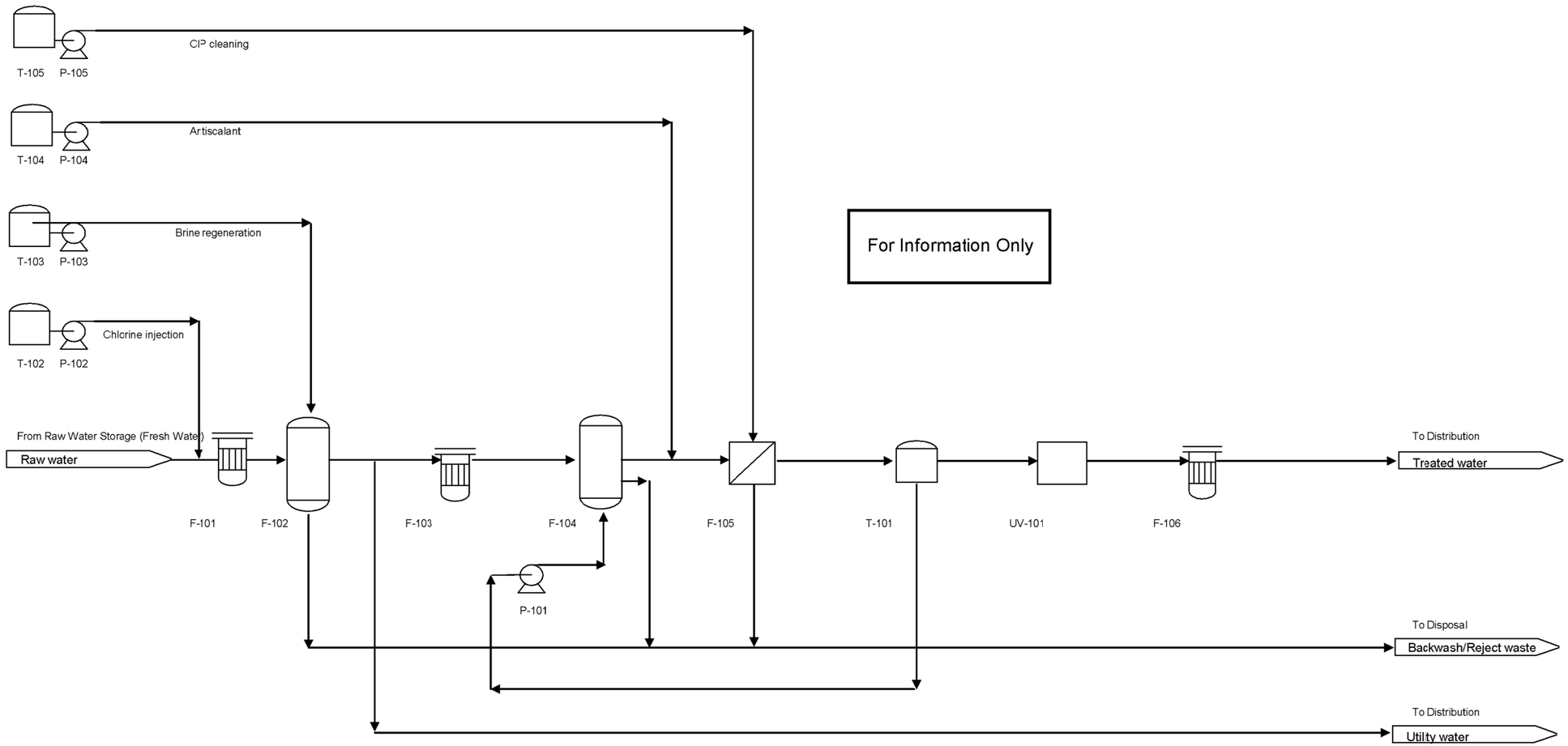
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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **EXISTING RESERVOIR**	Approved by/Approuve par S.T. Designed by/Concept par R.W. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-08	Project No./No. du projet **R.015446.001** Sheet/Feuille **3** OF **27** Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001

F-101 Ion exchange	F-102 Cartridge filter	F-103 GAC filter	P-101 Backwash pump	F-104 Membrane filter	T-101 Storage tank	UV-101 UV reactor	F-105 Cartridge filter	T-102/P-102 Brine regeneration system	T-103/P-103 Coagulant injection system	T-104/P-104 Antiscalant system	T-105/P-105 CIP system	T-106/P-106 Chlorine injection system



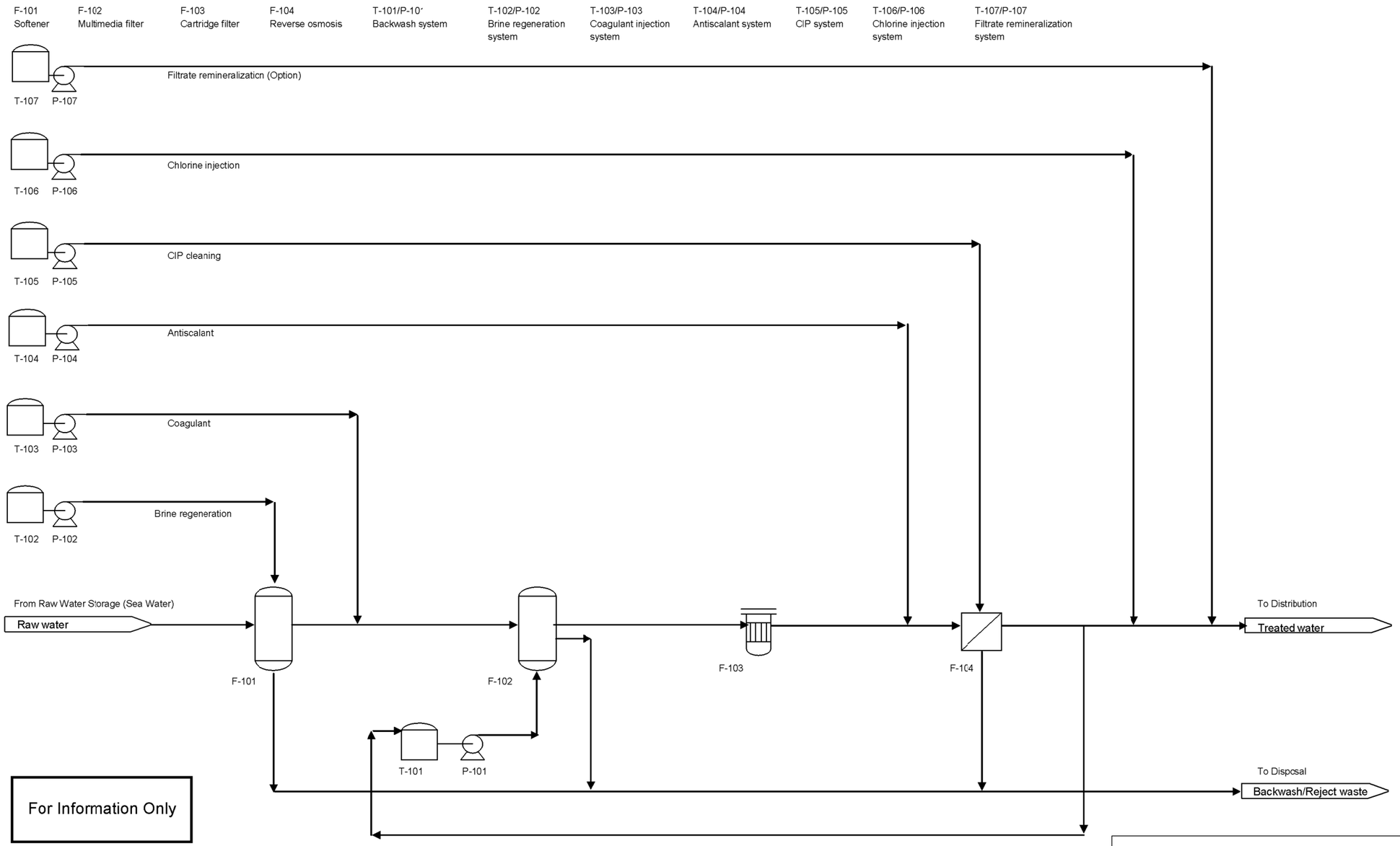
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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **BLOCK DIAGRAM FOR EXISTING WATER TREATMENT SYSTEM**	Approved by/Approuve par **J.Q.** Designed by/Concept par **L.M.** Drawn by/Dessine par **A.J.M.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.** PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date **2010-12-09**	Project No./No. du projet **R.015446.001** Sheet/Feuille **4** OF **27** Revision/ Revision

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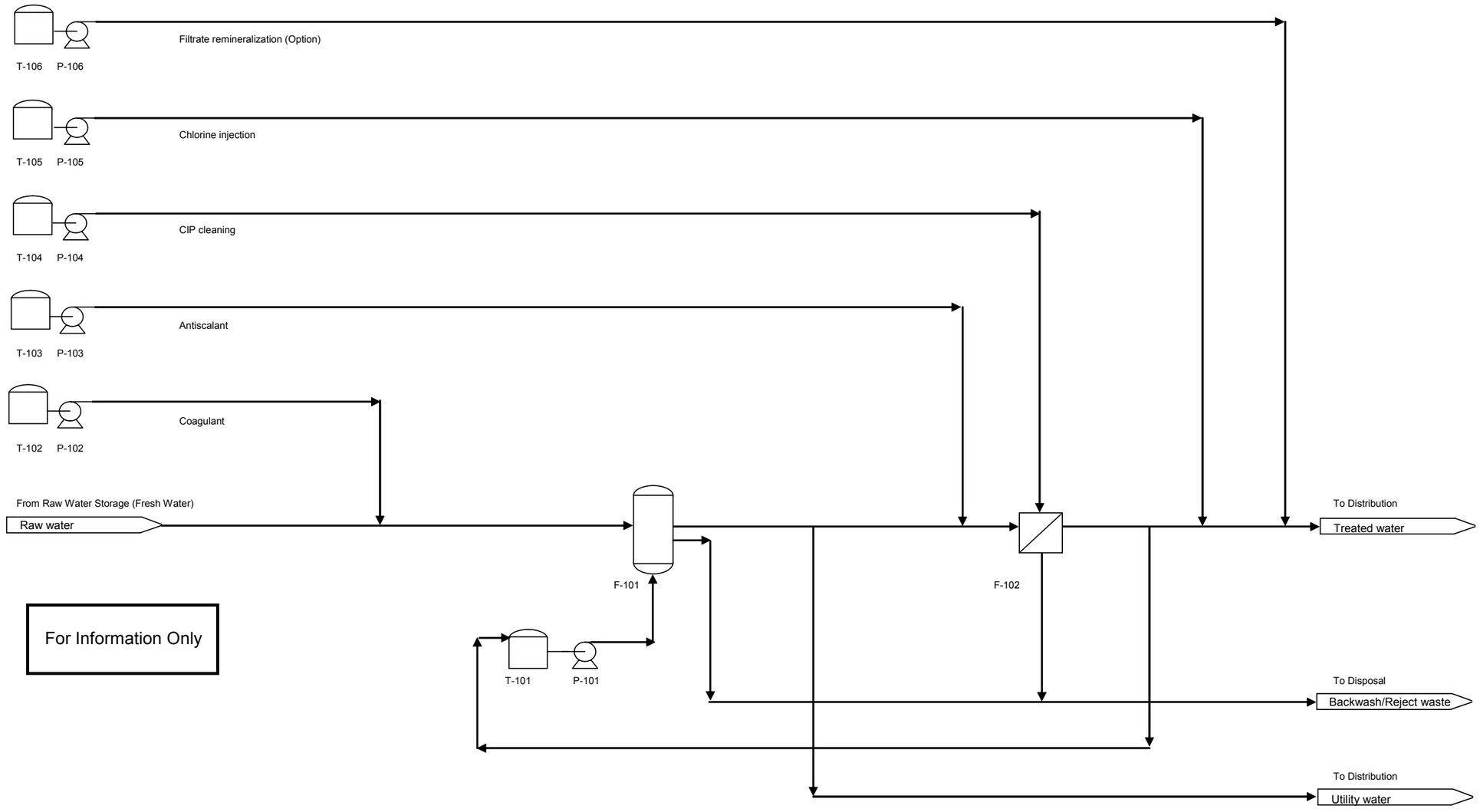
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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **BLOCK DIAGRAM FOR WATER TREATMENT SYSTEM - OPTION 1**	Approved by/Approuve par **J.Q.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.**	Project No./No du projet **R.015446.001**
			Designed by/Concept par **L.M.**	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille **5** **OF 27** / Revision/ Revision
			Drawn by/Dessine par **A.J.M.**	Date/Date **2010-12-09**	

A0 – PWGSC – ANSI B–L2 – 11X17

F-101 Multimedia filter
F-102 Reverse Osmosis
T-101/P-101 Backwash System
T-102/P-102 Coagulant injection
T-103/P-103 Antiscalant system
T-104/P-104 CIP system
T-105/P-105 Chlorine injection system
T-106/P-106 Filtrate remineralization system



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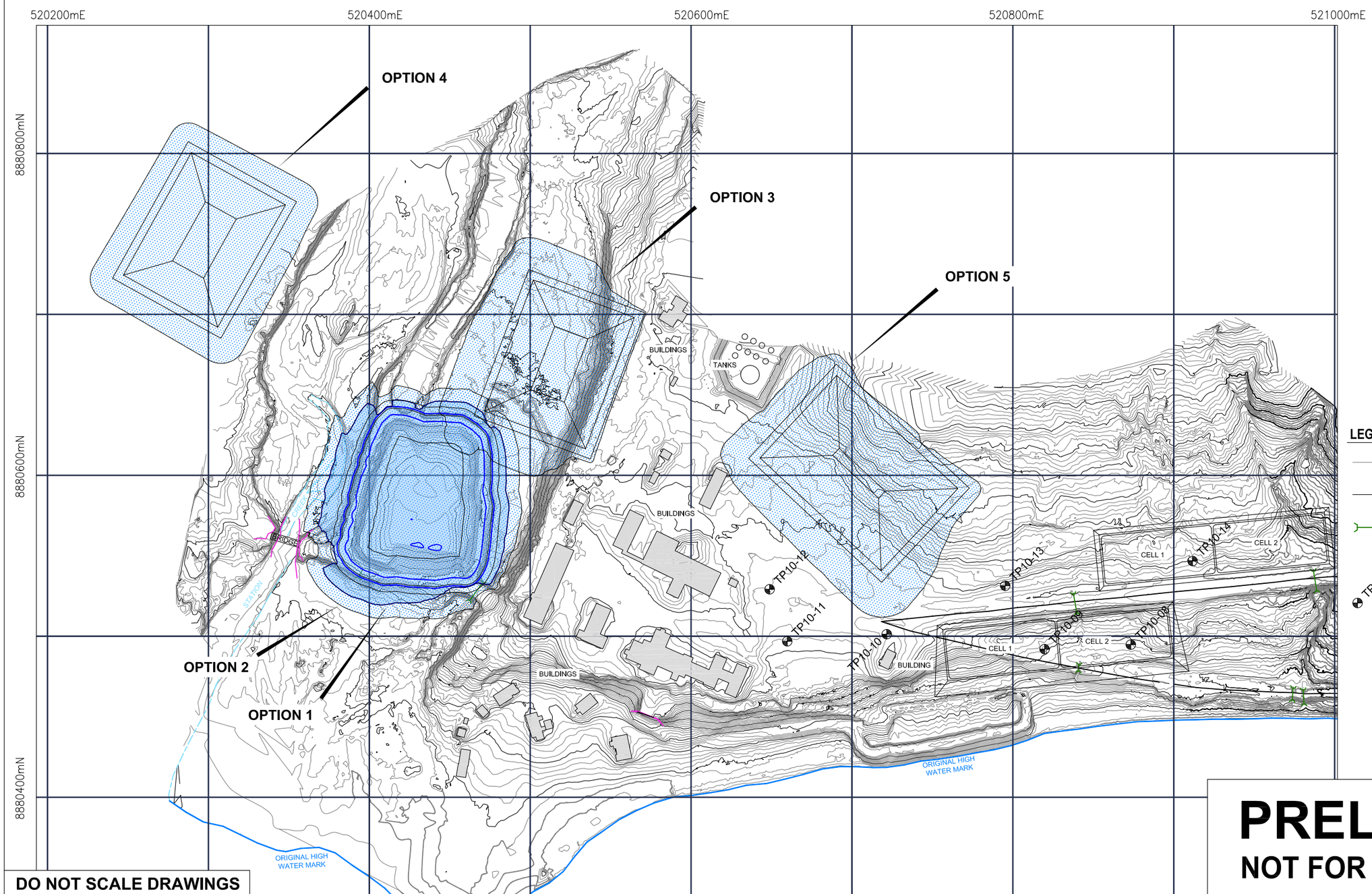
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			Designed by/Concept par **L.M.**	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille **6 OF 27**	Revision/ Revision
			Drawn by/Dessine par **A.J.M.**	Date/Date **2010-12-09**		

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest



N

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 1-5 SITE PLAN**	Approved by/Approuve par S.T. Designed by/Concept par R.W. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-09	Project No./No. du projet **R.015446.001** Sheet/Feuille **7** OF 27 Revision/ Revision

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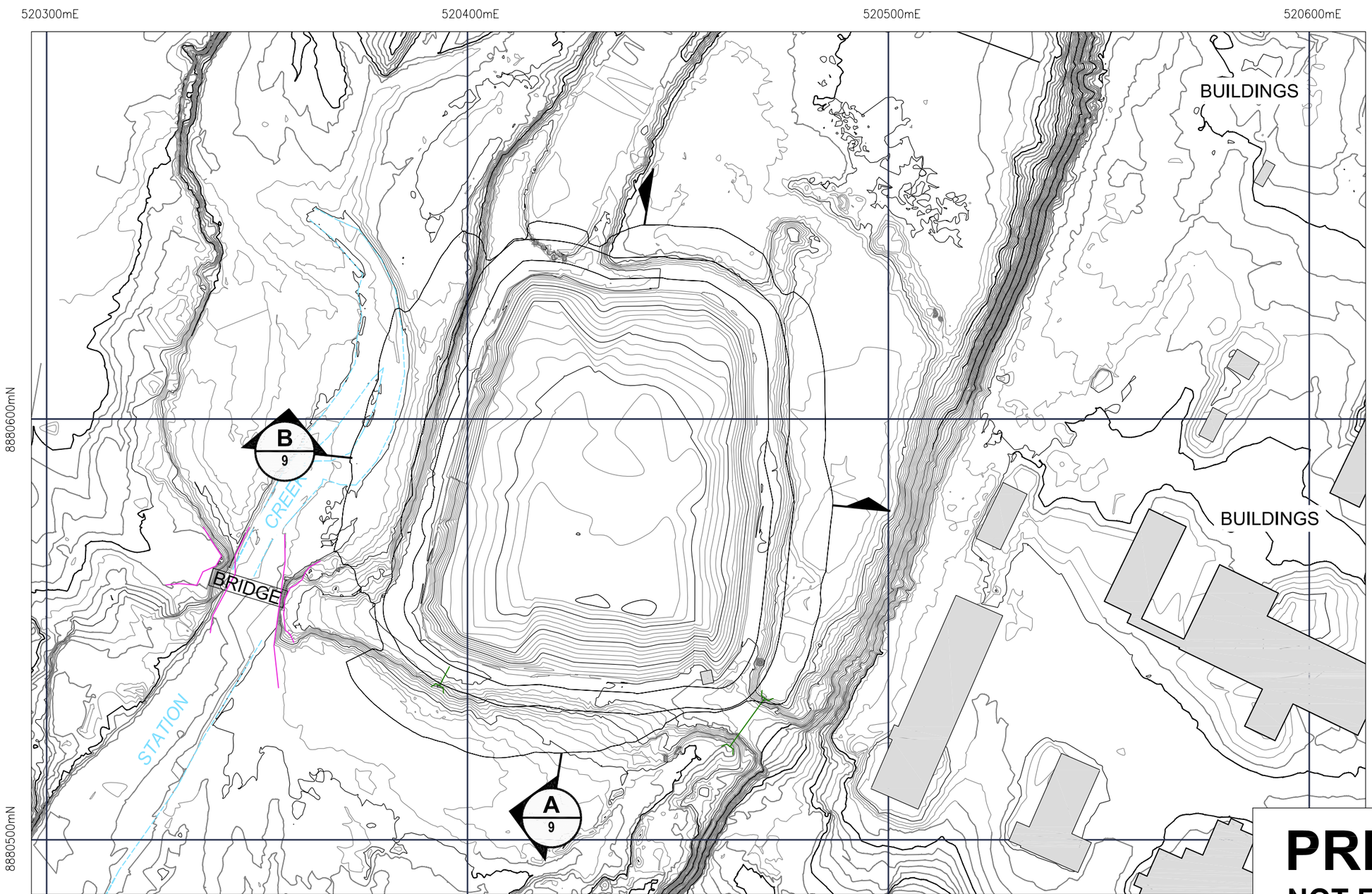
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Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest



LEGEND

MINOR CONTOUR (0.2m INTERVAL)

MAJOR CONTOUR (1.0m INTERVAL)

0 10 20 30 40 50m

SCALE 1 : 1,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

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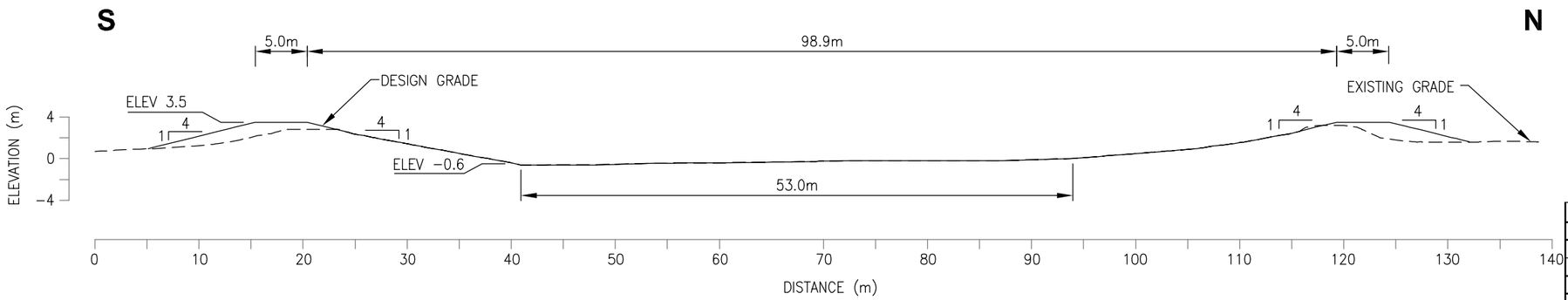
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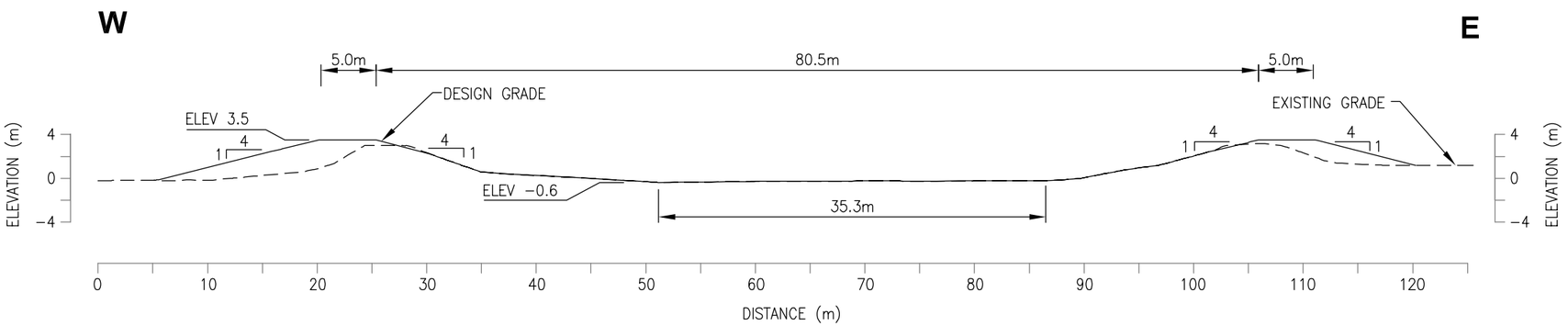
Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet EUREKA, NUNAVUT CANADA **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 1 SITE PLAN**	Approved by/Approuve par S.T. Designed by/Concept par R.W. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'ingénierie, TPSGC Date/Date 2010-12-09	Project No./No. du projet R.015446.001 Sheet/Feuille 8 OF 27 Revision/ Revision

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A/8 OPTION 1 S-N SECTION
1:500



B/8 OPTION 1 W-E SECTION
1:500

CUT VOLUME = 100m³
FILL VOLUME = 4,700m³
LINER AREA = 8,000m²

OPTION 1

DEPTH (m)	ELEV (m)	VOLUME (m³)	DESCRIPTION
0.0	-0.60	0	DEAD STORAGE (700 m³)
0.1	-0.50	20	
0.2	-0.40	100	
0.3	-0.30	200	
0.4	-0.20	500	
0.5	-0.10	700	
0.6	0.00	900	ACTIVE STORAGE (2,100 m³)
0.7	0.10	1,100	
0.8	0.20	1,400	
0.9	0.30	1,700	
1.0	0.40	2,000	
1.1	0.50	2,400	
1.2	0.60	2,800	
1.3	0.70	3,100	ICE ALLOWANCE (10,000 m³)
1.4	0.80	3,500	
1.5	0.90	4,000	
1.6	1.00	4,400	
1.7	1.10	4,900	
1.8	1.20	5,300	
1.9	1.30	5,800	
2.0	1.40	6,300	
2.1	1.50	6,800	
2.2	1.60	7,300	
2.3	1.70	7,800	
2.4	1.80	8,400	
2.5	1.90	8,900	
2.6	2.00	9,500	
2.7	2.10	10,000	
2.8	2.20	10,600	
2.9	2.30	11,200	
3.0	2.40	11,800	
3.1	2.50	12,200	
3.2	2.60	12,800	
3.3	2.70	13,400	FREEBOARD
3.4	2.80	14,100	
3.5	2.90	14,700	
3.6	3.00	15,400	
3.7	3.10	16,100	
3.8	3.20	16,800	
3.9	3.30	17,500	
4.0	3.40	18,200	
4.1	3.50	19,000	

PRELIMINARY
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Client/client
PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)
BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA

Project title/Titre du projet
EUREKA, NUNAVUT CANADA
CIVIL CONSULTING SERVICES

Drawing title/Titre du dessin
OPTION 1 SECTIONS

Approved by/Approuve par: S.T.
Designed by/Concept par: R.W.
Drawn by/Dessine par: L.P./D.R.H.

PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.
PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'ingénierie, TPSGC
Date/Date: 2010-12-09

Project No./No. du projet: R.015446.001
Sheet/Feuille: 9 OF 27
Revision/Revision:

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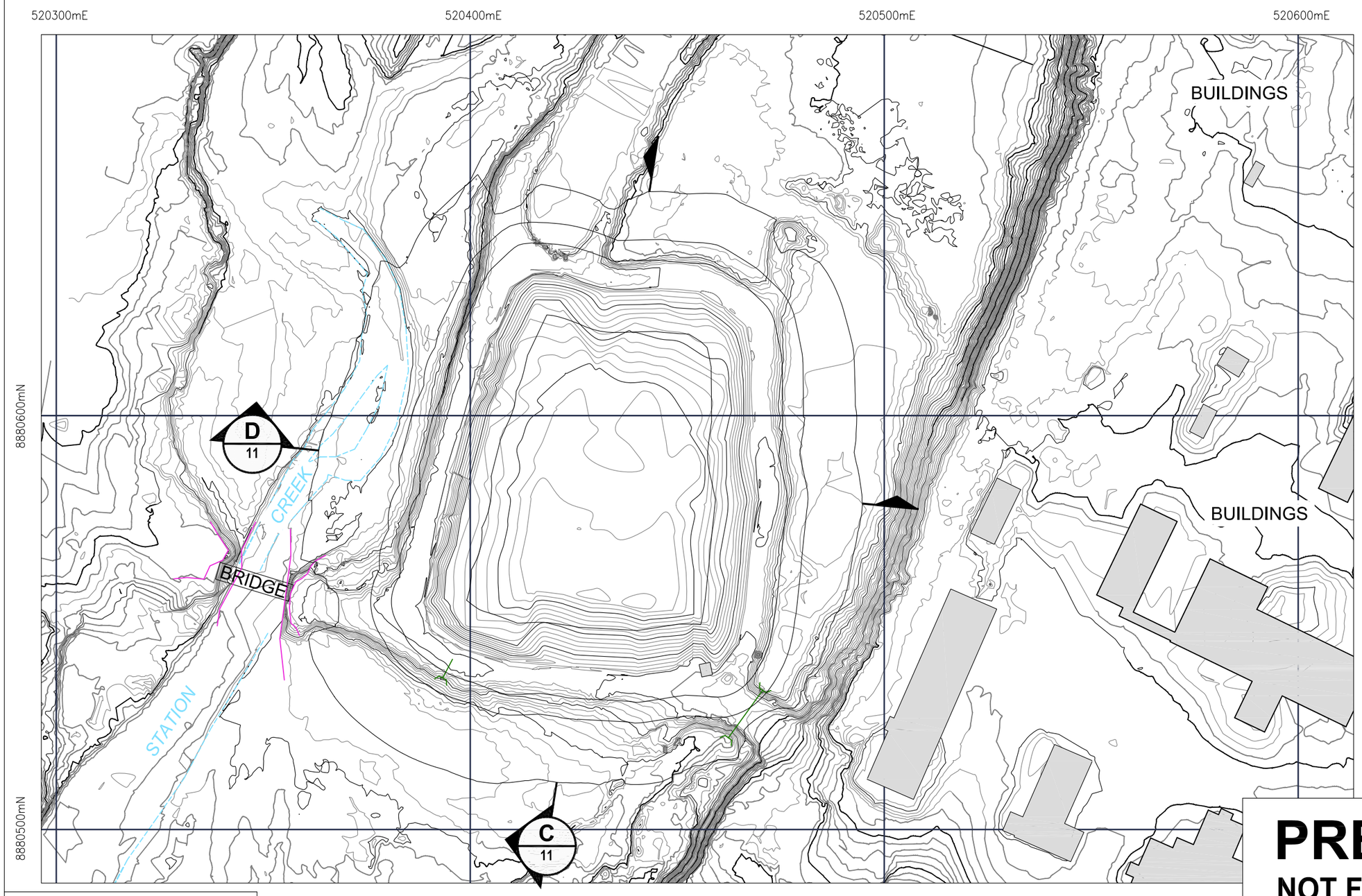
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REAL PROPERTY SERVICES
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Région de l'ouest



LEGEND

MINOR CONTOUR (0.2m INTERVAL)

MAJOR CONTOUR (1.0m INTERVAL)

0 10 20 30 40 50m

SCALE 1 : 1,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

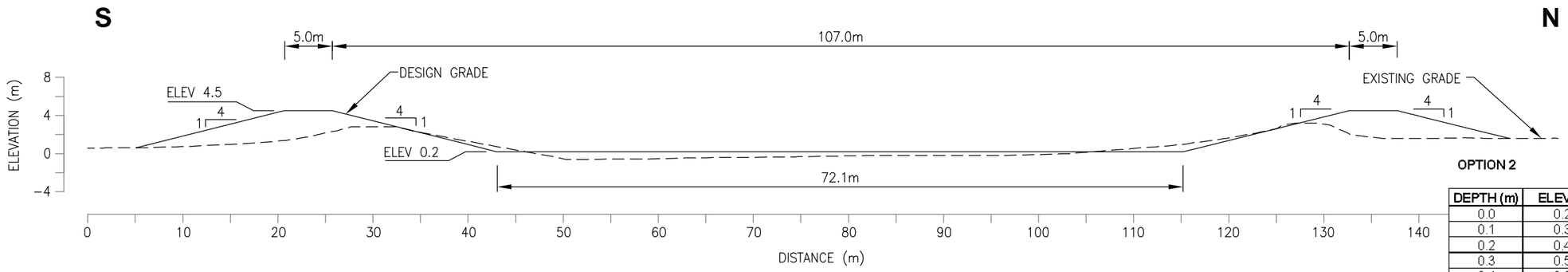
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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet EUREKA, NUNAVUT CANADA **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 2 SITE PLAN**	Approved by/Approuve par S.T. Designed by/Concept par R.W. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'ingénierie, TPSGC Date/Date 2010-12-09	Project No./No. du projet R.015446.001 Sheet/Feuille 10 OF 27 Revision/ Revision

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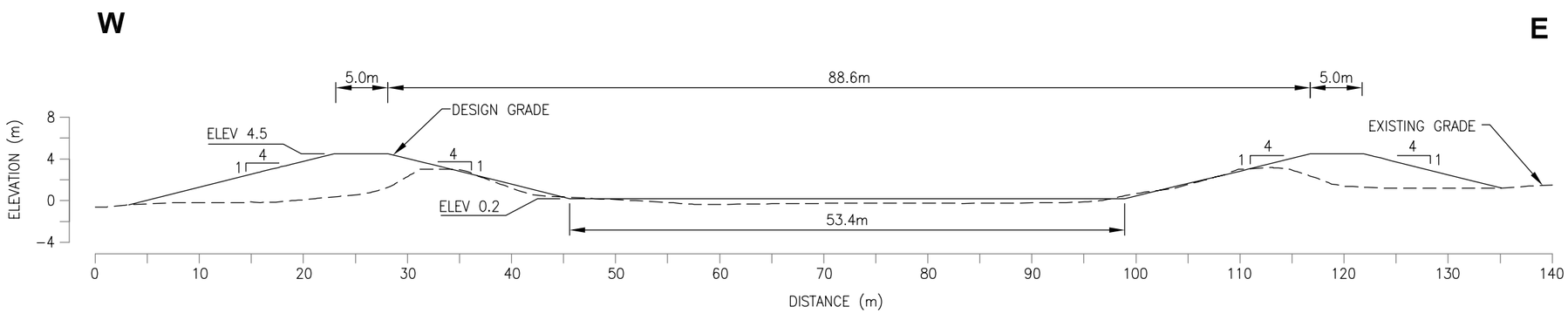


C/10 OPTION 2 S-N SECTION
1:500

CUT VOLUME = 600m³
FILL VOLUME = 17,000m³
LINER AREA = 9,500m²

OPTION 2

DEPTH (m)	ELEV (m)	VOLUME (m³)	DESCRIPTION
0.0	0.20	0	DEAD STORAGE (1,900 m³)
0.1	0.30	400	
0.2	0.40	700	
0.3	0.50	1,100	
0.4	0.60	1,500	
0.5	0.70	1,900	
0.6	0.80	2,300	ACTIVE STORAGE (3,600 m³)
0.7	0.90	2,700	
0.8	1.00	3,200	
0.9	1.10	3,600	
1.0	1.20	4,100	
1.1	1.30	4,500	
1.2	1.40	5,000	
1.3	1.50	5,500	
1.4	1.60	6,000	ICE ALLOWANCE (12,200 m³)
1.5	1.70	6,500	
1.6	1.80	7,000	
1.7	1.90	7,500	
1.8	2.00	8,100	
1.9	2.10	8,600	
2.0	2.20	9,200	
2.1	2.30	9,800	
2.2	2.40	10,400	
2.3	2.50	11,000	
2.4	2.60	11,600	
2.5	2.70	12,200	
2.6	2.80	12,900	
2.7	2.90	13,500	
2.8	3.00	14,200	
2.9	3.10	14,900	
3.0	3.20	15,600	
3.1	3.30	16,300	
3.2	3.40	17,000	
3.3	3.50	17,700	
3.4	3.60	18,500	FREEBOARD
3.5	3.70	19,300	
3.6	3.80	20,000	
3.7	3.90	20,800	
3.8	4.00	21,600	
3.9	4.10	22,500	
4.0	4.20	23,300	
4.1	4.30	24,100	
4.2	4.40	25,000	
4.3	4.50	25,900	



D/10 OPTION 2 W-E SECTION
1:500

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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 2 SECTIONS**	Approved by/Approuve par S.T.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D.	Project No./No. du projet **R.015446.001**	
			Designed by/Concept par R.W.	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille **11** OF 27	Revision/ Revision
			Drawn by/Dessine par L.P./D.R.H.	Date/Date **2010-12-09**		

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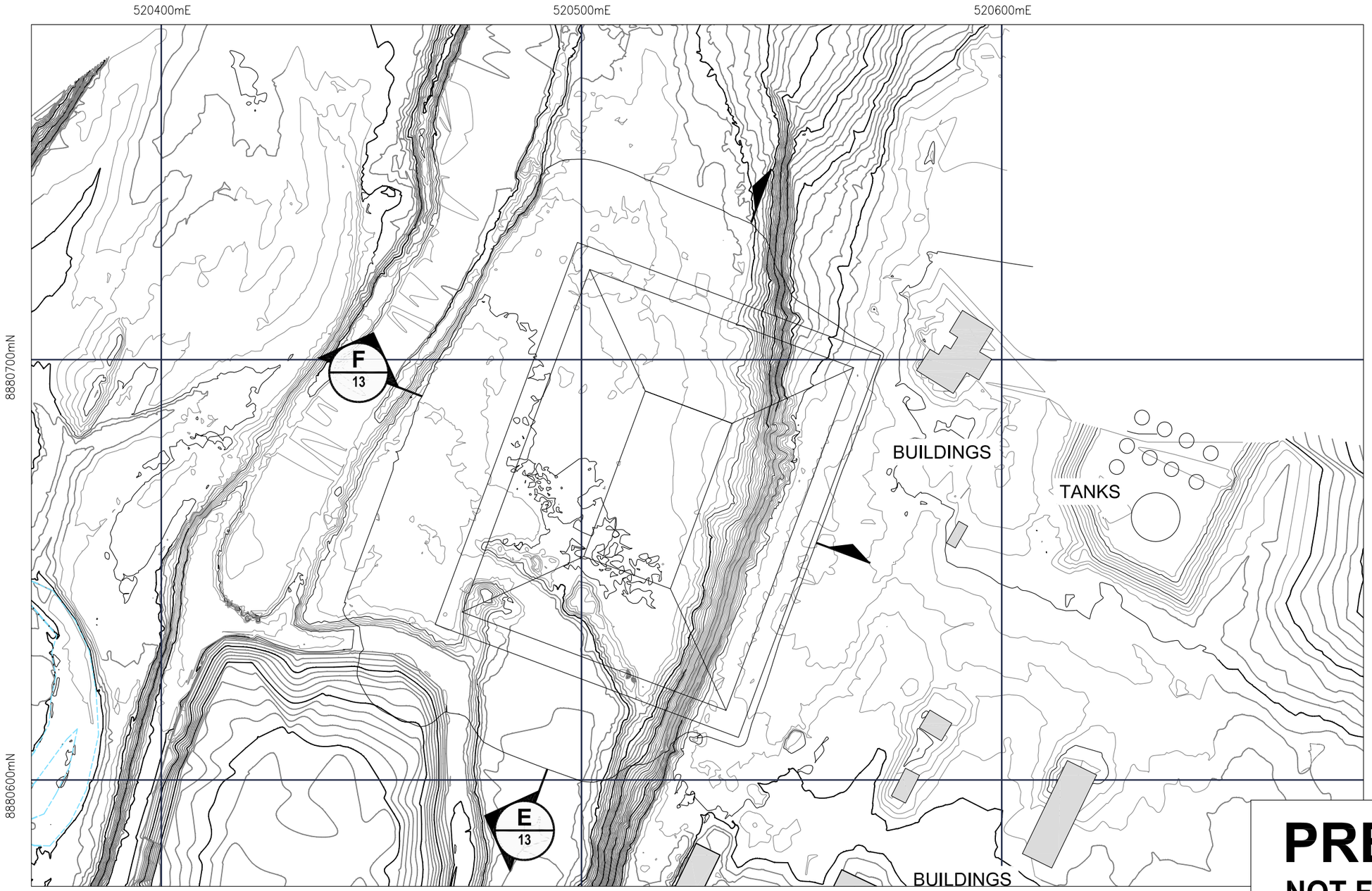
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Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest



N

LEGEND

MINOR CONTOUR (0.2m INTERVAL)

MAJOR CONTOUR (1.0m INTERVAL)

0 10 20 30 40 50m

SCALE 1 : 1,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

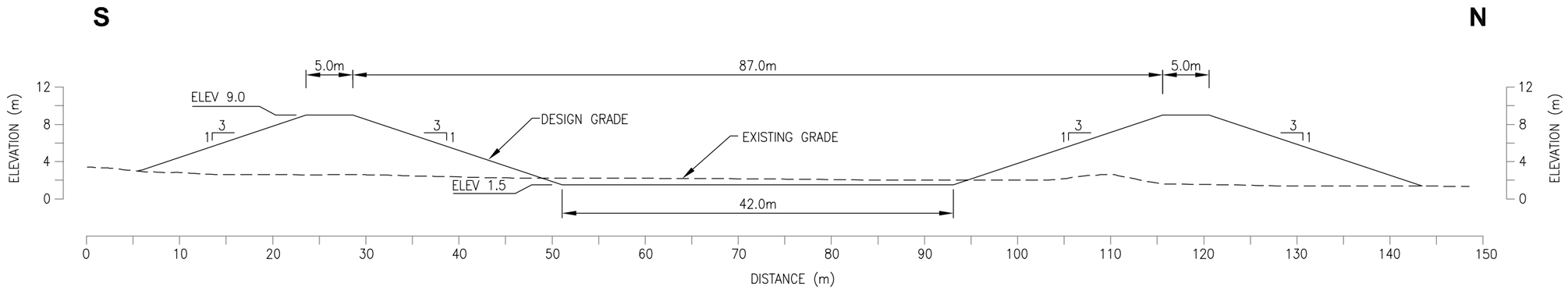
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DO NOT SCALE DRAWINGS

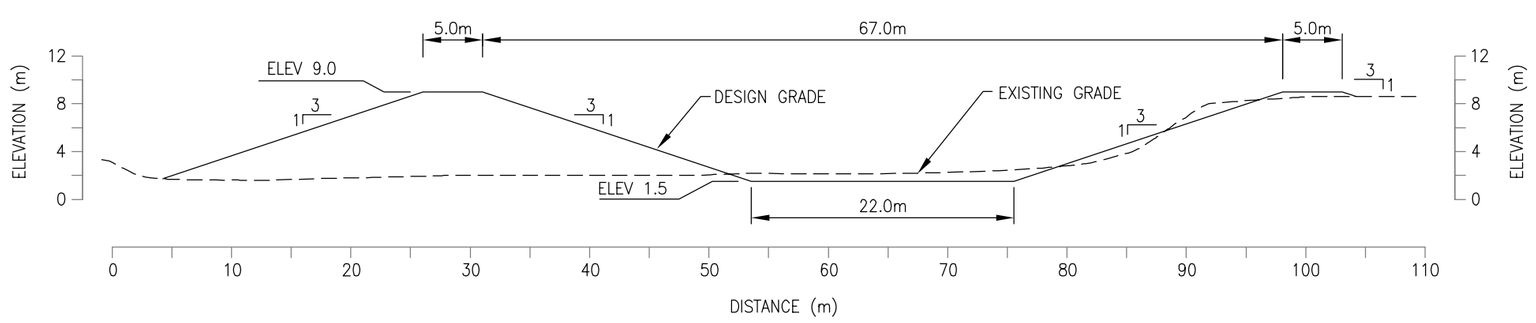
Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 3 SITE PLAN**	Approved by/Approuve par **S.T.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.**	Project No./No. du projet **R.015446.001**
			Designed by/Concept par **R.W.**	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille **12** OF **27** / Revision/ Revision
			Drawn by/Dessine par **L.P./D.R.H.**	Date/Date **2010-12-09**	

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001



E/12 OPTION 3 S-N SECTION
1:500



F/12 OPTION 3 W-E SECTION
1:500

CUT VOLUME = 1,300m³
FILL VOLUME = 35,000m³
LINER AREA = 6,600m²

OPTION 3

DEPTH (m)	ELEV (m)	VOLUME (m³)	DESCRIPTION
0.0	1.50	0	DEAD STORAGE (500 m³)
0.5	2.00	500	
1.0	2.50	1,100	ACTIVE STORAGE (6,600 m³)
1.5	3.00	1,900	
2.0	3.50	2,700	
2.5	4.00	3,700	
3.0	4.50	4,800	
3.5	5.00	6,100	
4.0	5.50	7,500	
4.5	6.00	9,100	
5.0	6.50	10,900	ICE ALLOWANCE (8,000 m³)
5.5	7.00	12,900	
6.0	7.50	15,000	
6.5	8.00	17,400	
7.0	8.50	20,000	FREEBOARD
7.5	9.00	22,800	

PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client
PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)
BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA

Project title/Titre du projet
EUREKA, NUNAVUT CANADA
CIVIL CONSULTING SERVICES

Drawing title/Titre du dessin
OPTION 3 SECTIONS

Approved by/Approuve par: S.T.
Designed by/Concept par: R.W.
Drawn by/Dessine par: L.P./D.R.H.

PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.
PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC
Date/Date: 2010-12-09

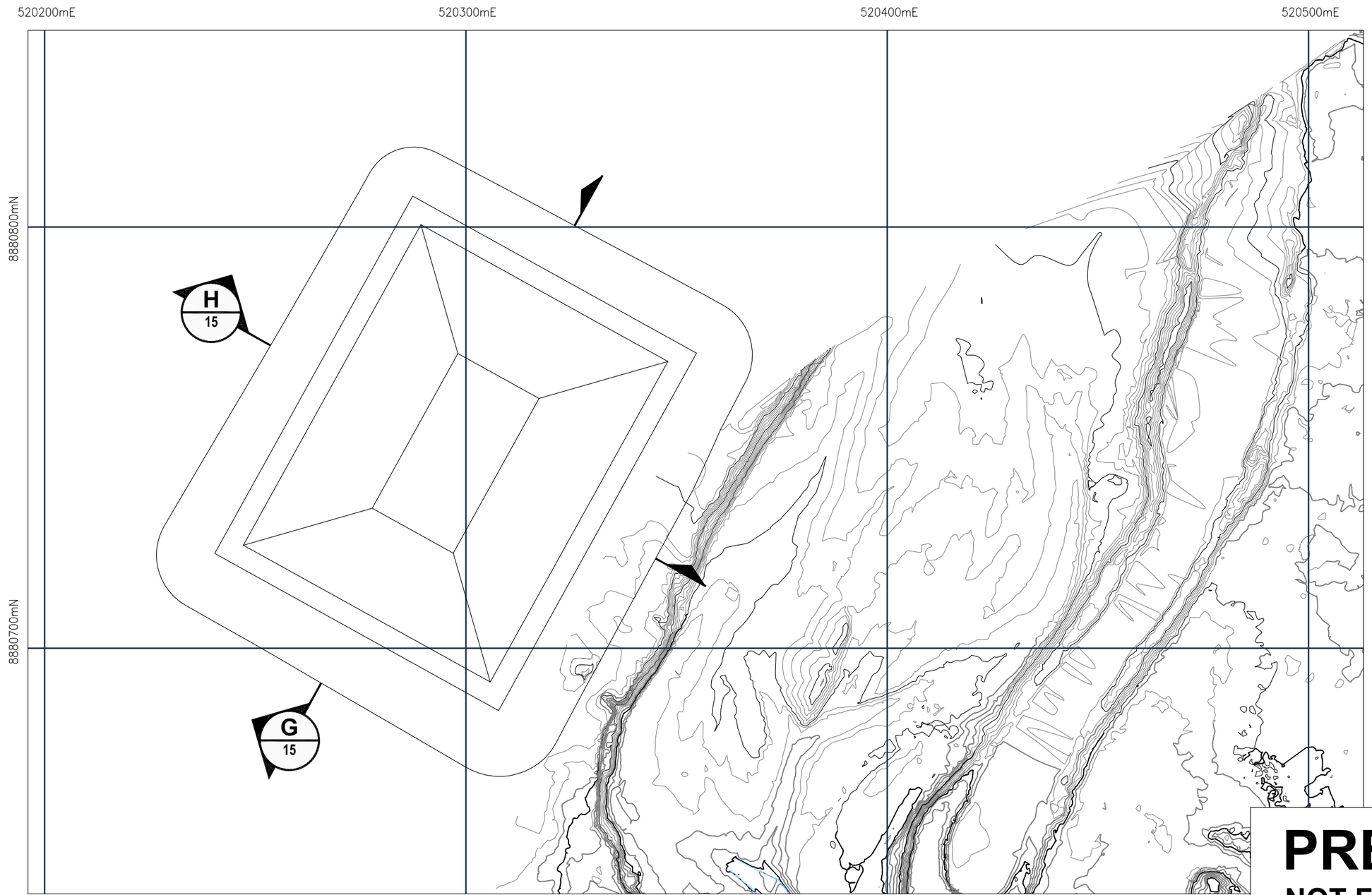
Project No./No. du projet: R.015446.001
Sheet/Feuille: 13 OF 27
Revision/ Revision:

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest



N

LEGEND

MINOR CONTOUR (0.2m INTERVAL)

MAJOR CONTOUR (1.0m INTERVAL)

0 10 20 30 40 50m

SCALE 1 : 1,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

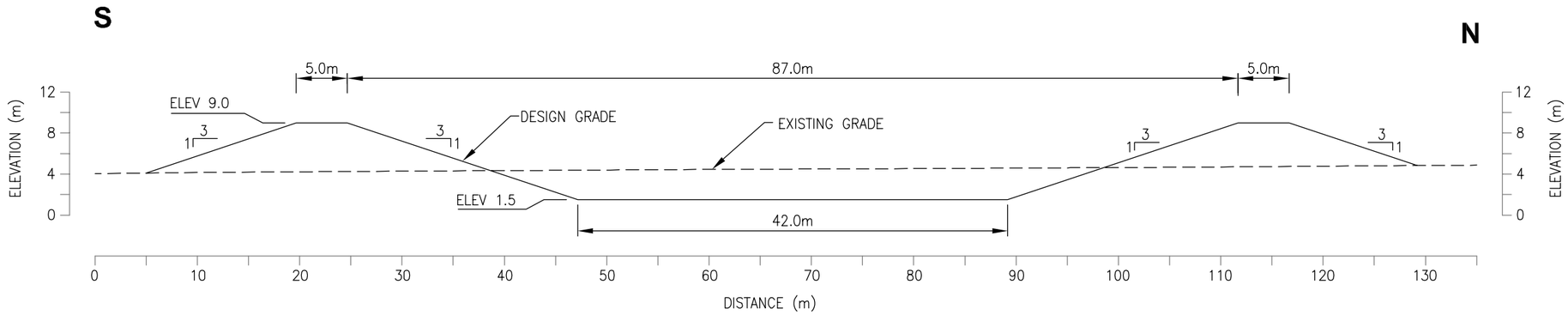
PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

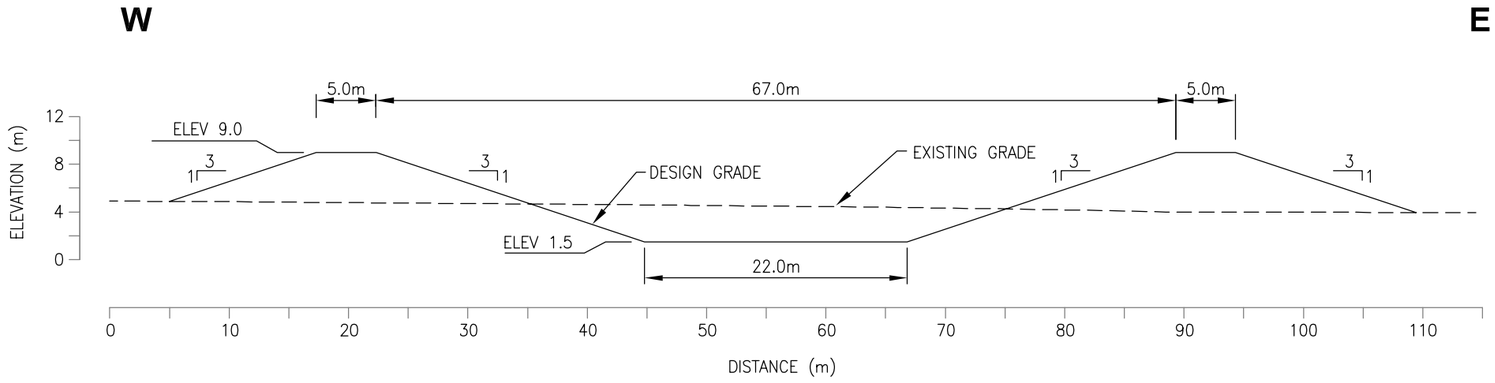
Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 4 SITE PLAN**	Approved by/Approuve par **S.T.** Designed by/Concept par **R.W.** Drawn by/Dessine par **L.P./D.R.H.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.** PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date **2010-12-09**	Project No./No. du projet **R.015446.001** Sheet/Feuille **14** OF **27** Revision/ Révision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001



G / 14 OPTION 4 S-N SECTION
1:500



H / 14 OPTION 4 W-E SECTION
1:500

CUT VOLUME = 4,800m³
FILL VOLUME = 28,000m³
LINER AREA = 6,600m²

OPTION 4

DEPTH (m)	ELEV (m)	VOLUME (m³)	DESCRIPTION
0.0	1.50	0	DEAD STORAGE (500 m³)
0.5	2.00	500	
1.0	2.50	1,100	ACTIVE STORAGE (6,600 m³)
1.5	3.00	1,900	
2.0	3.50	2,700	
2.5	4.00	3,700	
3.0	4.50	4,800	
3.5	5.00	6,100	
4.0	5.50	7,500	
4.5	6.00	9,100	
5.0	6.50	10,900	ICE ALLOWANCE (8,000 m³)
5.5	7.00	12,900	
6.0	7.50	15,000	
6.5	8.00	17,400	
7.0	8.50	20,000	FREEBOARD
7.5	9.00	22,800	

PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client
PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)
BOX 1408 100-167 LOMBARD AVE
WINNEPEG, MANITOBA

Project title/Titre du projet
EUREKA, NUNAVUT
CANADA
CIVIL CONSULTING SERVICES

Drawing title/Titre du dessin
OPTION 4 SECTIONS

Approved by/Approuve par: S.T.
Designed by/Concept par: R.W.
Drawn by/Dessine par: L.P./D.R.H.

PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.
PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC
Date/Date: 2010-12-09

Project No./No. du projet: R.015446.001
Sheet/Feuille: 15 OF 27
Revision/ Revision

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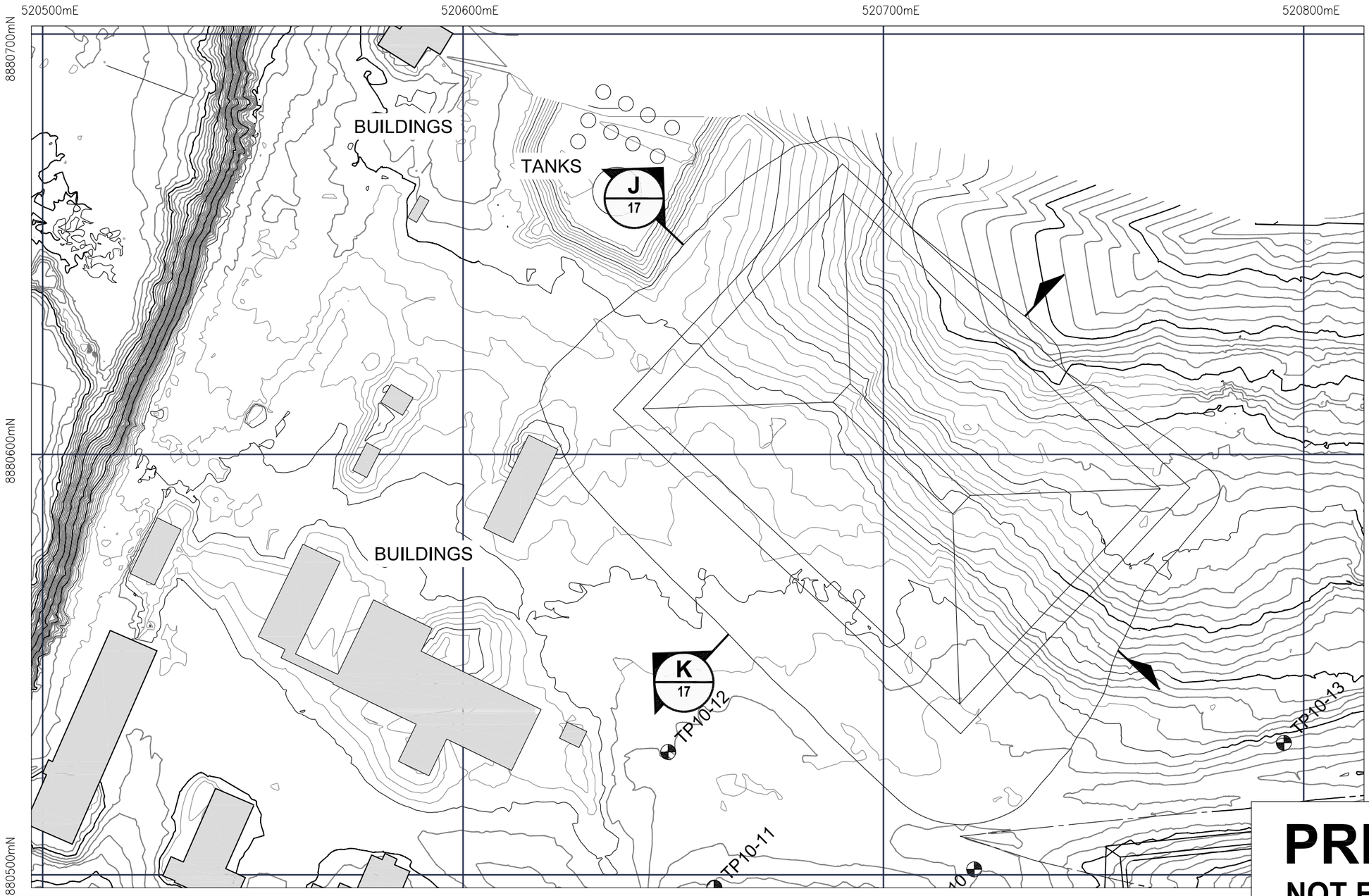
C71130000-CI-DPP-0001

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES / SERVICES IMMOBILIERS

Western Region / Région de l'ouest



LEGEND

MINOR CONTOUR (0.2m INTERVAL)

MAJOR CONTOUR (1.0m INTERVAL)

TP10-09 TEST PIT LOCATION

0 10 20 30 40 50m

SCALE 1 : 1,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

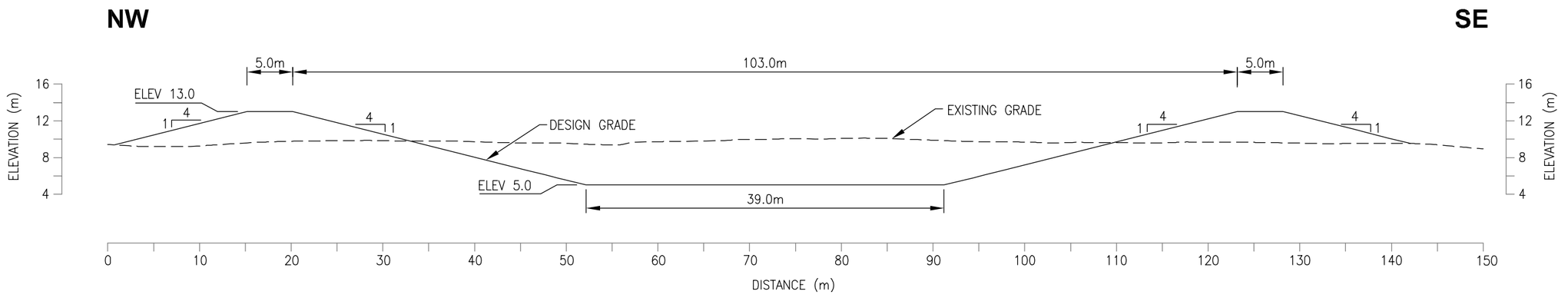
NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

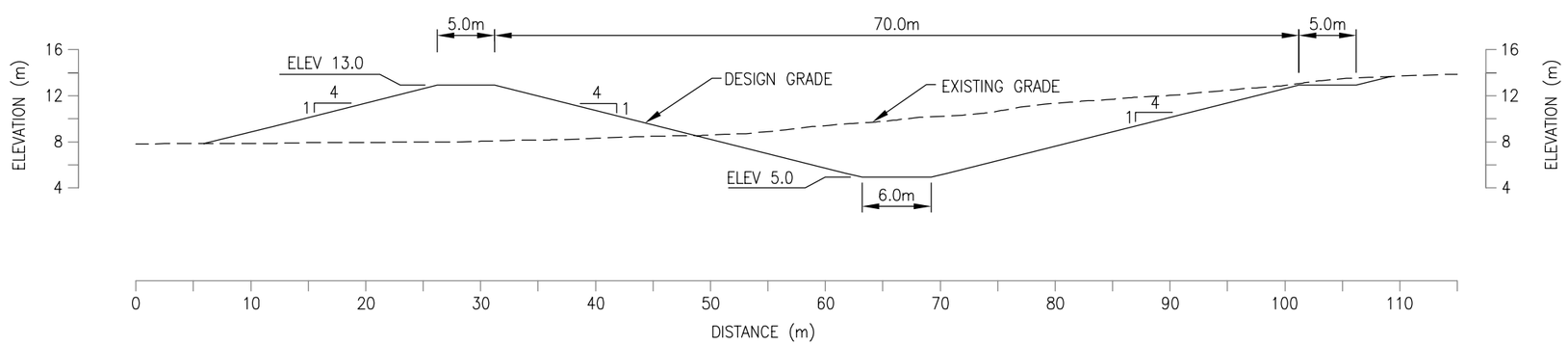
Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet EUREKA, NUNAVUT CANADA **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 5 SITE PLAN**	Approved by/Approuve par S.T. Designed by/Concept par R.W. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-09	Project No./No. du projet R.015446.001 Sheet/Feuille 16 OF 27 Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001



J/16 OPTION 5 NW-SE SECTION
1:500



K/16 OPTION 5 SW-NE SECTION
1:500

CUT VOLUME = 9,400m³
FILL VOLUME = 24,000m³
LINER AREA = 8,000m²

OPTION 5

DEPTH (m)	ELEV (m)	VOLUME (m³)	DESCRIPTION
0.0	5.00	0	DEAD STORAGE (200 m³)
0.5	5.50	200	
1.0	6.00	400	ACTIVE STORAGE (8,600 m³)
1.5	6.50	800	
2.0	7.00	1,400	
2.5	7.50	2,000	
3.0	8.00	2,900	
3.5	8.50	3,900	
4.0	9.00	5,200	
4.5	9.50	6,600	
5.0	10.00	8,800	
5.5	10.50	10,300	ICE ALLOWANCE (9,700 m³)
6.0	11.00	12,500	
6.5	11.50	15,000	
7.0	12.00	18,000	
7.5	12.50	20,900	FREEBOARD
8.0	13.00	24,300	

PRELIMINARY
NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client
PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)
BOX 1408 100-167 LOMBARD AVE
WINNEPEG, MANITOBA

Project title/Titre du projet
EUREKA, NUNAVUT
CANADA
CIVIL CONSULTING SERVICES

Drawing title/Titre du dessin
OPTION 5 SECTIONS

Approved by/Approuve par: S.T.	PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.	Project No./No. du projet: R.015446.001
Designed by/Concept par: R.W.	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'ingénierie, TPSGC	Sheet/Feuille: 17 OF 27 — Revision/Revision
Drawn by/Dessine par: L.P./D.R.H.	Date/Date: 2010-12-09	

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES / SERVICES IMMOBILIERS

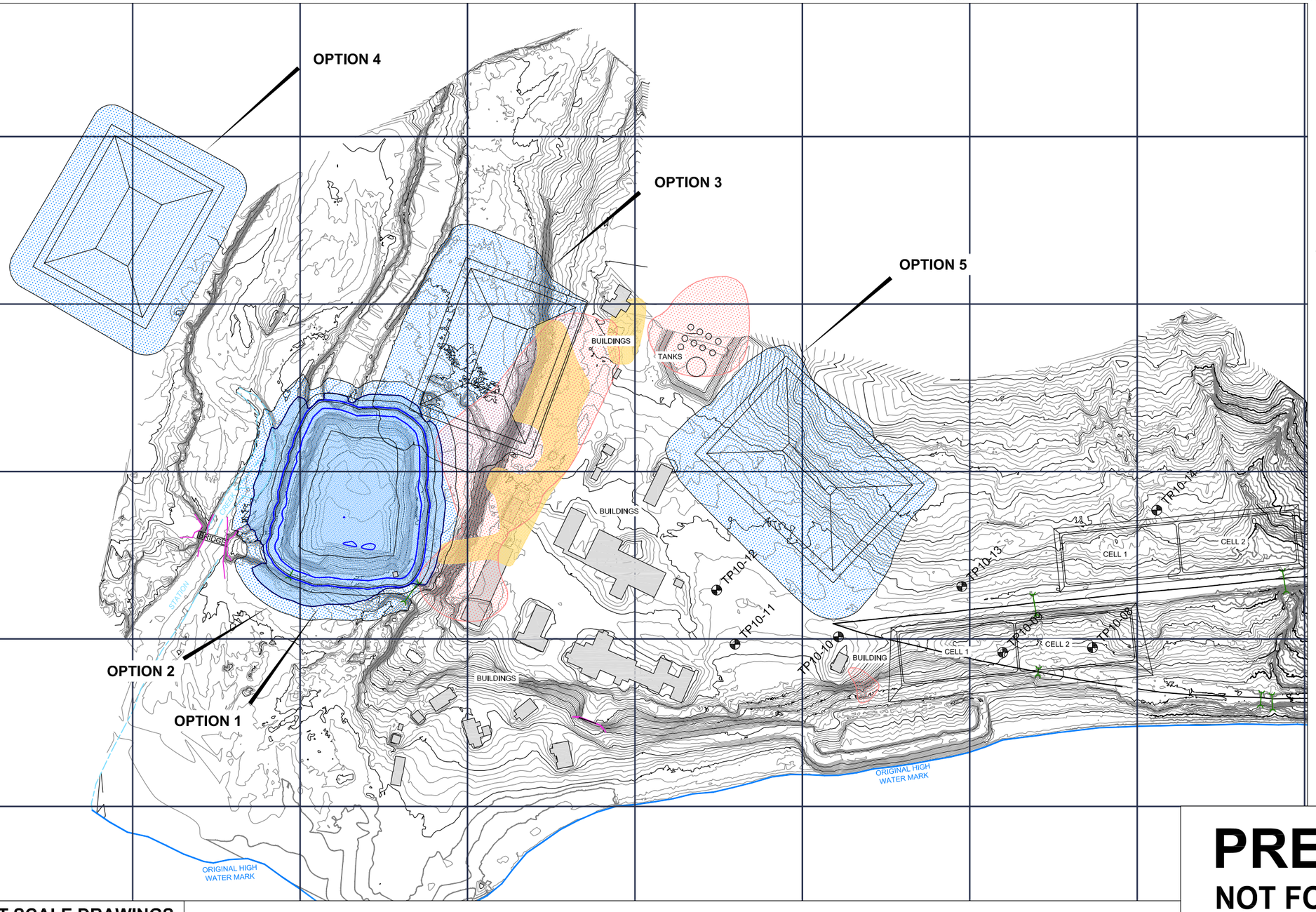
Western Region / Région de l'ouest

520200mE 520400mE 520600mE 520800mE 521000mE

8880800mN

8880600mN

8880400mN



N

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION
- INFERRED EXTENT OF ENVIRONMENTAL IMPACTED ZONE (Others; Franz 2009)
- INFERRED EXTENT OF CONTAMINATION (Franz 2009)

Franz Environmental Inc. 2009. Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada. Report prepared for Public Works Government Services Canada on Behalf of Environment Canada. March, 2009.

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet EUREKA, NUNAVUT CANADA **EUREKA ENGINEERING SERVICES**	Drawing title/Titre du dessin **AREAS OF ENVIRONMENTAL CONCERN**	Approved by/Approuve par S.T. Designed by/Concept par G.H. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-14	Project No./No. du projet R.015446.001 Sheet/Feuille 27 OF 27 Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-Environmental Concern.dwg

Appendices

Appendix 1.1 Photographs from Site Visit



Photo 1. Intake at Station Creek



Photo 2. Station Creek

Photo By: HA
Date: October 13, 2010

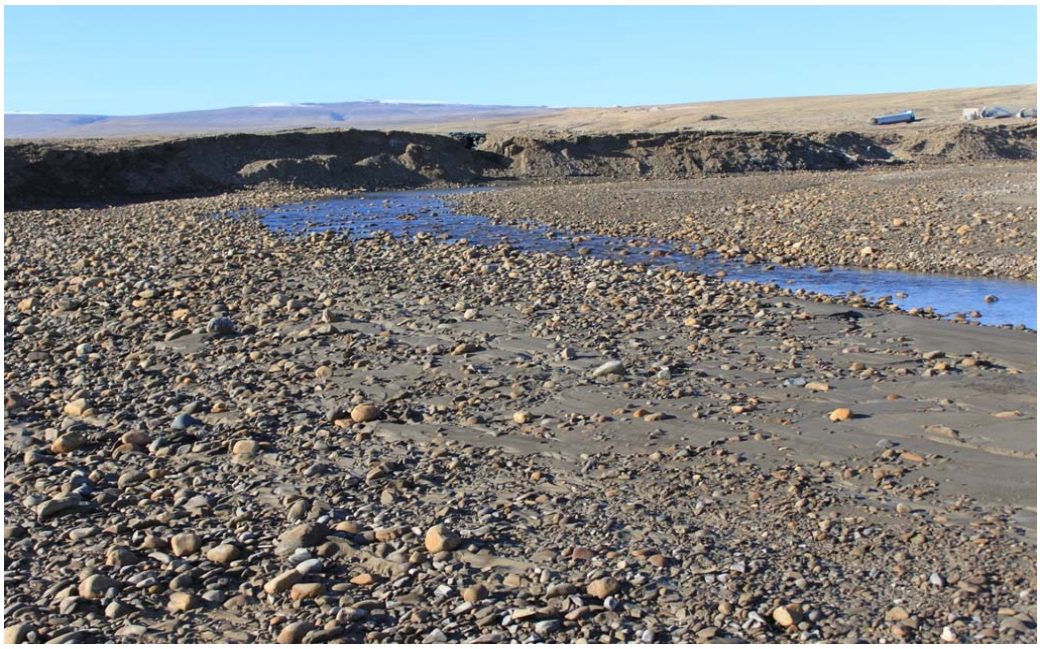


Photo 3. Station Creek (Bed Material)



Photo 4. Reservoir Overflow Chanel (Orange Line is the Reservoir)

Photo By: HA
Date: October 13, 2010



Photo 5. Garbage in Reservoir Overflow



Photo 6. Old Drums at Station Creek

Photo By: HA
Date: October 13, 2010



Photo 7. Station Creek



Photo 8. Fiord Main Cover and Route to New Sewage Lagoon Location

Photo By: HA
Date: October 13, 2010



Photo 9. Chlorine Dosing System for Reservoir Water



Photo 10. Fire Suppression System

Photo By: HA
Date: October 13, 2010



Photo 11. Reverse Osmosis System Part 1

Photo By: HA
Date: October 13, 2010



Photo 12. Reverse Osmosis System Part 2

Photo By: HA
Date: October 13, 2010



Photo 13. Sewage Pipeline to Sewage Lagoon

Photo By: HA
Date: October 13, 2010



Photo 14. Sewage Storage Tank

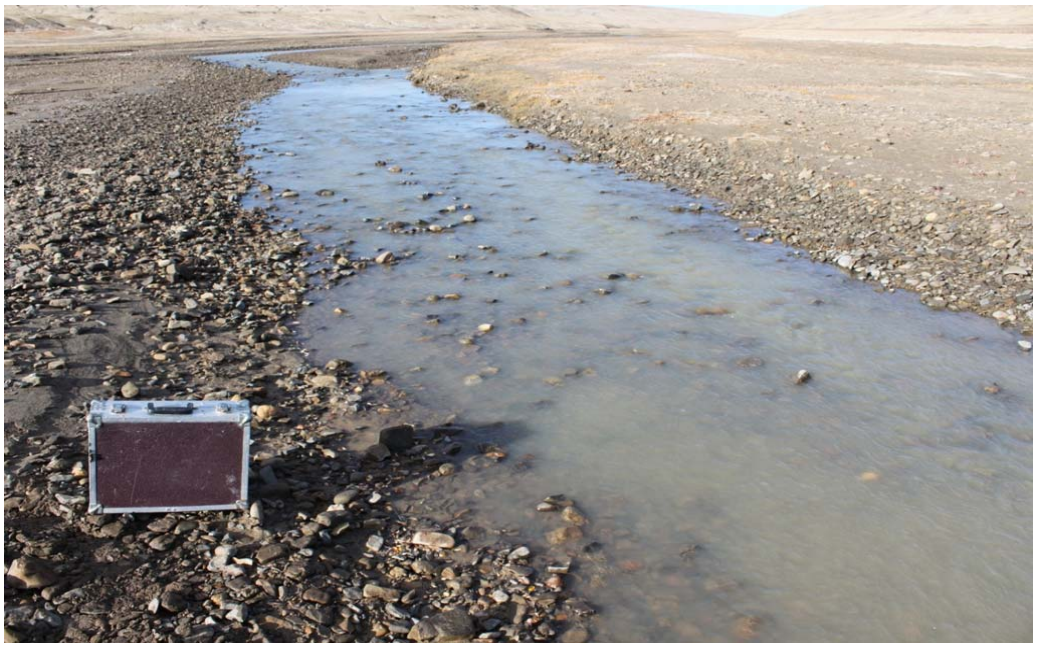


Photo 15. Black Top Creek Sampling Location

Photo By: HA
Date: October 13, 2010



Photo 16. Contaminated Site Near Water-Reservoir (1)



Photo 17. Contaminated Site Near Water-Reservoir (2)

Photo By: HA
Date: October 13, 2010



Photo 18. Contaminated Site Near Water-Reservoir (3)

Photo By: HA
Date: October 13, 2010

Appendix 1.2 Surface Water Sampling Protocol

APPENDIX 1.2
SURFACE WATER SAMPLING PROTOCOL

The following procedures were followed during surface water sampling at the Site.

- Hand-held containers were used to obtain surface water samples.
- Surface water samples were obtained as close to the centre of the vertical profile as possible. Disturbance of sediments was avoided.
- Water from the specific sample depth was acquired by inverting the sample bottle on the sampling device, and rotating 180° at the desired sample depth.
- Surface water samples were transferred from the sampling device to new HDPE plastic, or glass bottles, supplied by the laboratory.
- Agitation of surface water samples was minimized while transferring the water to the sample bottles.
- All sample bottles were filled to zero headspace.
- New gloves were used at each monitoring station to reduce the potential for cross-contamination.
- Samples were promptly delivered to the laboratory after completion of the field program.

Field-measured parameters were obtained using the following instrumentation:

- **temperature and pH** – measured with a pH meter, calibrated using buffer solutions of pH 4 and pH 7.
- **electrical conductivity** – measured with a conductivity meter, calibrated with standard KCl solution (1,420 µS/m at 25°C).

Appendix 1.3 Water Quality Laboratory Test Results

Certificate of Analysis

WORLEYPARSONS
ATTN: HECTOR ANAYA
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6

Report Date: 17-SEP-10 10:37 (MT)
Version: FINAL

Lab Work Order #: L922913 **Date Received:** 22-AUG-10

Project P.O. #: NOT SUBMITTED
Job Reference: C71130000
Legal Site Desc: EUREKA, NU
CofC Numbers: 10-062841, 10-062842

Other Information:

Comments:

03-SEP-10:
13-SEP-10:
14-SEP-10: Additional

Maureen Olinek
Senior Account Manager

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN AUTHORITY OF THE LABORATORY.
ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS FOLLOWING ANALYSIS. PLEASE CONTACT THE LAB IF YOU REQUIRE ADDITIONAL SAMPLE STORAGE TIME.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-1 BLACKTOP CREEK							
Sampled By: KS/HA on 17-AUG-10 @ 14:42							
Matrix: WATER							
Dissolved Metals - CDWQ Guidelines							
Diss. Metals in Water by ICPMS (Low)							
Aluminum (Al)-Dissolved	0.100		0.020	mg/L		29-AUG-10	R1453309
Antimony (Sb)-Dissolved	<0.00050		0.00050	mg/L		29-AUG-10	R1453309
Arsenic (As)-Dissolved	<0.00050		0.00050	mg/L		29-AUG-10	R1453309
Barium (Ba)-Dissolved	0.0267		0.0050	mg/L		29-AUG-10	R1453309
Boron (B)-Dissolved	<0.050		0.050	mg/L		29-AUG-10	R1453309
Cadmium (Cd)-Dissolved	<0.00020		0.00020	mg/L		29-AUG-10	R1453309
Chromium (Cr)-Dissolved	<0.0050		0.0050	mg/L		29-AUG-10	R1453309
Copper (Cu)-Dissolved	0.0012		0.0010	mg/L		29-AUG-10	R1453309
Lead (Pb)-Dissolved	<0.00010		0.00010	mg/L		29-AUG-10	R1453309
Selenium (Se)-Dissolved	<0.0020	DLM	0.0020	mg/L		29-AUG-10	R1453309
Silver (Ag)-Dissolved	<0.0050		0.0050	mg/L		29-AUG-10	R1453309
Uranium (U)-Dissolved	<0.00050		0.00050	mg/L		29-AUG-10	R1453309
Zinc (Zn)-Dissolved	<0.050		0.050	mg/L		29-AUG-10	R1453309
Dissolved Metals in Water by ICPOES							
Calcium (Ca)-Dissolved	117		0.50	mg/L		27-AUG-10	R1451891
Iron (Fe)-Dissolved	<0.050		0.050	mg/L		27-AUG-10	R1451891
Magnesium (Mg)-Dissolved	42.6		0.10	mg/L		27-AUG-10	R1451891
Manganese (Mn)-Dissolved	0.290		0.010	mg/L		27-AUG-10	R1451891
Potassium (K)-Dissolved	2.60		0.50	mg/L		27-AUG-10	R1451891
Sodium (Na)-Dissolved	42.1		1.0	mg/L		27-AUG-10	R1451891
Mercury (Hg) - Dissolved							
Mercury (Hg)-Dissolved	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Miscellaneous Parameters							
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
Dissolved Organic Carbon	<1.0		1.0	mg/L		26-AUG-10	R1449321
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	774		5.0	mg/L		27-AUG-10	R1451390
Total Organic Carbon	1.5		1.0	mg/L		26-AUG-10	R1449321
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	75.8		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	0.258		0.050	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	96.1			%		30-AUG-10	
TDS (Calculated)	717			mg/L		30-AUG-10	
Hardness (as CaCO3)	468			mg/L		30-AUG-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	0.196		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.196		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	398		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	9.44		0.020	mg/L		31-AUG-10	R1454747
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Arsenic (As)-Total	0.00202		0.00040	mg/L		31-AUG-10	R1454747

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-1 BLACKTOP CREEK							
Sampled By: KS/HA on 17-AUG-10 @ 14:42							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Barium (Ba)-Total	0.0394		0.00020	mg/L		31-AUG-10	R1454747
Beryllium (Be)-Total	0.0014		0.0010	mg/L		31-AUG-10	R1454747
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		31-AUG-10	R1454747
Boron (B)-Total	0.031		0.020	mg/L		31-AUG-10	R1454747
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		31-AUG-10	R1454747
Chromium (Cr)-Total	0.00596		0.00080	mg/L		31-AUG-10	R1454747
Cobalt (Co)-Total	0.0204		0.00020	mg/L		31-AUG-10	R1454747
Copper (Cu)-Total	0.0119		0.0010	mg/L		31-AUG-10	R1454747
Lead (Pb)-Total	0.00156		0.00010	mg/L		31-AUG-10	R1454747
Molybdenum (Mo)-Total	0.00019		0.00010	mg/L		31-AUG-10	R1454747
Nickel (Ni)-Total	0.0500		0.00020	mg/L		31-AUG-10	R1454747
Selenium (Se)-Total	0.0032	DLM	0.0020	mg/L		31-AUG-10	R1454747
Silver (Ag)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Strontium (Sr)-Total	0.377		0.00020	mg/L		31-AUG-10	R1454747
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		31-AUG-10	R1454747
Tin (Sn)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Titanium (Ti)-Total	0.116		0.0050	mg/L		31-AUG-10	R1454747
Uranium (U)-Total	0.00164		0.00010	mg/L		31-AUG-10	R1454747
Vanadium (V)-Total	0.00562		0.00050	mg/L		31-AUG-10	R1454747
Zinc (Zn)-Total	0.130		0.0040	mg/L		31-AUG-10	R1454747
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	124		0.50	mg/L		31-AUG-10	R1454832
Iron (Fe)-Total	7.67		0.010	mg/L		31-AUG-10	R1454832
Magnesium (Mg)-Total	51.2		0.10	mg/L		31-AUG-10	R1454832
Manganese (Mn)-Total	0.408		0.0020	mg/L		31-AUG-10	R1454832
Potassium (K)-Total	3.55		0.50	mg/L		31-AUG-10	R1454832
Sodium (Na)-Total	49.2		1.0	mg/L		31-AUG-10	R1454832
Turbidity							
Turbidity	32.1		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	7.88		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	1060		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	76.3		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	62.5		5.0	mg/L		25-AUG-10	R1449176
L922913-2 SLIDRE FIORD							
Sampled By: KS/HA on 17-AUG-10 @ 18:50							
Matrix: WATER							
Dissolved Metals - CDWQ Guidelines							
Diss. Metals in Water by ICPMS (Low)							
Aluminum (Al)-Dissolved	<0.10	DLM	0.10	mg/L		29-AUG-10	R1453309
Antimony (Sb)-Dissolved	<0.0080	DLM	0.0080	mg/L		29-AUG-10	R1453309
Arsenic (As)-Dissolved	0.0461	DLM	0.0080	mg/L		29-AUG-10	R1453309
Barium (Ba)-Dissolved	0.0118	DLM	0.0050	mg/L		29-AUG-10	R1453309
Boron (B)-Dissolved	3.13	DLM	0.050	mg/L		29-AUG-10	R1453309
Cadmium (Cd)-Dissolved	<0.0010	DLM	0.0010	mg/L		29-AUG-10	R1453309
Chromium (Cr)-Dissolved	0.0280	DLM	0.0080	mg/L		29-AUG-10	R1453309
Copper (Cu)-Dissolved	0.016	DLM	0.012	mg/L		29-AUG-10	R1453309
Lead (Pb)-Dissolved	<0.0020	DLM	0.0020	mg/L		29-AUG-10	R1453309
Selenium (Se)-Dissolved	<0.040	DLM	0.040	mg/L		29-AUG-10	R1453309

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-2 SLIDRE FIORD							
Sampled By: KS/HA on 17-AUG-10 @ 18:50							
Matrix: WATER							
Diss. Metals in Water by ICPMS (Low)							
Silver (Ag)-Dissolved	<0.0050	DLM	0.0050	mg/L		29-AUG-10	R1453309
Uranium (U)-Dissolved	0.0023	DLM	0.0020	mg/L		29-AUG-10	R1453309
Zinc (Zn)-Dissolved	0.070	DLM	0.050	mg/L		29-AUG-10	R1453309
Dissolved Metals in Water by ICPOES							
Calcium (Ca)-Dissolved	303	DLM	1.0	mg/L		31-AUG-10	R1454830
Iron (Fe)-Dissolved	0.145	DLM	0.060	mg/L		31-AUG-10	R1454830
Magnesium (Mg)-Dissolved	933	DLM	0.20	mg/L		31-AUG-10	R1454830
Manganese (Mn)-Dissolved	<0.010	DLM	0.010	mg/L		31-AUG-10	R1454830
Potassium (K)-Dissolved	289	DLM	1.0	mg/L		31-AUG-10	R1454830
Sodium (Na)-Dissolved	7820	DLM	2.0	mg/L		31-AUG-10	R1454830
Mercury (Hg) - Dissolved							
Mercury (Hg)-Dissolved	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Miscellaneous Parameters							
Color, True	3.0		2.0	T.C.U.		25-AUG-10	R1449393
Dissolved Organic Carbon	1.3		1.0	mg/L		26-AUG-10	R1449321
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	27300		5.0	mg/L		27-AUG-10	R1451390
Total Organic Carbon	1.3		1.0	mg/L		26-AUG-10	R1449321
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	15500	DLM	50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	<5.0	DLM	5.0	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	91.1			%		31-AUG-10	
TDS (Calculated)	27000			mg/L		31-AUG-10	
Hardness (as CaCO3)	4600			mg/L		31-AUG-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<5.0	DLM	5.0	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<7.1		7.1	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<5.0	DLM	5.0	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	2070	DLM	50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	0.43	DLM	0.20	mg/L		31-AUG-10	R1454747
Antimony (Sb)-Total	<0.0080	DLM	0.0080	mg/L		31-AUG-10	R1454747
Arsenic (As)-Total	<0.080	DLM	0.080	mg/L		31-AUG-10	R1454747
Barium (Ba)-Total	0.0165	DLM	0.0040	mg/L		31-AUG-10	R1454747
Beryllium (Be)-Total	<0.020	DLM	0.020	mg/L		31-AUG-10	R1454747
Bismuth (Bi)-Total	<0.0040	DLM	0.0040	mg/L		31-AUG-10	R1454747
Boron (B)-Total	3.65	DLM	0.080	mg/L		31-AUG-10	R1454747
Cadmium (Cd)-Total	<0.0010	DLM	0.0010	mg/L		31-AUG-10	R1454747
Chromium (Cr)-Total	0.025	DLM	0.016	mg/L		31-AUG-10	R1454747
Cobalt (Co)-Total	<0.0040	DLM	0.0040	mg/L		31-AUG-10	R1454747
Copper (Cu)-Total	<0.020	DLM	0.020	mg/L		31-AUG-10	R1454747
Lead (Pb)-Total	<0.0020	DLM	0.0020	mg/L		31-AUG-10	R1454747
Molybdenum (Mo)-Total	0.0056	DLM	0.0020	mg/L		31-AUG-10	R1454747

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-2 SLIDRE FIORD							
Sampled By: KS/HA on 17-AUG-10 @ 18:50							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Nickel (Ni)-Total	0.0084	DLM	0.0040	mg/L		31-AUG-10	R1454747
Selenium (Se)-Total	<0.40	DLM	0.40	mg/L		31-AUG-10	R1454747
Silver (Ag)-Total	<0.0020	DLM	0.0020	mg/L		31-AUG-10	R1454747
Strontium (Sr)-Total	5.91	DLM	0.0040	mg/L		31-AUG-10	R1454747
Thallium (Tl)-Total	<0.0020	DLM	0.0020	mg/L		31-AUG-10	R1454747
Tin (Sn)-Total	<0.0080	DLM	0.0080	mg/L		31-AUG-10	R1454747
Titanium (Ti)-Total	<0.012	DLM	0.012	mg/L		31-AUG-10	R1454747
Uranium (U)-Total	0.0025	DLM	0.0020	mg/L		31-AUG-10	R1454747
Vanadium (V)-Total	<0.10	DLM	0.10	mg/L		31-AUG-10	R1454747
Zinc (Zn)-Total	<0.080	DLM	0.080	mg/L		31-AUG-10	R1454747
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	336	DLM	10	mg/L		31-AUG-10	R1454832
Iron (Fe)-Total	0.41	DLM	0.20	mg/L		31-AUG-10	R1454832
Magnesium (Mg)-Total	1040	DLM	2.0	mg/L		31-AUG-10	R1454832
Manganese (Mn)-Total	<0.040	DLM	0.040	mg/L		31-AUG-10	R1454832
Potassium (K)-Total	332	DLM	2.0	mg/L		31-AUG-10	R1454832
Sodium (Na)-Total	8750	DLM	20	mg/L		31-AUG-10	R1454832
Turbidity							
Turbidity	2.36		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	7.85		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	39300		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	114		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	93.6		5.0	mg/L		25-AUG-10	R1449176
L922913-3 WATER RESERVOIR							
Sampled By: KS/HA on 18-AUG-10 @ 11:50							
Matrix: WATER							
BTEX & F1-F4							
BTEX and F1 (C6-C10)							
Benzene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
Toluene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
Ethylbenzene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
o-Xylene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
m+p-Xylene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
F1(C6-C10)	<0.10		0.10	mg/L	26-AUG-10	28-AUG-10	R1451309
F1-BTEX	<0.10		0.10	mg/L	26-AUG-10	28-AUG-10	R1451309
Xylenes	<0.00071		0.00071	mg/L	26-AUG-10	28-AUG-10	R1451309
F2, F3, F4							
F2 (>C10-C16)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
F3 (C16-C34)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
F4 (C34-C50)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
Miscellaneous Parameters							
Ammonia-N	<0.050		0.050	mg/L		26-AUG-10	R1450634
Asbestos-TEM	See Attached					28-AUG-10	
Bromate	<0.010		0.010	mg/L		01-SEP-10	R1458404
Chlorate	0.186		0.050	mg/L		01-SEP-10	R1458404
Chlorite	<0.050		0.050	mg/L		01-SEP-10	R1458404
Color, True	3.0		2.0	T.C.U.		25-AUG-10	R1449393
Cyanide, Total	<0.0020		0.0020	mg/L	30-AUG-10	30-AUG-10	R1453055

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-3 WATER RESERVOIR							
Sampled By: KS/HA on 18-AUG-10 @ 11:50							
Matrix: WATER							
Dissolved Organic Carbon	2.9	RRV	1.0	mg/L		26-AUG-10	R1449321
MTBE	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Phenols (4AAP)	<0.0010		0.0010	mg/L		27-AUG-10	R1451976
Special Request	See Attached					16-SEP-10	
Sulphide	<0.0020		0.0020	mg/L		25-AUG-10	R1449662
Sulphide (as H2S)	<0.0020		0.0020	mg/L		26-AUG-10	
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	544		5.0	mg/L		27-AUG-10	R1451390
Total Organic Carbon	<1.0	RRV	1.0	mg/L		26-AUG-10	R1449321
Drinking Water Volatile Organics							
Vinyl chloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,1-Dichloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Methylene chloride	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chloroform	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichloroethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Carbon tetrachloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Benzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Trichloroethene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Toluene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Tetrachloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chlorobenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Ethylbenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
m+p-Xylenes	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
o-Xylene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
1,4-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	100		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Trihalomethanes							
Chloroform	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	100		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Total THMs	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Formaldehyde							
Acetaldehyde	<0.010		0.010	mg/L	26-AUG-10	26-AUG-10	R1452889
Formaldehyde	0.012		0.010	mg/L	26-AUG-10	26-AUG-10	R1452889
Chlorophenols and Benzo(a)Pyrene							
2,4-Dichlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
2,4,6-Trichlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
2,3,4,6-Tetrachlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
Pentachlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
Benzo(a)pyrene	<0.0000050		0.0000050	mg/L	25-AUG-10	27-AUG-10	R1452284
Surrogate: p-Terphenyl d14	89		N/A	%	25-AUG-10	27-AUG-10	R1452284
Surrogate: 2-Fluorophenol	96		N/A	%	25-AUG-10	27-AUG-10	R1452284

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-3 WATER RESERVOIR							
Sampled By: KS/HA on 18-AUG-10 @ 11:50							
Matrix: WATER							
Chlorophenols and Benzo(a)Pyrene							
Surrogate: Phenol d5	90		N/A	%	25-AUG-10	27-AUG-10	R1452284
Surrogate: 2,4,6-Tribromophenol	99		N/A	%	25-AUG-10	27-AUG-10	R1452284
Herbicides/Pesticides-CDWP							
Carbamate Screen in Water							
Aldicarb	<0.90		0.90	ug/L	27-AUG-10	03-SEP-10	R1461155
Azinphos-methyl	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Bendiocarb	<7.0		7.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Carbaryl	<9.0		9.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Carbofuran	<12		12	ug/L	27-AUG-10	03-SEP-10	R1461155
Diuron	<15		15	ug/L	27-AUG-10	03-SEP-10	R1461155
Temephos	<28		28	ug/L	27-AUG-10	03-SEP-10	R1461155
Diquat and Paraquat							
Diquat	<7.0		7.0	ug/L	30-AUG-10	08-SEP-10	R1461822
Paraquat	<1.0		1.0	ug/L	30-AUG-10	08-SEP-10	R1461822
Glyphosate							
Glyphosate	<28		28	ug/L	06-SEP-10	10-SEP-10	R1464154
Herbicide & Organo-phosphate Screen							
Surrogate: 2,4-D d5	37	SURR-ND	N/A	%	27-AUG-10	03-SEP-10	R1461123
Surrogate: Treflan d14	60		N/A	%	27-AUG-10	03-SEP-10	R1461123
Bromoxynil	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Dicamba	<12		12	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4-Dichlorophenol	<90		90	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4-D	<10		10	ug/L	27-AUG-10	03-SEP-10	R1461123
Pentachlorophenol	<6.0		6.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Picloram	<19		19	ug/L	27-AUG-10	03-SEP-10	R1461123
2,3,4,6-Tetrachlorophenol	<10		10	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4,6-Trichlorophenol	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4,5-T	<28		28	ug/L	27-AUG-10	03-SEP-10	R1461123
Alachlor	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Atrazine	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
De-ethylated atrazine	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Chlorpyrifos	<9.0		9.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Cyanazine	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Diazinon	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Diclofop-methyl	<0.90		0.90	ug/L	27-AUG-10	03-SEP-10	R1461123
Dimethoate	<2.5		2.5	ug/L	27-AUG-10	03-SEP-10	R1461123
Dinoseb	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Malathion	<19		19	ug/L	27-AUG-10	03-SEP-10	R1461123
Metribuzin	<8.0		8.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Metolachlor	<5.0		5.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Parathion	<5.0		5.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Phorate	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Prometryne	<0.25		0.25	ug/L	27-AUG-10	03-SEP-10	R1461123
Simazine	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Terbufos	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Triallate	<23		23	ug/L	27-AUG-10	03-SEP-10	R1461123
Trifluralin	<4.5		4.5	ug/L	27-AUG-10	03-SEP-10	R1461123
Atrazine + N-dealkylated metabolites	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
OC Screen GC/ECD							
pp-DDD	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
pp-DDE	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
pp-DDT	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-3 WATER RESERVOIR							
Sampled By: KS/HA on 18-AUG-10 @ 11:50							
Matrix: WATER							
OC Screen GC/ECD							
op-DDT	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
Aldrin	<0.020		0.020	ug/L	27-AUG-10	03-SEP-10	R1461163
Dieldrin	<0.050		0.050	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor epoxide	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163
Lindane	<0.40		0.40	ug/L	27-AUG-10	03-SEP-10	R1461163
Methoxychlor	<90		90	ug/L	27-AUG-10	03-SEP-10	R1461163
a-chlordane	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163
g-chlordane	<0.20		0.20	ug/L	27-AUG-10	03-SEP-10	R1461163
Oxychlordane	<0.40		0.40	ug/L	27-AUG-10	03-SEP-10	R1461163
Chlordane (Total)	<0.70		0.70	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor + Heptachlor Epoxide	<0.20		0.20	ug/L	27-AUG-10	03-SEP-10	R1461163
(DDT) + Metabolites	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461163
Aldrin + Dieldrin	<0.070		0.070	ug/L	27-AUG-10	03-SEP-10	R1461163
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	80.3		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	0.118		0.050	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	109			%		30-AUG-10	
TDS (Calculated)	503			mg/L		30-AUG-10	
Hardness (as CaCO3)	306			mg/L		30-AUG-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.071		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	207		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	0.215		0.020	mg/L		31-AUG-10	R1454747
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Arsenic (As)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Barium (Ba)-Total	0.0196		0.00020	mg/L		31-AUG-10	R1454747
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		31-AUG-10	R1454747
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		31-AUG-10	R1454747
Boron (B)-Total	0.042		0.020	mg/L		31-AUG-10	R1454747
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		31-AUG-10	R1454747
Chromium (Cr)-Total	0.00107		0.00080	mg/L		31-AUG-10	R1454747
Cobalt (Co)-Total	0.00033		0.00020	mg/L		31-AUG-10	R1454747
Copper (Cu)-Total	0.0012		0.0010	mg/L		31-AUG-10	R1454747
Lead (Pb)-Total	0.00015		0.00010	mg/L		31-AUG-10	R1454747
Molybdenum (Mo)-Total	0.00014		0.00010	mg/L		31-AUG-10	R1454747
Nickel (Ni)-Total	0.00278		0.00020	mg/L		31-AUG-10	R1454747
Selenium (Se)-Total	0.0021	DLM	0.0020	mg/L		31-AUG-10	R1454747
Silver (Ag)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Strontium (Sr)-Total	0.276		0.00020	mg/L		31-AUG-10	R1454747
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		31-AUG-10	R1454747

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-3 WATER RESERVOIR							
Sampled By: KS/HA on 18-AUG-10 @ 11:50							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Tin (Sn)-Total	<0.00040		0.00040	mg/L		31-AUG-10	R1454747
Titanium (Ti)-Total	0.0066		0.0050	mg/L		31-AUG-10	R1454747
Uranium (U)-Total	0.00042		0.00010	mg/L		31-AUG-10	R1454747
Vanadium (V)-Total	0.00072		0.00050	mg/L		31-AUG-10	R1454747
Zinc (Zn)-Total	0.0084		0.0040	mg/L		31-AUG-10	R1454747
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	71.6		0.50	mg/L		31-AUG-10	R1454832
Iron (Fe)-Total	0.192		0.010	mg/L		31-AUG-10	R1454832
Magnesium (Mg)-Total	31.0		0.10	mg/L		31-AUG-10	R1454832
Manganese (Mn)-Total	0.0095		0.0020	mg/L		31-AUG-10	R1454832
Potassium (K)-Total	3.74		0.50	mg/L		31-AUG-10	R1454832
Sodium (Na)-Total	61.9		1.0	mg/L		31-AUG-10	R1454832
Turbidity							
Turbidity	3.27		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	8.08		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	792		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	96.7		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	79.3		5.0	mg/L		25-AUG-10	R1449176
L922913-4 FINAL TAP DRINKING WATER							
Sampled By: KS/HA on 18-AUG-10 @ 20:03							
Matrix: WATER							
BTEX & F1-F4							
BTEX and F1 (C6-C10)							
Benzene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
Toluene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
Ethylbenzene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
o-Xylene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
m+p-Xylene	<0.00050		0.00050	mg/L	26-AUG-10	28-AUG-10	R1451309
F1(C6-C10)	<0.10		0.10	mg/L	26-AUG-10	28-AUG-10	R1451309
F1-BTEX	<0.10		0.10	mg/L	26-AUG-10	28-AUG-10	R1451309
Xylenes	<0.00071		0.00071	mg/L	26-AUG-10	28-AUG-10	R1451309
F2, F3, F4							
F2 (>C10-C16)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
F3 (C16-C34)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
F4 (C34-C50)	<0.25		0.25	mg/L	26-AUG-10	26-AUG-10	R1451824
Miscellaneous Parameters							
Ammonia-N	<0.050		0.050	mg/L		26-AUG-10	R1450634
Asbestos-TEM	See Attached					28-AUG-10	
Bromate	<0.010		0.010	mg/L		01-SEP-10	R1458404
Chlorate	<0.050		0.050	mg/L		01-SEP-10	R1458404
Chlorite	<0.050		0.050	mg/L		01-SEP-10	R1458404
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
Cyanide, Total	<0.0020		0.0020	mg/L	30-AUG-10	30-AUG-10	R1453055
MTBE	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Phenols (4AAP)	<0.0010		0.0010	mg/L		27-AUG-10	R1451976
Special Request	See Attached					16-SEP-10	
Sulphide	<0.0020		0.0020	mg/L		25-AUG-10	R1449662

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-4 FINAL TAP DRINKING WATER							
Sampled By: KS/HA on 18-AUG-10 @ 20:03							
Matrix: WATER							
Sulphide (as H2S)	<0.0020		0.0020	mg/L		26-AUG-10	
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	23.0	RRV	5.0	mg/L		01-SEP-10	R1455814
Total Organic Carbon	<1.0		1.0	mg/L		26-AUG-10	R1449321
Drinking Water Volatile Organics							
Vinyl chloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,1-Dichloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Methylene chloride	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chloroform	0.00820		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichloroethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Carbon tetrachloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Benzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Trichloroethene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	0.0131		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	0.0213		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	0.0145		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Toluene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Tetrachloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chlorobenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Ethylbenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
m+p-Xylenes	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
o-Xylene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
1,4-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	101		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	91		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Trihalomethanes							
Chloroform	0.0082		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	0.0131		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	0.0213		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	0.0145		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	101		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	91		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Total THMs	0.0571		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Formaldehyde							
Acetaldehyde	<0.010		0.010	mg/L	26-AUG-10	26-AUG-10	R1452889
Formaldehyde	0.052		0.010	mg/L	26-AUG-10	26-AUG-10	R1452889
Chlorophenols and Benzo(a)Pyrene							
2,4-Dichlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
2,4,6-Trichlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
2,3,4,6-Tetrachlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
Pentachlorophenol	<0.00010		0.00010	mg/L	25-AUG-10	27-AUG-10	R1452284
Benzo(a)pyrene	<0.0000050		0.0000050	mg/L	25-AUG-10	27-AUG-10	R1452284
Surrogate: p-Terphenyl d14	96		N/A	%	25-AUG-10	27-AUG-10	R1452284
Surrogate: 2-Fluorophenol	96		N/A	%	25-AUG-10	27-AUG-10	R1452284
Surrogate: Phenol d5	73		N/A	%	25-AUG-10	27-AUG-10	R1452284
Surrogate: 2,4,6-Tribromophenol	102		N/A	%	25-AUG-10	27-AUG-10	R1452284
Herbicides/Pesticides-CDWP							
Carbamate Screen in Water							
Aldicarb	<0.90		0.90	ug/L	27-AUG-10	03-SEP-10	R1461155

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-4 FINAL TAP DRINKING WATER							
Sampled By: KS/HA on 18-AUG-10 @ 20:03							
Matrix: WATER							
Carbamate Screen in Water							
Azinphos-methyl	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Bendiocarb	<7.0		7.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Carbaryl	<9.0		9.0	ug/L	27-AUG-10	03-SEP-10	R1461155
Carbofuran	<12		12	ug/L	27-AUG-10	03-SEP-10	R1461155
Diuron	<15		15	ug/L	27-AUG-10	03-SEP-10	R1461155
Temephos	<28		28	ug/L	27-AUG-10	03-SEP-10	R1461155
Diquat and Paraquat							
Diquat	<7.0		7.0	ug/L	30-AUG-10	08-SEP-10	R1461822
Paraquat	<1.0		1.0	ug/L	30-AUG-10	08-SEP-10	R1461822
Glyphosate							
Glyphosate	<28		28	ug/L	06-SEP-10	10-SEP-10	R1464154
Herbicide & Organo-phosphate Screen							
Surrogate: 2,4-D d5	37	SURR-ND	N/A	%	27-AUG-10	03-SEP-10	R1461123
Surrogate: Treflan d14	80		N/A	%	27-AUG-10	03-SEP-10	R1461123
Bromoxynil	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Dicamba	<12		12	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4-Dichlorophenol	<90		90	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4-D	<10		10	ug/L	27-AUG-10	03-SEP-10	R1461123
Pentachlorophenol	<6.0		6.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Picloram	<19		19	ug/L	27-AUG-10	03-SEP-10	R1461123
2,3,4,6-Tetrachlorophenol	<10		10	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4,6-Trichlorophenol	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
2,4,5-T	<28		28	ug/L	27-AUG-10	03-SEP-10	R1461123
Alachlor	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Atrazine	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
De-ethylated atrazine	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Chlorpyrifos	<9.0		9.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Cyanazine	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Diazinon	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Diclofop-methyl	<0.90		0.90	ug/L	27-AUG-10	03-SEP-10	R1461123
Dimethoate	<2.5		2.5	ug/L	27-AUG-10	03-SEP-10	R1461123
Dinoseb	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Malathion	<19		19	ug/L	27-AUG-10	03-SEP-10	R1461123
Metribuzin	<8.0		8.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Metolachlor	<5.0		5.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Parathion	<5.0		5.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Phorate	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461123
Prometryne	<0.25		0.25	ug/L	27-AUG-10	03-SEP-10	R1461123
Simazine	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Terbufos	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
Triallate	<23		23	ug/L	27-AUG-10	03-SEP-10	R1461123
Trifluralin	<4.5		4.5	ug/L	27-AUG-10	03-SEP-10	R1461123
Atrazine + N-dealkylated metabolites	<1.0		1.0	ug/L	27-AUG-10	03-SEP-10	R1461123
OC Screen GC/ECD							
pp-DDD	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
pp-DDE	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
pp-DDT	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
op-DDT	<0.50		0.50	ug/L	27-AUG-10	03-SEP-10	R1461163
Aldrin	<0.020		0.020	ug/L	27-AUG-10	03-SEP-10	R1461163
Dieldrin	<0.050		0.050	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor epoxide	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-4 FINAL TAP DRINKING WATER							
Sampled By: KS/HA on 18-AUG-10 @ 20:03							
Matrix: WATER							
OC Screen GC/ECD							
Lindane	<0.40		0.40	ug/L	27-AUG-10	03-SEP-10	R1461163
Methoxychlor	<90		90	ug/L	27-AUG-10	03-SEP-10	R1461163
a-chlordane	<0.10		0.10	ug/L	27-AUG-10	03-SEP-10	R1461163
g-chlordane	<0.20		0.20	ug/L	27-AUG-10	03-SEP-10	R1461163
Oxychlordane	<0.40		0.40	ug/L	27-AUG-10	03-SEP-10	R1461163
Chlordane (Total)	<0.70		0.70	ug/L	27-AUG-10	03-SEP-10	R1461163
Heptachlor + Heptachlor Epoxide	<0.20		0.20	ug/L	27-AUG-10	03-SEP-10	R1461163
(DDT) + Metabolites	<2.0		2.0	ug/L	27-AUG-10	03-SEP-10	R1461163
Aldrin + Dieldrin	<0.070		0.070	ug/L	27-AUG-10	03-SEP-10	R1461163
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	1.37		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	Low EC			%		01-SEP-10	
TDS (Calculated)	4.1			mg/L		01-SEP-10	
Hardness (as CaCO3)	<1.0			mg/L		01-SEP-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.071		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	0.80		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Arsenic (As)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Barium (Ba)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Boron (B)-Total	0.039		0.020	mg/L		30-AUG-10	R1454157
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Chromium (Cr)-Total	<0.00080		0.00080	mg/L		30-AUG-10	R1454157
Cobalt (Co)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Copper (Cu)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Lead (Pb)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Molybdenum (Mo)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Nickel (Ni)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Selenium (Se)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Silver (Ag)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Strontium (Sr)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Tin (Sn)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Titanium (Ti)-Total	<0.0050		0.0050	mg/L		30-AUG-10	R1454157
Uranium (U)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Vanadium (V)-Total	<0.00050		0.00050	mg/L		30-AUG-10	R1454157
Zinc (Zn)-Total	<0.0040		0.0040	mg/L		30-AUG-10	R1454157

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-4 FINAL TAP DRINKING WATER							
Sampled By: KS/HA on 18-AUG-10 @ 20:03							
Matrix: WATER							
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Iron (Fe)-Total	<0.010		0.010	mg/L		30-AUG-10	R1454352
Magnesium (Mg)-Total	<0.10		0.10	mg/L		30-AUG-10	R1454352
Manganese (Mn)-Total	<0.0020		0.0020	mg/L		30-AUG-10	R1454352
Potassium (K)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Sodium (Na)-Total	1.9		1.0	mg/L		30-AUG-10	R1454352
Turbidity							
Turbidity	0.10		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	7.08		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	9.76		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
L922913-5 NON-DRINKING FINAL TAP							
Sampled By: KS/HA on 18-AUG-10 @ 20:32							
Matrix: WATER							
Miscellaneous Parameters							
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	511		5.0	mg/L		27-AUG-10	R1451390
Total Organic Carbon	<1.0		1.0	mg/L		26-AUG-10	R1449321
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	91.3	RRV	0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	0.124		0.050	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	86.2	BL:INT		%		30-AUG-10	
TDS (Calculated)	496			mg/L		30-AUG-10	
Hardness (as CaCO3)	<1.0			mg/L		30-AUG-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	0.357		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	0.357		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	195	RRV	0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	0.066		0.020	mg/L		30-AUG-10	R1454157
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Arsenic (As)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Barium (Ba)-Total	0.00032		0.00020	mg/L		30-AUG-10	R1454157
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Boron (B)-Total	0.043		0.020	mg/L		30-AUG-10	R1454157
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-5 NON-DRINKING FINAL TAP							
Sampled By: KS/HA on 18-AUG-10 @ 20:32							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Chromium (Cr)-Total	<0.00080		0.00080	mg/L		30-AUG-10	R1454157
Cobalt (Co)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Copper (Cu)-Total	0.0824		0.0010	mg/L		30-AUG-10	R1454157
Lead (Pb)-Total	0.00020		0.00010	mg/L		30-AUG-10	R1454157
Molybdenum (Mo)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Nickel (Ni)-Total	0.00033		0.00020	mg/L		30-AUG-10	R1454157
Selenium (Se)-Total	<0.0020	DLM	0.0020	mg/L		30-AUG-10	R1454157
Silver (Ag)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Strontium (Sr)-Total	0.00106		0.00020	mg/L		30-AUG-10	R1454157
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Tin (Sn)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Titanium (Ti)-Total	<0.0050		0.0050	mg/L		30-AUG-10	R1454157
Uranium (U)-Total	0.00029		0.00010	mg/L		30-AUG-10	R1454157
Vanadium (V)-Total	<0.00050		0.00050	mg/L		30-AUG-10	R1454157
Zinc (Zn)-Total	0.0115		0.0040	mg/L		30-AUG-10	R1454157
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	<0.50	RRV	0.50	mg/L		30-AUG-10	R1454352
Iron (Fe)-Total	0.051	RRV	0.010	mg/L		30-AUG-10	R1454352
Magnesium (Mg)-Total	<0.10	RRV	0.10	mg/L		30-AUG-10	R1454352
Manganese (Mn)-Total	<0.0020	RRV	0.0020	mg/L		30-AUG-10	R1454352
Potassium (K)-Total	0.63	RRV	0.50	mg/L		30-AUG-10	R1454352
Sodium (Na)-Total	162	RRV	1.0	mg/L		30-AUG-10	R1454352
Turbidity							
Turbidity	1.25		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	8.19		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	851		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	92.9		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	76.2		5.0	mg/L		25-AUG-10	R1449176
L922913-6 DUP1							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Miscellaneous Parameters							
Ammonia-N	<0.050		0.050	mg/L		26-AUG-10	R1450634
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
MTBE	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Phenols (4AAP)	<0.0010		0.0010	mg/L		27-AUG-10	R1451976
Sulphide	<0.0020		0.0020	mg/L		25-AUG-10	R1449662
Sulphide (as H2S)	<0.0020		0.0020	mg/L		26-AUG-10	
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	18.5	RRV	5.0	mg/L		01-SEP-10	R1455814
Drinking Water Volatile Organics							
Vinyl chloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,1-Dichloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Methylene chloride	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chloroform	0.00800		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichloroethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Carbon tetrachloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-6 DUP1							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Drinking Water Volatile Organics							
Benzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Trichloroethene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	0.0135		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	0.0226		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	0.0144		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Toluene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Tetrachloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chlorobenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Ethylbenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
m+p-Xylenes	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
o-Xylene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
1,4-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	102		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	96		N/A	%	29-AUG-10	29-AUG-10	R1453344
Trihalomethanes							
Chloroform	0.0080		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	0.0135		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	0.0226		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	0.0144		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	102		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	96		N/A	%	29-AUG-10	29-AUG-10	R1453344
Total THMs	0.0585		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	1.35		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Ion Balance Calculation							
Ion Balance	Low EC			%		01-SEP-10	
TDS (Calculated)	4.2			mg/L		01-SEP-10	
Hardness (as CaCO3)	<1.0			mg/L		01-SEP-10	
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.071		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	0.78		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Arsenic (As)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Barium (Ba)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Boron (B)-Total	0.040		0.020	mg/L		30-AUG-10	R1454157

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-6 DUP1							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Chromium (Cr)-Total	<0.00080		0.00080	mg/L		30-AUG-10	R1454157
Cobalt (Co)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Copper (Cu)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Lead (Pb)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Molybdenum (Mo)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Nickel (Ni)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Selenium (Se)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Silver (Ag)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Strontium (Sr)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Tin (Sn)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Titanium (Ti)-Total	<0.0050		0.0050	mg/L		30-AUG-10	R1454157
Uranium (U)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Vanadium (V)-Total	<0.00050		0.00050	mg/L		30-AUG-10	R1454157
Zinc (Zn)-Total	<0.0040		0.0040	mg/L		30-AUG-10	R1454157
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Iron (Fe)-Total	<0.010		0.010	mg/L		30-AUG-10	R1454352
Magnesium (Mg)-Total	<0.10		0.10	mg/L		30-AUG-10	R1454352
Manganese (Mn)-Total	<0.0020		0.0020	mg/L		30-AUG-10	R1454352
Potassium (K)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Sodium (Na)-Total	2.1		1.0	mg/L		31-AUG-10	R1454832
Turbidity							
Turbidity	0.11		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	6.88		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	9.97		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
L922913-7 DUP2							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Miscellaneous Parameters							
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
MTBE	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	<5.0		5.0	mg/L		27-AUG-10	R1451390
Drinking Water Volatile Organics							
Vinyl chloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,1-Dichloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Methylene chloride	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chloroform	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichloroethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Carbon tetrachloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Benzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Trichloroethene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-7 DUP2							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Drinking Water Volatile Organics							
Dibromochloromethane	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Toluene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Tetrachloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chlorobenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Ethylbenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
m+p-Xylenes	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
o-Xylene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
1,4-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	102		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	95		N/A	%	29-AUG-10	29-AUG-10	R1453344
Trihalomethanes							
Chloroform	0.0026		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	102		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	95		N/A	%	29-AUG-10	29-AUG-10	R1453344
Total THMs	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	<0.50		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.071		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	<0.50		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Arsenic (As)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Barium (Ba)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Boron (B)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Chromium (Cr)-Total	<0.00080		0.00080	mg/L		30-AUG-10	R1454157
Cobalt (Co)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Copper (Cu)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Lead (Pb)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Molybdenum (Mo)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Nickel (Ni)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Selenium (Se)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-7 DUP2							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Silver (Ag)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Strontium (Sr)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Tin (Sn)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Titanium (Ti)-Total	<0.0050		0.0050	mg/L		30-AUG-10	R1454157
Uranium (U)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Vanadium (V)-Total	<0.00050		0.00050	mg/L		30-AUG-10	R1454157
Zinc (Zn)-Total	<0.0040		0.0040	mg/L		30-AUG-10	R1454157
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Iron (Fe)-Total	<0.010		0.010	mg/L		30-AUG-10	R1454352
Magnesium (Mg)-Total	<0.10		0.10	mg/L		30-AUG-10	R1454352
Manganese (Mn)-Total	<0.0020		0.0020	mg/L		30-AUG-10	R1454352
Potassium (K)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Sodium (Na)-Total	<1.0		1.0	mg/L		30-AUG-10	R1454352
Turbidity							
Turbidity	<0.10		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	5.94		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	0.50		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
L922913-8 TRIP BLANK							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Miscellaneous Parameters							
Color, True	<2		2.0	T.C.U.		25-AUG-10	R1449393
MTBE	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Temperature	25.0		1.0	Degree C		25-AUG-10	R1449176
Total Dissolved Solids	<5.0		5.0	mg/L		27-AUG-10	R1451390
Total Organic Carbon	<1.0		1.0	mg/L		26-AUG-10	R1449321
Drinking Water Volatile Organics							
Vinyl chloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,1-Dichloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Methylene chloride	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chloroform	0.00370		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichloroethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Carbon tetrachloride	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Benzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
1,2-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Trichloroethene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.00050		0.00050	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.00060		0.00060	mg/L	29-AUG-10	29-AUG-10	R1453344
Toluene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Tetrachloroethylene	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Chlorobenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
Ethylbenzene	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344
m+p-Xylenes	<0.00010		0.00010	mg/L	29-AUG-10	29-AUG-10	R1453344

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-8 TRIP BLANK							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Drinking Water Volatile Organics							
o-Xylene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
1,4-Dichlorobenzene	<0.00020		0.00020	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	83		N/A	%	29-AUG-10	29-AUG-10	R1453344
Trihalomethanes							
Chloroform	0.0037		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromodichloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Dibromochloromethane	<0.0010		0.0010	mg/L	29-AUG-10	29-AUG-10	R1453344
Bromoform	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Surrogate: 1,2-Dichloroethane d4	98		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: Toluene d8	99		N/A	%	29-AUG-10	29-AUG-10	R1453344
Surrogate: 4-Bromofluorobenzene	83		N/A	%	29-AUG-10	29-AUG-10	R1453344
Total THMs	<0.0050		0.0050	mg/L	29-AUG-10	29-AUG-10	R1453344
Routine Potable Water plus Metals							
Chloride by IC							
Chloride (Cl)	<0.50		0.50	mg/L		25-AUG-10	R1449889
Fluoride by IC							
Fluoride (F)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Mercury (Hg) - Total							
Mercury (Hg)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1453405
Nitrate as N by IC							
Nitrate (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.071		0.071	mg/L		27-AUG-10	
Nitrite as N by IC							
Nitrite (as N)	<0.050		0.050	mg/L		25-AUG-10	R1449889
Sulfate by IC							
Sulfate (SO4)	<0.50		0.50	mg/L		25-AUG-10	R1449889
Total Metals in Water by ICPMS (Low)							
Aluminum (Al)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Antimony (Sb)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Arsenic (As)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Barium (Ba)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Beryllium (Be)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Boron (B)-Total	<0.020		0.020	mg/L		30-AUG-10	R1454157
Cadmium (Cd)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Chromium (Cr)-Total	<0.00080		0.00080	mg/L		30-AUG-10	R1454157
Cobalt (Co)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Copper (Cu)-Total	<0.0010		0.0010	mg/L		30-AUG-10	R1454157
Lead (Pb)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Molybdenum (Mo)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Nickel (Ni)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Selenium (Se)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Silver (Ag)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Strontium (Sr)-Total	<0.00020		0.00020	mg/L		30-AUG-10	R1454157
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Tin (Sn)-Total	<0.00040		0.00040	mg/L		30-AUG-10	R1454157
Titanium (Ti)-Total	<0.0050		0.0050	mg/L		30-AUG-10	R1454157
Uranium (U)-Total	<0.00010		0.00010	mg/L		30-AUG-10	R1454157
Vanadium (V)-Total	<0.00050		0.00050	mg/L		30-AUG-10	R1454157

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L922913-8 TRIP BLANK							
Sampled By: KS/HA on 18-AUG-10 @ 12:00							
Matrix: WATER							
Total Metals in Water by ICPMS (Low)							
Zinc (Zn)-Total	<0.0040		0.0040	mg/L		30-AUG-10	R1454157
Total Metals in Water by ICPOES (Low)							
Calcium (Ca)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Iron (Fe)-Total	<0.010		0.010	mg/L		30-AUG-10	R1454352
Magnesium (Mg)-Total	<0.10		0.10	mg/L		30-AUG-10	R1454352
Manganese (Mn)-Total	<0.0020		0.0020	mg/L		30-AUG-10	R1454352
Potassium (K)-Total	<0.50		0.50	mg/L		30-AUG-10	R1454352
Sodium (Na)-Total	<1.0		1.0	mg/L		30-AUG-10	R1454352
Turbidity							
Turbidity	<0.10		0.10	NTU		25-AUG-10	R1449472
pH, Conductivity and Total Alkalinity							
pH	5.80		0.10	pH		25-AUG-10	R1449176
Conductivity (EC)	0.62		0.20	uS/cm		25-AUG-10	R1449176
Bicarbonate (HCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Carbonate (CO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Hydroxide (OH)	<5.0		5.0	mg/L		25-AUG-10	R1449176
Alkalinity, Total (as CaCO3)	<5.0		5.0	mg/L		25-AUG-10	R1449176

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Selenium (Se)-Dissolved	DLM	L922913-1, -2
Duplicate	Iron (Fe)-Total	G	L922913-1, -2, -3
Comments: Results for iron is 2% off the acceptance criteria. We have not identified a major non-conformance, and therefore have approved the related client data.			
Laboratory Control Sample	2,3,4,6-Tetrachlorophenol	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	2,4,6-Trichlorophenol	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	2,4-Dichlorophenol	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	Pentachlorophenol	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample Duplicate	Bromoxynil	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable. %RPD outside DQO for bromoxynil, phorate and terbufos. No residues detected in samples. Data reliable.			
Laboratory Control Sample Duplicate	Phorate	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable. %RPD outside DQO for bromoxynil, phorate and terbufos. No residues detected in samples. Data reliable.			
Laboratory Control Sample Duplicate	Terbufos	G	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable. %RPD outside DQO for bromoxynil, phorate and terbufos. No residues detected in samples. Data reliable.			
Laboratory Control Sample Duplicate	Aldicarb	G	L922913-3, -4
Comments: %RPD outside DQO for several parameters, possibly due to to extraction error for LCSD. No residues were detected in samples. Data reliable.			
Laboratory Control Sample Duplicate	Azinphos-methyl	G	L922913-3, -4
Comments: %RPD outside DQO for several parameters, possibly due to to extraction error for LCSD. No residues were detected in samples. Data reliable.			
Laboratory Control Sample	Aldicarb	LCS-L	L922913-3, -4
Laboratory Control Sample	2,4-D	LCS-ND	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	Bromoxynil	LCS-ND	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	Phorate	LCS-ND	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Laboratory Control Sample	Picloram	LCS-ND	L922913-3, -4
Comments: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.			
Matrix Spike	Sulfate (SO4)	MS-B	L922913-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Total Organic Carbon	MS-B	L922913-1, -2, -3, -4, -5, -8
Matrix Spike	Chloride (Cl)	MS-B	L922913-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Nitrate (as N)	MS-B	L922913-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Chloride (Cl)	MS-B	L922913-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfate (SO4)	MS-B	L922913-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Total Organic Carbon	MS-B	L922913-1, -2, -3, -4, -5, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L922913-1, -2, -3

Qualifiers for Individual Samples Listed:

Sample Numbe	Client ID	Qualifier	Description
L922913-3	WATER RESERVOIR	SP	sulphide, NH4, Phenols - Sample was Preserved at the laboratory
L922913-4	FINAL TAP DRINKING WATI	SP	sulphide, NH4, Phenols - Sample was Preserved at the laboratory
L922913-6	DUP1	SP	sulphide, NH4, Phenols - Sample was Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
BL:INT	Balance Reviewed: Interference Or Non-Measured Component
DLM	Detection Limit Adjusted For Sample Matrix Effects

Reference Information

E	Matrix Spike recovery outside ALS DQO due to analyte background in sample.
G	QC result did not meet ALS DQO. Refer to narrative comments for further information.
LCS-L	Lab Control Sample recovery was below ALS DQO. Reference Material and/or Matrix Spike results were acceptable. Non-detected sample results are considered reliable. Other results, if reported, have been qualified.
LCS-ND	Lab Control Sample recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
NR:SNA	No Result: Surrogate Not Added
RRV	Reported Result Verified By Repeat Analysis
SURR-ND	Surrogate recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ASBESTOS-TEM-AD	Water	Asbestos TEM Datachem Ohio	SEE SUBLET LAB RESULTS
BAP,CHLPHN-ED	Water	Chlorophenols and Benzo(a)Pyrene	EPA 3510/8270-GC-MS
BRO3-IND-ED	Water	Bromate	EPA 300-Ion Chromatography
BTX,F1-ED	Water	BTEX and F1 (C6-C10)	EPA 5021/8015&8260 GC-MS & FID
C-DIS-ORG-ED	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental
C-TOT-ORG-ED	Water	Total Organic Carbon	APHA 5310 B-Instrumental
CARBAMATE-CDWP-ED	Water	Carbamate Screen in Water	EPA 8318-LC/MS/MS
CL-IC-ED	Water	Chloride by IC	APHA 4110 B-ION CHROMATOGRAPHY
CLO2-IND-ED	Water	Chlorite	EPA 300-Ion Chromatography
CLO3-IND-ED	Water	Chlorate	EPA 300-Ion Chromatography
CN-TOT-WT	Water	Cyanide, Total	APHA 4500CN C E-STRONG ACID DIST COLORIM
Total cyanide is determined by the combination of UV digestion and distillation. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.			
COL-TRU-ED	Water	Color, True	APHA 2120
The reported color applies to the pH of the sample as submitted unless otherwise noted on the report.			
DI/PARAQUAT-CDWP-ED	Water	Diquat and Paraquat	DQPQ-E3405
F-IC-ED	Water	Fluoride by IC	APHA 4110 B-ION CHROMATOGRAPHY
F2,F3,F4-ED	Water	F2, F3, F4	EPA 3510/CCME PHC CWS-GC-FID
FOR-ED	Water	Formaldehyde	EPA 8270 GC/MS
"Ozonation Byproducts. 2. Improvement of an Aqueous-Phase Derivatization Method for the Detection of Formaldehyde and Other Carbonyl Compounds Formed by the Ozonation of Drinking Water": William H. Glaze, Minoru Koga and Devon Cancilla;Env Science and Technology, 1989, #23, 838-847			
GLYPHOSATE-CDWP-ED	Water	Glyphosate	EPA 8318-HPLC/Fluorescence
HERB,OP-CDWP-ED	Water	Herbicide & Organo-phosphate Screen	EPA 8151-GC/MS
HG-D-CVAA-ED	Water	Mercury (Hg) - Dissolved	EPA 245.7 / EPA 245.1
HG-T-CVAA-ED	Water	Mercury (Hg) - Total	EPA 245.7 / EPA 245.1
IONBALANCE-ED	Water	Ion Balance Calculation	APHA 1030E
MET-D-ICP-ED	Water	Dissolved Metals in Water by ICPOES	APHA 3120 B-ICP-OES
MET-D-L-MS-ED	Water	Diss. Metals in Water by ICPMS (Low)	SW 846 - 6020-ICPMS
MET-T-L-ICP-ED	Water	Total Metals in Water by ICPOES (Low)	APHA 3120 B-ICP-OES
MET-T-L-MS-ED	Water	Total Metals in Water by ICPMS (Low)	SW 846 - 6020-ICPMS

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NH4-ED	Water	Ammonia-N	APHA4500NH3F Colorimetry
NO2+NO3-CALC-ED	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-ED	Water	Nitrite as N by IC	APHA 4110 B-ION CHROMATOGRAPHY
NO3-IC-ED	Water	Nitrate as N by IC	APHA 4110 B-ION CHROMATOGRAPHY
OCSCREEN-CDWP-ED	Water	OC Screen GC/ECD	EPA 8081-GC/ECD
PH/EC/ALK-ED	Water	pH, Conductivity and Total Alkalinity	APHA 4500-H, 2510, 2320
PHENOLS-4AAP-ED	Water	Phenols (4AAP)	AB ENV.06537-COLORIMETRIC
SO4-IC-ED	Water	Sulfate by IC	APHA 4110 B-ION CHROMATOGRAPHY
SOLIDS-TDS-ED	Water	Total Dissolved Solids	APHA 2540 C
SPECIAL REQUEST-BE	Misc.	Radionuclides Becquerel Labs	SEE SUBLET LAB RESULTS
SULPHIDE-ED	Water	Sulphide	APHA 4500 -S E-Auto-Colorimetry
SULPHIDE>H2S-ED	Water	Sulphide as Hydrogen Sulphide	Calculation from Sulphide
TEMP-ED	Water	Temperature	APHA 2550-Thermometer
THM-ED	Water	Trihalomethanes	SW 846 8260-GC/MS
TURBIDITY-ED	Water	Turbidity	APHA 2130 B-Nephelometer
VOC-DRINKING-ED	Water	Drinking Water Volatile Organics	EPA 5030/8260-GC-MS
VOC-MISC-ED	Water	Misc. Volatile Organics	EPA 5000/8260-HEADSPACE GC/MS

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
ED	ALS LABORATORY GROUP - EDMONTON, ALBERTA, CANADA
WT	ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA
BE	Bequerel Laboratories Inc. - Mississauga, Ontario, Canada
AD	ALS DATACHEM LABORATORIES

Chain of Custody Numbers:

10-062841 10-062842

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS LABORATORY GROUP SOIL SALINITY CONVERSION

L922913

Lab ID	Sample ID					Lab ID	Sample ID				

"Calculations are as per:
Methods of Analysis for Soils, Plants and Waters
Homer D. Chapman and Parker F. Pratt
University of California, Riverside, Cl.
August, 1961."

Quality Control Report

Workorder: L922913 Report Date: 17-SEP-10

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BAP,CHLPHN-ED	**Water**							
Batch R1452284								
WG1154307-3 LCS								
2,4-Dichlorophenol			57		%		40-130	27-AUG-10
2,4,6-Trichlorophenol			70		%		50-130	27-AUG-10
2,3,4,6-Tetrachlorophenol			80		%		60-130	27-AUG-10
Pentachlorophenol			86		%		60-130	27-AUG-10
Benzo(a)pyrene			87		%		-	27-AUG-10
WG1155798-3 LCS								
2,4-Dichlorophenol			81		%		40-130	27-AUG-10
2,4,6-Trichlorophenol			111		%		50-130	27-AUG-10
2,3,4,6-Tetrachlorophenol			103		%		60-130	27-AUG-10
Pentachlorophenol			102		%		60-130	27-AUG-10
Benzo(a)pyrene			99		%		60-130	27-AUG-10
WG1154307-2 MB								
2,4-Dichlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
2,4,6-Trichlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
2,3,4,6-Tetrachlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
Pentachlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
Benzo(a)pyrene			<0.000005		mg/L			27-AUG-10
WG1155798-2 MB								
2,4-Dichlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
2,4,6-Trichlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
2,3,4,6-Tetrachlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
Pentachlorophenol			<0.00010		mg/L		0.0001	27-AUG-10
Benzo(a)pyrene			<0.000005(		mg/L		0.000005	27-AUG-10
BRO3-IND-ED	**Water**							
Batch R1458404								
WG1161593-3 DUP		**L922913-4**						
Bromate		<0.010	<0.010	RPD-NA	mg/L	N/A	26	01-SEP-10
WG1161593-2 LCS								
Bromate			105		%		85-115	01-SEP-10
WG1161593-1 MB								
Bromate			<0.010		mg/L		0.01	01-SEP-10
BTX,F1-ED	**Water**							

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BTX,F1-ED	**Water**							
Batch R1451309								
WG1156901-4 DUP		**L922701-3**						
Benzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	29-AUG-10
Toluene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	29-AUG-10
Ethylbenzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	29-AUG-10
o-Xylene		0.00138	0.00174		mg/L	23	24	29-AUG-10
m+p-Xylene		0.00202	0.00221		mg/L	9.1	24	29-AUG-10
F1(C6-C10)		<0.10	<0.10	RPD-NA	mg/L	N/A	30	29-AUG-10
WG1156901-2 LCS								
Benzene			110		%		70-130	29-AUG-10
Toluene			112		%		70-130	29-AUG-10
Ethylbenzene			114		%		70-130	29-AUG-10
o-Xylene			111		%		70-130	29-AUG-10
m+p-Xylene			112		%		70-130	29-AUG-10
WG1156901-3 LCS								
F1(C6-C10)			108		%		70-130	29-AUG-10
WG1156901-1 MB								
Benzene			<0.00050		mg/L		0.0005	29-AUG-10
Toluene			<0.00050		mg/L		0.0005	29-AUG-10
Ethylbenzene			<0.00050		mg/L		0.0005	29-AUG-10
o-Xylene			<0.00050		mg/L		0.0005	29-AUG-10
m+p-Xylene			<0.00050		mg/L		0.0005	29-AUG-10
F1(C6-C10)			<0.10		mg/L		0.1	29-AUG-10
C-DIS-ORG-ED	**Water**							
Batch R1449321								
WG1156090-12 CVS								
Dissolved Organic Carbon			103		%		80-160	26-AUG-10
WG1156090-19 CVS								
Dissolved Organic Carbon			103		%		80-160	27-AUG-10
WG1156090-3 CVS								
Dissolved Organic Carbon			105		%		80-160	25-AUG-10
WG1156090-35 CVS								
Dissolved Organic Carbon			106		%		80-160	31-AUG-10
WG1156090-26 DUP		**L921883-2**						
Dissolved Organic Carbon		4.7	4.7		mg/L	0.85	20	28-AUG-10
WG1156090-36 DUP		**L924716-3**						
Dissolved Organic Carbon		28.5	28.3		mg/L	0.42	20	30-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-ED	**Water**							
Batch R1449321								
WG1156090-11 LCS								
Dissolved Organic Carbon			95		%		80-120	26-AUG-10
WG1156090-18 LCS								
Dissolved Organic Carbon			94		%		80-120	27-AUG-10
WG1156090-2 LCS								
Dissolved Organic Carbon			95		%		80-120	25-AUG-10
WG1156090-32 LCS								
Dissolved Organic Carbon			103		%		80-120	30-AUG-10
WG1156090-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	25-AUG-10
WG1156090-10 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	26-AUG-10
WG1156090-17 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	27-AUG-10
WG1156090-27 MS		**L921883-2**						
Dissolved Organic Carbon			97		%		70-130	28-AUG-10
WG1156090-37 MS		**L924716-3**						
Dissolved Organic Carbon			N/A	MS-B	%		-	30-AUG-10
C-TOT-ORG-ED	**Water**							
Batch R1449321								
WG1156090-12 CVS								
Total Organic Carbon			103		%		80-160	27-AUG-10
WG1156090-19 CVS								
Total Organic Carbon			103		%		80-160	27-AUG-10
WG1156090-3 CVS								
Total Organic Carbon			105		%		80-160	25-AUG-10
WG1156090-35 CVS								
Total Organic Carbon			106		%		80-160	31-AUG-10
WG1156090-13 DUP		**L919278-4**						
Total Organic Carbon		<1.0	<1.0	RPD-NA	mg/L	N/A	20	26-AUG-10
WG1156090-15 DUP		**L920913-5**						
Total Organic Carbon		5.4	5.4		mg/L	0.74	20	26-AUG-10
WG1156090-20 DUP		**L923405-4**						
Total Organic Carbon		3.1	3.0		mg/L	4.2	20	27-AUG-10
WG1156090-22 DUP		**L919812-10**						
Total Organic Carbon		2.2	2.1		mg/L	4.6	20	27-AUG-10
WG1156090-24 DUP		**L921293-14**						
Total Organic Carbon		2.8	2.7		mg/L	3.2	20	28-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TOT-ORG-ED	**Water**							
Batch R1449321								
WG1156090-28 DUP		**L924596-4**						
Total Organic Carbon		3.0	2.9		mg/L	3.1	20	28-AUG-10
WG1156090-30 DUP		**L919880-15**						
Total Organic Carbon		<1.0	<1.0	RPD-NA	mg/L	N/A	20	30-AUG-10
WG1156090-33 DUP		**L922165-2**						
Total Organic Carbon		11.8	10.8		mg/L	8.4	20	30-AUG-10
WG1156090-4 DUP		**L921743-2**						
Total Organic Carbon		4.7	4.6		mg/L	3.2	20	25-AUG-10
WG1156090-6 DUP		**L921992-8**						
Total Organic Carbon		<1.0	<1.0	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156090-8 DUP		**L918842-2**						
Total Organic Carbon		23.9	24.3		mg/L	1.7	20	25-AUG-10
WG1156090-11 LCS								
Total Organic Carbon			95		%		80-120	27-AUG-10
WG1156090-18 LCS								
Total Organic Carbon			94		%		80-120	27-AUG-10
WG1156090-2 LCS								
Total Organic Carbon			95		%		80-120	25-AUG-10
WG1156090-32 LCS								
Total Organic Carbon			103		%		80-120	31-AUG-10
WG1156090-1 MB								
Total Organic Carbon			<1.0		mg/L		1	25-AUG-10
WG1156090-10 MB								
Total Organic Carbon			<1.0		mg/L		1	26-AUG-10
WG1156090-17 MB								
Total Organic Carbon			<1.0		mg/L		1	27-AUG-10
WG1156090-14 MS		**L919278-4**						
Total Organic Carbon			98		%		70-130	26-AUG-10
WG1156090-16 MS		**L920913-5**						
Total Organic Carbon			93		%		70-130	26-AUG-10
WG1156090-21 MS		**L923405-4**						
Total Organic Carbon			93		%		70-130	27-AUG-10
WG1156090-23 MS		**L919812-10**						
Total Organic Carbon			97		%		70-130	27-AUG-10
WG1156090-25 MS		**L921293-14**						
Total Organic Carbon			100		%		70-130	28-AUG-10
WG1156090-29 MS		**L924596-4**						
Total Organic Carbon			97		%		70-130	28-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TOT-ORG-ED	**Water**							
Batch R1449321								
WG1156090-31 MS		**L919880-15**						
Total Organic Carbon			101		%		70-130	30-AUG-10
WG1156090-34 MS		**L922165-2**						
Total Organic Carbon			N/A	MS-B	%		-	30-AUG-10
WG1156090-5 MS		**L921743-2**						
Total Organic Carbon			98		%		70-130	25-AUG-10
WG1156090-7 MS		**L921992-8**						
Total Organic Carbon			97		%		70-130	25-AUG-10
WG1156090-9 MS		**L918842-2**						
Total Organic Carbon			N/A	MS-B	%		-	25-AUG-10
CARBAMATE-CDWP-ED	**Water**							
Batch R1461155								
WG1157198-3 LCS								
Aldicarb			29	LCS-L	%		40-130	03-SEP-10
Azinphos-methyl			40		%		40-140	03-SEP-10
Bendiocarb			59		%		30-130	03-SEP-10
Carbaryl			46		%		30-130	03-SEP-10
Carbofuran			51		%		28-143	03-SEP-10
Diuron			50		%		40-140	03-SEP-10
Temephos			48		%		-4-167	03-SEP-10
WG1157198-4 LCSD		**WG1157198-3**						
Aldicarb		29	4	G	%	150	50	03-SEP-10
Azinphos-methyl		40	24	G	%	51	50	03-SEP-10
Bendiocarb		59	39		%	42	50	03-SEP-10
Carbaryl		46	33		%	32	50	03-SEP-10
Carbofuran		51	43		%	16	50	03-SEP-10
Diuron		50	37		%	32	50	03-SEP-10
Temephos		48	37		%	26	50	03-SEP-10
COMMENTS: %RPD outside DQO for several parameters, possibly due to to extraction error for LCSD. No residues were detected in samples. Data reliable.								
WG1157198-2 MB								
Aldicarb			<0.90		ug/L		0.9	03-SEP-10
Azinphos-methyl			<2.0		ug/L		2	03-SEP-10
Bendiocarb			<7.0		ug/L		7	03-SEP-10
Carbaryl			<9.0		ug/L		9	03-SEP-10
Carbofuran			<12		ug/L		12	03-SEP-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CARBAMATE-CDWP-ED	**Water**							
Batch R1461155								
WG1157198-2 MB								
Diuron			<15		ug/L		15	03-SEP-10
Temephos			<28		ug/L		28	03-SEP-10
CL-IC-ED	**Water**							
Batch R1449889								
WG1156076-11 DUP		**L924331-1**						
Chloride (Cl)		155	155		mg/L	0.063	20	25-AUG-10
WG1156076-3 DUP		**L922913-8**						
Chloride (Cl)		<0.50	<0.50	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-5 DUP		**L923785-15**						
Chloride (Cl)		15.8	15.8		mg/L	0.050	20	25-AUG-10
WG1156076-9 DUP		**L917893-13**						
Chloride (Cl)		103	102		mg/L	0.048	20	26-AUG-10
WG1156076-2 LCS								
Chloride (Cl)			110		%		85-115	25-AUG-10
WG1156076-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	25-AUG-10
WG1156076-10 MS		**L917893-13**						
Chloride (Cl)			N/A	MS-B	%		-	26-AUG-10
WG1156076-12 MS		**L924331-1**						
Chloride (Cl)			N/A	MS-B	%		-	25-AUG-10
WG1156076-4 MS		**L922913-8**						
Chloride (Cl)			109		%		75-125	25-AUG-10
WG1156076-6 MS		**L923785-15**						
Chloride (Cl)			107		%		75-125	25-AUG-10
CLO2-IND-ED	**Water**							
Batch R1458404								
WG1161593-3 DUP		**L922913-4**						
Chlorite		<0.050	<0.050	RPD-NA	mg/L	N/A	10	01-SEP-10
WG1161593-2 LCS								
Chlorite			101		%		85-115	01-SEP-10
WG1161593-1 MB								
Chlorite			<0.050		mg/L		0.05	01-SEP-10
CLO3-IND-ED	**Water**							

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CLO3-IND-ED	**Water**							
Batch R1458404								
WG1161593-3 DUP		**L922913-4**						
Chlorate		<0.050	<0.050	RPD-NA	mg/L	N/A	6.5	01-SEP-10
WG1161593-2 LCS								
Chlorate			101		%		85-115	01-SEP-10
WG1161593-1 MB								
Chlorate			<0.050		mg/L		0.05	01-SEP-10
CN-TOT-WT	**Water**							
Batch R1453055								
WG1158429-4 CVS								
Cyanide, Total			100		%		85-115	30-AUG-10
WG1158429-3 LCS								
Cyanide, Total			111		%		80-120	30-AUG-10
WG1158429-1 MB								
Cyanide, Total			<0.0020		mg/L		0.002	30-AUG-10
COL-TRU-ED	**Water**							
Batch R1449393								
WG1155963-3 DUP		**L922913-8**						
WG1155963-2 LCS								
Color, True			100		%		85-115	25-AUG-10
WG1155963-1 MB								
Color, True			<2		T.C.U.			25-AUG-10
DI/PARAQUAT-CDWP-ED	**Water**							
Batch R1461822								
WG1157206-2 LCS								
Diquat			66		%		40-150	08-SEP-10
Paraquat			66		%		30-140	08-SEP-10
WG1157206-3 LCSD		**WG1157206-2**						
Diquat		66	77		%	15	50	08-SEP-10
Paraquat		66	71		%	7.2	50	08-SEP-10
WG1157206-1 MB								
Diquat			<7.0		ug/L		7	08-SEP-10
Paraquat			<1.0		ug/L		1	08-SEP-10
F-IC-ED	**Water**							
Batch R1449889								
WG1156076-3 DUP		**L922913-8**						
Fluoride (F)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-2 LCS								

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-ED	**Water**							
Batch R1449889								
WG1156076-2 LCS								
Fluoride (F)			108		%		85-115	25-AUG-10
WG1156076-1 MB								
Fluoride (F)			<0.050		mg/L		0.05	25-AUG-10
WG1156076-4 MS		**L922913-8**						
Fluoride (F)			110		%		75-125	25-AUG-10
F2,F3,F4-ED	**Water**							
Batch R1451824								
WG1157680-2 LCS								
F2 (>C10-C16)			96		%		65-135	26-AUG-10
F3 (C16-C34)			96		%		65-135	26-AUG-10
F4 (C34-C50)			96		%		65-135	26-AUG-10
WG1157680-1 MB								
F2 (>C10-C16)			<0.25		mg/L		0.25	26-AUG-10
F3 (C16-C34)			<0.25		mg/L		0.25	26-AUG-10
F4 (C34-C50)			<0.25		mg/L		0.25	26-AUG-10
WG1157680-4 MS		**L922913-3**						
F2 (>C10-C16)			100		%		50-150	26-AUG-10
F3 (C16-C34)			100		%		50-150	26-AUG-10
F4 (C34-C50)			100		%		50-150	26-AUG-10
FOR-ED	**Water**							
Batch R1452889								
WG1156147-4 DUP		**L922913-4**						
Acetaldehyde		<0.010	<0.010	RPD-NA	mg/L	N/A	33	26-AUG-10
Formaldehyde		0.052	0.050		mg/L	2.7	39	26-AUG-10
WG1156147-2 LCS								
Acetaldehyde			120		%		70-130	26-AUG-10
Formaldehyde			108		%		44-148	26-AUG-10
WG1156147-1 MB								
Acetaldehyde			<0.010		mg/L		0.01	26-AUG-10
Formaldehyde			<0.010		mg/L		0.01	26-AUG-10
GLYPHOSATE-CDWP-ED	**Water**							
Batch R1464154								
WG1157205-2 LCS								
Glyphosate			72		%		40-140	10-SEP-10
WG1157205-3 LCSD		**WG1157205-2**						

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
GLYPHOSATE-CDWP-ED	**Water**							
Batch R1464154								
WG1157205-3 LCSD		**WG1157205-2**						
Glyphosate		72	91		%	23	50	10-SEP-10
WG1157205-1 MB								
Glyphosate			<28		ug/L		28	10-SEP-10
HERB,OP-CDWP-ED	**Water**							
Batch R1461123								
WG1157198-3 LCS								
Bromoxynil			48	LCS-ND	%		50-150	03-SEP-10
Dicamba			89		%		50-150	03-SEP-10
2,4-Dichlorophenol			0	G	%		50-130	03-SEP-10
2,4-D			183	LCS-ND	%		50-150	03-SEP-10
Pentachlorophenol			0	G	%		60-130	03-SEP-10
Picloram			46	LCS-ND	%		50-150	03-SEP-10
2,3,4,6-Tetrachlorophenol			0	G	%		60-130	03-SEP-10
2,4,6-Trichlorophenol			0	G	%		50-130	03-SEP-10
2,4,5-T			120		%		50-150	03-SEP-10
Alachlor			90		%		43-171	03-SEP-10
Atrazine			71		%		12-187	03-SEP-10
De-ethylated atrazine			55		%		55-145	03-SEP-10
Chlorpyrifos			46		%		35-137	03-SEP-10
Cyanazine			76		%		0-216	03-SEP-10
Diazinon			63		%		-12-159	03-SEP-10
Diclofop-methyl			120		%		50-150	03-SEP-10
Dimethoate			47		%		-35-145	03-SEP-10
Dinoseb			56		%		50-150	03-SEP-10
Malathion			51		%		-19-167	03-SEP-10
Metribuzin			94		%		-24-206	03-SEP-10
Metolachlor			89		%		29-162	03-SEP-10
Parathion			40		%		-4-155	03-SEP-10
Phorate			36	LCS-ND	%		70-130	03-SEP-10
Prometryne			91		%		5-165	03-SEP-10
Simazine			91		%		23-176	03-SEP-10
Terbufos			70		%		50-150	03-SEP-10
Triallate			83		%		50-150	03-SEP-10
Trifluralin			72		%		50-150	03-SEP-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HERB,OP-CDWP-ED	**Water**							
Batch R1461123								
WG1157198-3 LCS								
COMMENTS: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable.								
WG1157198-4 LCSD		**WG1157198-3**						
Bromoxynil		48	95	G	%	66	50	03-SEP-10
Dicamba		89	74		%	18	50	03-SEP-10
2,4-Dichlorophenol		0	0		%	0.0	50	03-SEP-10
2,4-D		183	136		%	29	50	03-SEP-10
Pentachlorophenol		0	0		%	0.0	50	03-SEP-10
Picloram		46	47		%	2.2	50	03-SEP-10
2,3,4,6-Tetrachlorophenol		0	0		%	0.0	50	03-SEP-10
2,4,6-Trichlorophenol		0	0		%	0.0	50	03-SEP-10
2,4,5-T		120	102		%	16	50	03-SEP-10
Alachlor		90	100		%	11	50	03-SEP-10
Atrazine		71	62		%	14	50	03-SEP-10
De-ethylated atrazine		55	46		%	17	50	03-SEP-10
Chlorpyrifos		46	52		%	12	50	03-SEP-10
Cyanazine		76	92		%	20	50	03-SEP-10
Diazinon		63	67		%	6.2	50	03-SEP-10
Diclofop-methyl		120	118		%	1.7	50	03-SEP-10
Dimethoate		47	54		%	14	50	03-SEP-10
Dinoseb		56	83		%	39	50	03-SEP-10
Malathion		51	57		%	11	50	03-SEP-10
Metribuzin		94	77		%	20	50	03-SEP-10
Metolachlor		89	100		%	12	50	03-SEP-10
Parathion		40	42		%	4.9	50	03-SEP-10
Phorate		36	16	G	%	77	50	03-SEP-10
Prometryne		91	98		%	7.4	50	03-SEP-10
Simazine		91	76		%	18	50	03-SEP-10
Terbufos		70	27	G	%	89	50	03-SEP-10
Triallate		83	100		%	19	50	03-SEP-10
Trifluralin		72	81		%	12	50	03-SEP-10
COMMENTS: Chlorophenols accidentally not spiked. Surrogate recoveries indicate extraction efficiency is acceptable. Data reliable. %RPD outside DQO for bromoxynil, phorate and terbufos. No residues detected in samples. Data reliable.								
WG1157198-2 MB								
Bromoxynil			<0.50		ug/L		0.5	03-SEP-10

Quality Control Report

Workorder: L922913 Report Date: 17-SEP-10

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HERB,OP-CDWP-ED	**Water**							
Batch R1461123								
WG1157198-2 MB								
Dicamba			<12		ug/L		12	03-SEP-10
2,4-Dichlorophenol			<90		ug/L		90	03-SEP-10
2,4-D			<10		ug/L		10	03-SEP-10
Pentachlorophenol			<6.0		ug/L		6	03-SEP-10
Picloram			<19		ug/L		19	03-SEP-10
2,3,4,6-Tetrachlorophenol			<10		ug/L		10	03-SEP-10
2,4,6-Trichlorophenol			<0.50		ug/L		0.5	03-SEP-10
2,4,5-T			<28		ug/L		28	03-SEP-10
Alachlor			<0.50		ug/L		0.5	03-SEP-10
Atrazine			<0.50		ug/L		0.5	03-SEP-10
De-ethylated atrazine			<0.50		ug/L		0.5	03-SEP-10
Chlorpyrifos			<9.0		ug/L		9	03-SEP-10
Cyanazine			<1.0		ug/L		1	03-SEP-10
Diazinon			<2.0		ug/L		2	03-SEP-10
Diclofop-methyl			<0.90		ug/L		0.9	03-SEP-10
Dimethoate			<2.5		ug/L		2.5	03-SEP-10
Dinoseb			<1.0		ug/L		1	03-SEP-10
Malathion			<19		ug/L		19	03-SEP-10
Metribuzin			<8.0		ug/L		8	03-SEP-10
Metolachlor			<5.0		ug/L		5	03-SEP-10
Parathion			<5.0		ug/L		5	03-SEP-10
Phorate			<0.50		ug/L		0.5	03-SEP-10
Prometryne			<0.25		ug/L		0.25	03-SEP-10
Simazine			<1.0		ug/L		1	03-SEP-10
Terbufos			<1.0		ug/L		1	03-SEP-10
Triallate			<23		ug/L		23	03-SEP-10
Trifluralin			<4.5		ug/L		4.5	03-SEP-10
HG-D-CVAA-ED	**Water**							
Batch R1453405								
WG1158543-10 DUP		**L922913-2**						
Mercury (Hg)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-AUG-10
WG1158543-8 DUP		**L920815-9**						
Mercury (Hg)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-AUG-10
WG1158543-2 LCS								

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-CVAA-ED	**Water**							
Batch R1453405								
WG1158543-2 LCS								
Mercury (Hg)-Dissolved			115		%		80-120	30-AUG-10
WG1158543-3 LCSD		**WG1158543-2**						
Mercury (Hg)-Dissolved		115	107		%	7.4	20	30-AUG-10
WG1158543-1 MB								
Mercury (Hg)-Dissolved			<0.00010		mg/L		0.0001	30-AUG-10
WG1158543-11 MS		**L922913-2**						
Mercury (Hg)-Dissolved			77		%		70-130	30-AUG-10
WG1158543-9 MS		**L920815-9**						
Mercury (Hg)-Dissolved			105		%		70-130	30-AUG-10
HG-T-CVAA-ED	**Water**							
Batch R1453405								
WG1158543-6 DUP		**L920130-1**						
Mercury (Hg)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-AUG-10
WG1158543-2 LCS								
Mercury (Hg)-Total			115		%		80-120	30-AUG-10
WG1158543-3 LCSD		**WG1158543-2**						
Mercury (Hg)-Total		115	107		%	7.4	20	30-AUG-10
WG1158543-1 MB								
Mercury (Hg)-Total			<0.00010		mg/L		0.0001	30-AUG-10
WG1158543-7 MS		**L920130-1**						
Mercury (Hg)-Total			110		%		70-130	30-AUG-10
MET-D-ICP-ED	**Water**							
Batch R1451891								
WG1157314-2 CRM		**EU-H-3_OPTWATER**						
WG1157314-5 DUP		**L922647-31**						
Calcium (Ca)-Dissolved		101	105		mg/L	3.7	20	27-AUG-10
Iron (Fe)-Dissolved		2.42	2.55		mg/L	4.9	20	27-AUG-10
Magnesium (Mg)-Dissolved		30.7	32.8		mg/L	6.5	20	27-AUG-10
Manganese (Mn)-Dissolved		0.222	0.232		mg/L	4.4	20	27-AUG-10
Potassium (K)-Dissolved		5.51	5.76		mg/L	4.5	20	27-AUG-10
Sodium (Na)-Dissolved		112	116		mg/L	4.2	20	27-AUG-10
WG1157314-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	27-AUG-10
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	27-AUG-10
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	27-AUG-10
Manganese (Mn)-Dissolved			<0.0050		mg/L		0.005	27-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-ICP-ED	**Water**							
Batch R1451891								
WG1157314-1 MB								
Potassium (K)-Dissolved			<0.50		mg/L		0.5	27-AUG-10
Sodium (Na)-Dissolved			<1.0		mg/L		1	27-AUG-10
WG1157314-6 MS		**L922647-31**						
Calcium (Ca)-Dissolved			84		%		70-130	27-AUG-10
Iron (Fe)-Dissolved			99		%		70-130	27-AUG-10
Magnesium (Mg)-Dissolved			95		%		70-130	27-AUG-10
Manganese (Mn)-Dissolved			104		%		70-130	27-AUG-10
Potassium (K)-Dissolved			100		%		70-130	27-AUG-10
Sodium (Na)-Dissolved			87		%		70-130	27-AUG-10
Batch R1454830								
WG1159199-2 CRM		**EU-H-3_OPTWATER**						
WG1159199-11 DUP		**L921144-16**						
Calcium (Ca)-Dissolved		22.2	20.4		mg/L	1.6	20	31-AUG-10
Iron (Fe)-Dissolved		1.78	1.64		mg/L	2.8	20	31-AUG-10
Magnesium (Mg)-Dissolved		7.73	7.05		mg/L	1.9	20	31-AUG-10
Manganese (Mn)-Dissolved		0.0347	0.0315		mg/L	2.1	20	31-AUG-10
Potassium (K)-Dissolved		10.4	9.73		mg/L	3.2	20	31-AUG-10
Sodium (Na)-Dissolved		25.2	23.5		mg/L	3.0	20	31-AUG-10
WG1159199-3 DUP		**L924557-2**						
Calcium (Ca)-Dissolved		45.0	42.0		mg/L	1.6	20	31-AUG-10
Iron (Fe)-Dissolved		1.74	1.70		mg/L	4.4	20	31-AUG-10
Magnesium (Mg)-Dissolved		15.7	15.7		mg/L	4.6	20	31-AUG-10
Manganese (Mn)-Dissolved		0.0535	0.0525		mg/L	3.9	20	31-AUG-10
Potassium (K)-Dissolved		4.85	4.15		mg/L	1.0	20	31-AUG-10
Sodium (Na)-Dissolved		129	119		mg/L	3.7	20	31-AUG-10
WG1159199-7 DUP		**L925243-1**						
Calcium (Ca)-Dissolved		69.7	70.7		mg/L	1.5	20	31-AUG-10
Iron (Fe)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	31-AUG-10
Magnesium (Mg)-Dissolved		91.4	89.8		mg/L	1.7	20	31-AUG-10
Manganese (Mn)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	31-AUG-10
Potassium (K)-Dissolved		6.53	6.73		mg/L	2.9	20	31-AUG-10
Sodium (Na)-Dissolved		375	363		mg/L	3.3	20	31-AUG-10
WG1159199-9 DUP		**L925346-17**						
Calcium (Ca)-Dissolved		93.5	88.8		mg/L	5.1	20	01-SEP-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-ICP-ED	**Water**							
Batch R1454830								
WG1159199-9 DUP		**L925346-17**						
Iron (Fe)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	01-SEP-10
Magnesium (Mg)-Dissolved		45.0	46.1		mg/L	2.5	20	01-SEP-10
Manganese (Mn)-Dissolved		0.137	0.136		mg/L	0.80	20	01-SEP-10
Potassium (K)-Dissolved		4.79	4.83		mg/L	0.70	20	01-SEP-10
Sodium (Na)-Dissolved		40.4	39.7		mg/L	1.6	20	01-SEP-10
WG1159199-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	31-AUG-10
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	31-AUG-10
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	31-AUG-10
Manganese (Mn)-Dissolved			<0.0050		mg/L		0.005	31-AUG-10
Potassium (K)-Dissolved			<0.50		mg/L		0.5	31-AUG-10
Sodium (Na)-Dissolved			<1.0		mg/L		1	31-AUG-10
WG1159199-10 MS		**L925346-17**						
Calcium (Ca)-Dissolved			90		%		70-130	01-SEP-10
Iron (Fe)-Dissolved			91		%		70-130	01-SEP-10
Magnesium (Mg)-Dissolved			87		%		70-130	01-SEP-10
Manganese (Mn)-Dissolved			93		%		70-130	01-SEP-10
Potassium (K)-Dissolved			90		%		70-130	01-SEP-10
Sodium (Na)-Dissolved			93		%		70-130	01-SEP-10
WG1159199-12 MS		**L921144-16**						
Calcium (Ca)-Dissolved			113		%		70-130	31-AUG-10
Iron (Fe)-Dissolved			107		%		70-130	31-AUG-10
Magnesium (Mg)-Dissolved			110		%		70-130	31-AUG-10
Manganese (Mn)-Dissolved			109		%		70-130	31-AUG-10
Potassium (K)-Dissolved			109		%		70-130	31-AUG-10
Sodium (Na)-Dissolved			113		%		70-130	31-AUG-10
WG1159199-4 MS		**L924557-2**						
Calcium (Ca)-Dissolved			93		%		70-130	31-AUG-10
Iron (Fe)-Dissolved			89		%		70-130	31-AUG-10
Magnesium (Mg)-Dissolved			90		%		70-130	31-AUG-10
Manganese (Mn)-Dissolved			91		%		70-130	31-AUG-10
Potassium (K)-Dissolved			94		%		70-130	31-AUG-10
Sodium (Na)-Dissolved			98		%		70-130	31-AUG-10
WG1159199-8 MS		**L925243-1**						

Quality Control Report

Workorder: L922913 Report Date: 17-SEP-10

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6

Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-ICP-ED	**Water**							
Batch R1454830								
WG1159199-8 MS		**L925243-1**						
Calcium (Ca)-Dissolved			88		%		70-130	31-AUG-10
Iron (Fe)-Dissolved			95		%		70-130	31-AUG-10
Magnesium (Mg)-Dissolved			98		%		70-130	31-AUG-10
Manganese (Mn)-Dissolved			96		%		70-130	31-AUG-10
Potassium (K)-Dissolved			94		%		70-130	31-AUG-10
Sodium (Na)-Dissolved			79		%		70-130	31-AUG-10
MET-D-L-MS-ED	**Water**							
Batch R1453309								
WG1157662-2 CRM		**1643E_WATER**						
Aluminum (Al)-Dissolved			104		%		80-120	28-AUG-10
Antimony (Sb)-Dissolved			102		%		80-120	28-AUG-10
Arsenic (As)-Dissolved			98		%		80-120	28-AUG-10
Barium (Ba)-Dissolved			97		%		80-120	28-AUG-10
Boron (B)-Dissolved			100		%		80-120	28-AUG-10
Cadmium (Cd)-Dissolved			105		%		80-120	28-AUG-10
Chromium (Cr)-Dissolved			99		%		80-120	28-AUG-10
Copper (Cu)-Dissolved			101		%		80-120	28-AUG-10
Lead (Pb)-Dissolved			102		%		80-120	28-AUG-10
Selenium (Se)-Dissolved			100		%		80-120	28-AUG-10
Zinc (Zn)-Dissolved			98		%		80-120	28-AUG-10
WG1157662-11 DUP		**L923785-18**						
Aluminum (Al)-Dissolved		<0.010	0.0062		mg/L	4.9	20	29-AUG-10
Antimony (Sb)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Arsenic (As)-Dissolved		0.00086	0.00084		mg/L	2.7	20	29-AUG-10
Barium (Ba)-Dissolved		0.0525	0.0536		mg/L	2.0	20	29-AUG-10
Boron (B)-Dissolved		0.075	0.0759		mg/L	1.6	20	29-AUG-10
Cadmium (Cd)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	29-AUG-10
Chromium (Cr)-Dissolved		<0.0050	0.00047		mg/L	8.3	20	29-AUG-10
Copper (Cu)-Dissolved		0.0033	0.00331		mg/L	1.3	20	29-AUG-10
Lead (Pb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Selenium (Se)-Dissolved		0.00241	0.00246		mg/L	1.8	20	29-AUG-10
Silver (Ag)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Uranium (U)-Dissolved		0.00408	0.00412		mg/L	1.1	20	29-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-ED	**Water**							
Batch R1453309								
WG1157662-11 DUP		**L923785-18**						
Zinc (Zn)-Dissolved		0.0052	0.0054		mg/L	4.2	20	29-AUG-10
WG1157662-13 DUP		**L923785-22**						
Aluminum (Al)-Dissolved		<0.010	0.0076		mg/L	1.7	20	29-AUG-10
Antimony (Sb)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Arsenic (As)-Dissolved		0.00135	0.00138		mg/L	1.8	20	29-AUG-10
Barium (Ba)-Dissolved		0.0311	0.0312		mg/L	0.13	20	29-AUG-10
Boron (B)-Dissolved		<0.050	0.0295		mg/L	2.3	20	29-AUG-10
Cadmium (Cd)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	29-AUG-10
Chromium (Cr)-Dissolved		<0.0050	0.00108		mg/L	4.5	20	29-AUG-10
Copper (Cu)-Dissolved		0.0017	0.00163		mg/L	1.5	20	29-AUG-10
Lead (Pb)-Dissolved		0.00010	0.00010		mg/L	0.0	20	29-AUG-10
Selenium (Se)-Dissolved		<0.0020	<0.0020	RPD-NA	mg/L	N/A	20	29-AUG-10
Silver (Ag)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Uranium (U)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Zinc (Zn)-Dissolved		0.0049	0.0046		mg/L	5.5	20	29-AUG-10
WG1157662-5 DUP		**L919880-9**						
Aluminum (Al)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	29-AUG-10
Antimony (Sb)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Arsenic (As)-Dissolved		0.00058	0.00060		mg/L	2.5	20	29-AUG-10
Barium (Ba)-Dissolved		0.0293	0.0296		mg/L	1.3	20	29-AUG-10
Boron (B)-Dissolved		0.163	0.163		mg/L	0.042	20	29-AUG-10
Cadmium (Cd)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	29-AUG-10
Chromium (Cr)-Dissolved		<0.0010	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Copper (Cu)-Dissolved		<0.0010	<0.00060	RPD-NA	mg/L	N/A	20	29-AUG-10
Lead (Pb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Selenium (Se)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Silver (Ag)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Uranium (U)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
WG1157662-9 DUP		**L919880-11**						
Aluminum (Al)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	29-AUG-10
Antimony (Sb)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Arsenic (As)-Dissolved		0.00060	0.00060		mg/L	0.17	20	29-AUG-10
Barium (Ba)-Dissolved		0.0291	0.0289		mg/L	0.56	20	29-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-ED	**Water**							
Batch R1453309								
WG1157662-9 DUP		**L919880-11**						
Boron (B)-Dissolved		0.162	0.162		mg/L	0.31	20	29-AUG-10
Cadmium (Cd)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	29-AUG-10
Chromium (Cr)-Dissolved		<0.0010	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Copper (Cu)-Dissolved		<0.0010	<0.00060	RPD-NA	mg/L	N/A	20	29-AUG-10
Lead (Pb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Selenium (Se)-Dissolved		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	29-AUG-10
Silver (Ag)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Uranium (U)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	29-AUG-10
Zinc (Zn)-Dissolved		<0.0040	<0.0040	RPD-NA	mg/L	N/A	20	29-AUG-10
WG1157662-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	28-AUG-10
Antimony (Sb)-Dissolved			<0.00040		mg/L		0.0004	28-AUG-10
Arsenic (As)-Dissolved			<0.00040		mg/L		0.0004	28-AUG-10
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	28-AUG-10
Boron (B)-Dissolved			<0.0020		mg/L		0.002	28-AUG-10
Cadmium (Cd)-Dissolved			<0.000050		mg/L		0.00005	28-AUG-10
Chromium (Cr)-Dissolved			<0.00040		mg/L		0.0004	28-AUG-10
Copper (Cu)-Dissolved			<0.00060		mg/L		0.0006	28-AUG-10
Lead (Pb)-Dissolved			<0.00010		mg/L		0.0001	28-AUG-10
Selenium (Se)-Dissolved			<0.00040		mg/L		0.0004	28-AUG-10
Silver (Ag)-Dissolved			<0.00010		mg/L		0.0001	28-AUG-10
Uranium (U)-Dissolved			<0.00010		mg/L		0.0001	28-AUG-10
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	28-AUG-10
WG1157662-10 MS		**L919880-11**						
Aluminum (Al)-Dissolved			115		%		70-130	29-AUG-10
Antimony (Sb)-Dissolved			106		%		70-130	29-AUG-10
Arsenic (As)-Dissolved			117		%		70-130	29-AUG-10
Barium (Ba)-Dissolved			115		%		70-130	29-AUG-10
Boron (B)-Dissolved			111		%		70-130	29-AUG-10
Cadmium (Cd)-Dissolved			114		%		70-130	29-AUG-10
Chromium (Cr)-Dissolved			117		%		70-130	29-AUG-10
Copper (Cu)-Dissolved			111		%		70-130	29-AUG-10
Lead (Pb)-Dissolved			106		%		70-130	29-AUG-10
Selenium (Se)-Dissolved			117		%		70-130	29-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-ED	**Water**							
Batch R1453309								
WG1157662-10 MS		**L919880-11**						
Silver (Ag)-Dissolved			102		%		70-130	29-AUG-10
Uranium (U)-Dissolved			108		%		70-130	29-AUG-10
Zinc (Zn)-Dissolved			111		%		70-130	29-AUG-10
WG1157662-12 MS		**L923785-18**						
Aluminum (Al)-Dissolved			114		%		70-130	29-AUG-10
Antimony (Sb)-Dissolved			107		%		70-130	29-AUG-10
Arsenic (As)-Dissolved			117		%		70-130	29-AUG-10
Barium (Ba)-Dissolved			117		%		70-130	29-AUG-10
Boron (B)-Dissolved			104		%		70-130	29-AUG-10
Cadmium (Cd)-Dissolved			114		%		70-130	29-AUG-10
Chromium (Cr)-Dissolved			117		%		70-130	29-AUG-10
Copper (Cu)-Dissolved			107		%		70-130	29-AUG-10
Lead (Pb)-Dissolved			103		%		70-130	29-AUG-10
Selenium (Se)-Dissolved			117		%		70-130	29-AUG-10
Silver (Ag)-Dissolved			104		%		70-130	29-AUG-10
Uranium (U)-Dissolved			108		%		70-130	29-AUG-10
Zinc (Zn)-Dissolved			115		%		70-130	29-AUG-10
WG1157662-14 MS		**L923785-22**						
Aluminum (Al)-Dissolved			114		%		70-130	29-AUG-10
Antimony (Sb)-Dissolved			107		%		70-130	29-AUG-10
Arsenic (As)-Dissolved			116		%		70-130	29-AUG-10
Barium (Ba)-Dissolved			118		%		70-130	29-AUG-10
Boron (B)-Dissolved			101		%		70-130	29-AUG-10
Cadmium (Cd)-Dissolved			115		%		70-130	29-AUG-10
Chromium (Cr)-Dissolved			106		%		70-130	29-AUG-10
Copper (Cu)-Dissolved			104		%		70-130	29-AUG-10
Lead (Pb)-Dissolved			99		%		70-130	29-AUG-10
Selenium (Se)-Dissolved			107		%		70-130	29-AUG-10
Silver (Ag)-Dissolved			103		%		70-130	29-AUG-10
Uranium (U)-Dissolved			104		%		70-130	29-AUG-10
Zinc (Zn)-Dissolved			105		%		70-130	29-AUG-10
WG1157662-6 MS		**L919880-9**						
Aluminum (Al)-Dissolved			111		%		70-130	29-AUG-10
Antimony (Sb)-Dissolved			104		%		70-130	29-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-L-MS-ED	**Water**							
Batch R1453309								
WG1157662-6 MS		**L919880-9**						
Arsenic (As)-Dissolved			114		%		70-130	29-AUG-10
Barium (Ba)-Dissolved			113		%		70-130	29-AUG-10
Boron (B)-Dissolved			108		%		70-130	29-AUG-10
Cadmium (Cd)-Dissolved			114		%		70-130	29-AUG-10
Chromium (Cr)-Dissolved			114		%		70-130	29-AUG-10
Copper (Cu)-Dissolved			109		%		70-130	29-AUG-10
Lead (Pb)-Dissolved			104		%		70-130	29-AUG-10
Selenium (Se)-Dissolved			115		%		70-130	29-AUG-10
Silver (Ag)-Dissolved			102		%		70-130	29-AUG-10
Uranium (U)-Dissolved			107		%		70-130	29-AUG-10
Zinc (Zn)-Dissolved			106		%		70-130	29-AUG-10
MET-T-L-ICP-ED	**Water**							
Batch R1454832								
WG1159160-5 DUP		**L912812-22**						
Calcium (Ca)-Total		1.12	1.07		mg/L	5.1	20	31-AUG-10
Magnesium (Mg)-Total		0.14	0.14		mg/L	4.3	20	31-AUG-10
Manganese (Mn)-Total		0.0583	0.0519		mg/L	12	20	31-AUG-10
Potassium (K)-Total		0.37	0.39		mg/L	5.6	20	31-AUG-10
Sodium (Na)-Total		762	759		mg/L	0.35	20	31-AUG-10
WG1159160-7 DUP		**L922921-4**						
Calcium (Ca)-Total		1.10	0.87	J	mg/L	0.23	1	31-AUG-10
Iron (Fe)-Total		0.248	0.199	G	mg/L	22	20	31-AUG-10
Magnesium (Mg)-Total		0.58	0.47	J	mg/L	0.11	0.2	31-AUG-10
Manganese (Mn)-Total		0.0156	0.0122	J	mg/L	0.0034	0.004	31-AUG-10
Potassium (K)-Total		0.69	0.68		mg/L	0.62	20	31-AUG-10
Sodium (Na)-Total		<1.0	<1.0	RPD-NA	mg/L	N/A	20	31-AUG-10
COMMENTS: Results for iron is 2% off the acceptance criteria. We have not identified a major non-conformance, and therefore have approved the related client data.								
WG1159160-3 LCS								
Calcium (Ca)-Total			93		%		80-120	31-AUG-10
Iron (Fe)-Total			93		%		80-120	31-AUG-10
Magnesium (Mg)-Total			93		%		80-120	31-AUG-10
Manganese (Mn)-Total			92		%		80-120	31-AUG-10
Potassium (K)-Total			88		%		80-120	31-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-ICP-ED	**Water**							
Batch R1454832								
WG1159160-3 LCS								
Sodium (Na)-Total			88		%		80-120	31-AUG-10
WG1159160-4 LCS								
Calcium (Ca)-Total			102		%		80-120	31-AUG-10
Iron (Fe)-Total			101		%		80-120	31-AUG-10
Magnesium (Mg)-Total			101		%		80-120	31-AUG-10
Manganese (Mn)-Total			101		%		80-120	31-AUG-10
Potassium (K)-Total			99		%		80-120	31-AUG-10
Sodium (Na)-Total			99		%		80-120	31-AUG-10
WG1158786-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	31-AUG-10
Iron (Fe)-Total			<0.010		mg/L		0.01	31-AUG-10
Magnesium (Mg)-Total			<0.10		mg/L		0.1	31-AUG-10
Manganese (Mn)-Total			<0.0020		mg/L		0.002	31-AUG-10
Potassium (K)-Total			<0.10		mg/L		0.1	31-AUG-10
Sodium (Na)-Total			<1.0		mg/L		1	31-AUG-10
WG1159160-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	31-AUG-10
Iron (Fe)-Total			<0.010		mg/L		0.01	31-AUG-10
Magnesium (Mg)-Total			<0.10		mg/L		0.1	31-AUG-10
Manganese (Mn)-Total			<0.0020		mg/L		0.002	31-AUG-10
Potassium (K)-Total			<0.10		mg/L		0.1	31-AUG-10
Sodium (Na)-Total			<1.0		mg/L		1	31-AUG-10
WG1159160-2 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	31-AUG-10
Iron (Fe)-Total			<0.010		mg/L		0.01	31-AUG-10
Magnesium (Mg)-Total			<0.10		mg/L		0.1	31-AUG-10
Manganese (Mn)-Total			<0.0020		mg/L		0.002	31-AUG-10
Potassium (K)-Total			<0.10		mg/L		0.1	31-AUG-10
Sodium (Na)-Total			<1.0		mg/L		1	31-AUG-10
WG1159160-6 MS		**L912812-22**						
Calcium (Ca)-Total			88		%		70-130	31-AUG-10
Iron (Fe)-Total			87		%		70-130	31-AUG-10
Magnesium (Mg)-Total			88		%		70-130	31-AUG-10
Manganese (Mn)-Total			88		%		70-130	31-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-ICP-ED	**Water**							
Batch R1454832								
WG1159160-6 MS		**L912812-22**						
Potassium (K)-Total			88		%		70-130	31-AUG-10
WG1159160-8 MS		**L922921-4**						
Calcium (Ca)-Total			111		%		70-130	31-AUG-10
Iron (Fe)-Total			108		%		70-130	31-AUG-10
Magnesium (Mg)-Total			114		%		70-130	31-AUG-10
Manganese (Mn)-Total			114		%		70-130	31-AUG-10
Potassium (K)-Total			111		%		70-130	31-AUG-10
Sodium (Na)-Total			112		%		70-130	31-AUG-10
MET-T-L-MS-ED	**Water**							
Batch R1454157								
WG1158786-1 MB								
Aluminum (Al)-Total			<0.010		mg/L		0.01	30-AUG-10
Antimony (Sb)-Total			<0.00040		mg/L		0.0004	30-AUG-10
Arsenic (As)-Total			<0.00040		mg/L		0.0004	30-AUG-10
Barium (Ba)-Total			<0.00020		mg/L		0.0002	30-AUG-10
Beryllium (Be)-Total			<0.0010		mg/L		0.001	30-AUG-10
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	30-AUG-10
Boron (B)-Total			<0.0040		mg/L		0.004	30-AUG-10
Cadmium (Cd)-Total			<0.000050		mg/L		0.00005	30-AUG-10
Chromium (Cr)-Total			<0.00080		mg/L		0.0008	30-AUG-10
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	30-AUG-10
Copper (Cu)-Total			<0.0010		mg/L		0.001	30-AUG-10
Lead (Pb)-Total			<0.00010		mg/L		0.0001	30-AUG-10
Molybdenum (Mo)-Total			<0.00010		mg/L		0.0001	30-AUG-10
Nickel (Ni)-Total			<0.00020		mg/L		0.0002	30-AUG-10
Selenium (Se)-Total			<0.00040		mg/L		0.0004	30-AUG-10
Silver (Ag)-Total			<0.00010		mg/L		0.0001	30-AUG-10
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	30-AUG-10
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	30-AUG-10
Tin (Sn)-Total			<0.00040		mg/L		0.0004	30-AUG-10
Titanium (Ti)-Total			<0.00060		mg/L		0.0006	30-AUG-10
Uranium (U)-Total			<0.00010		mg/L		0.0001	30-AUG-10
Vanadium (V)-Total			<0.00050		mg/L		0.0005	30-AUG-10
Zinc (Zn)-Total			<0.0040		mg/L		0.004	30-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-ED	**Water**							
Batch R1454747								
WG1159160-7 DUP		**L922921-4**						
Aluminum (Al)-Total		0.220	0.223		mg/L	1.5	20	01-SEP-10
Antimony (Sb)-Total		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	01-SEP-10
Arsenic (As)-Total		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	01-SEP-10
Barium (Ba)-Total		0.0034	0.00352		mg/L	3.2	20	01-SEP-10
Beryllium (Be)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-SEP-10
Bismuth (Bi)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	01-SEP-10
Boron (B)-Total		<0.050	<0.0040	RPD-NA	mg/L	N/A	20	01-SEP-10
Cadmium (Cd)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	01-SEP-10
Chromium (Cr)-Total		<0.0050	<0.00080	RPD-NA	mg/L	N/A	20	01-SEP-10
Cobalt (Co)-Total		<0.0020	0.00066		mg/L	1.4	20	01-SEP-10
Copper (Cu)-Total		0.0018	0.0018		mg/L	5.4	20	01-SEP-10
Lead (Pb)-Total		0.00021	0.00023		mg/L	9.3	20	01-SEP-10
Molybdenum (Mo)-Total		<0.0050	0.00015	J	mg/L	0.00003	0.01	01-SEP-10
Nickel (Ni)-Total		<0.0020	0.00171		mg/L	3.9	20	01-SEP-10
Selenium (Se)-Total		<0.00040	<0.00040	RPD-NA	mg/L	N/A	20	01-SEP-10
Silver (Ag)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	01-SEP-10
Strontium (Sr)-Total		0.00720	0.00727		mg/L	1.0	20	01-SEP-10
Thallium (Tl)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	01-SEP-10
Tin (Sn)-Total		<0.050	<0.00040	RPD-NA	mg/L	N/A	20	01-SEP-10
Titanium (Ti)-Total		0.0094	0.00903		mg/L	4.4	20	01-SEP-10
Uranium (U)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	01-SEP-10
Vanadium (V)-Total		<0.0010	<0.00050	RPD-NA	mg/L	N/A	20	01-SEP-10
Zinc (Zn)-Total		<0.0040	<0.0040	RPD-NA	mg/L	N/A	20	01-SEP-10
WG1159160-3 LCS								
Aluminum (Al)-Total			103		%		80-120	31-AUG-10
Antimony (Sb)-Total			98		%		80-120	31-AUG-10
Arsenic (As)-Total			102		%		80-120	31-AUG-10
Barium (Ba)-Total			112		%		80-120	31-AUG-10
Beryllium (Be)-Total			93		%		80-120	31-AUG-10
Bismuth (Bi)-Total			105		%		80-120	31-AUG-10
Boron (B)-Total			94		%		80-120	31-AUG-10
Cadmium (Cd)-Total			103		%		80-120	31-AUG-10
Chromium (Cr)-Total			104		%		80-120	31-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-ED	**Water**							
Batch R1454747								
WG1159160-3 LCS								
Cobalt (Co)-Total			105		%		80-120	31-AUG-10
Copper (Cu)-Total			101		%		80-120	31-AUG-10
Lead (Pb)-Total			95		%		80-120	31-AUG-10
Molybdenum (Mo)-Total			107		%		80-120	31-AUG-10
Nickel (Ni)-Total			101		%		80-120	31-AUG-10
Selenium (Se)-Total			102		%		80-120	31-AUG-10
Silver (Ag)-Total			102		%		80-120	31-AUG-10
Strontium (Sr)-Total			104		%		80-120	31-AUG-10
Thallium (Tl)-Total			97		%		80-120	31-AUG-10
Tin (Sn)-Total			100		%		80-120	31-AUG-10
Titanium (Ti)-Total			105		%		80-120	31-AUG-10
Uranium (U)-Total			118		%		80-120	31-AUG-10
Vanadium (V)-Total			100		%		80-120	31-AUG-10
Zinc (Zn)-Total			98		%		80-120	31-AUG-10
WG1159160-4 LCS								
Aluminum (Al)-Total			111		%		80-120	31-AUG-10
Antimony (Sb)-Total			100		%		80-120	31-AUG-10
Arsenic (As)-Total			102		%		80-120	31-AUG-10
Barium (Ba)-Total			114		%		80-120	31-AUG-10
Beryllium (Be)-Total			88		%		80-120	31-AUG-10
Bismuth (Bi)-Total			105		%		80-120	31-AUG-10
Boron (B)-Total			94		%		80-120	31-AUG-10
Cadmium (Cd)-Total			105		%		80-120	31-AUG-10
Chromium (Cr)-Total			103		%		80-120	31-AUG-10
Cobalt (Co)-Total			107		%		80-120	31-AUG-10
Copper (Cu)-Total			103		%		80-120	31-AUG-10
Lead (Pb)-Total			94		%		80-120	31-AUG-10
Molybdenum (Mo)-Total			106		%		80-120	31-AUG-10
Nickel (Ni)-Total			103		%		80-120	31-AUG-10
Selenium (Se)-Total			104		%		80-120	31-AUG-10
Silver (Ag)-Total			102		%		80-120	31-AUG-10
Strontium (Sr)-Total			106		%		80-120	31-AUG-10
Thallium (Tl)-Total			98		%		80-120	31-AUG-10
Tin (Sn)-Total			102		%		80-120	31-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-ED	**Water**							
Batch R1454747								
WG1159160-4 LCS								
Titanium (Ti)-Total			106		%		80-120	31-AUG-10
Uranium (U)-Total			118		%		80-120	31-AUG-10
Vanadium (V)-Total			100		%		80-120	31-AUG-10
Zinc (Zn)-Total			97		%		80-120	31-AUG-10
WG1159160-1 MB								
Aluminum (Al)-Total			<0.010		mg/L		0.01	31-AUG-10
Antimony (Sb)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Arsenic (As)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Barium (Ba)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Beryllium (Be)-Total			<0.0010		mg/L		0.001	31-AUG-10
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Boron (B)-Total			<0.0040		mg/L		0.004	31-AUG-10
Cadmium (Cd)-Total			<0.000050		mg/L		0.00005	31-AUG-10
Chromium (Cr)-Total			<0.00080		mg/L		0.0008	31-AUG-10
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Copper (Cu)-Total			<0.0010		mg/L		0.001	31-AUG-10
Lead (Pb)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Molybdenum (Mo)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Nickel (Ni)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Selenium (Se)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Silver (Ag)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Tin (Sn)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Titanium (Ti)-Total			<0.00060		mg/L		0.0006	31-AUG-10
Uranium (U)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Vanadium (V)-Total			<0.00050		mg/L		0.0005	31-AUG-10
Zinc (Zn)-Total			<0.0040		mg/L		0.004	31-AUG-10
WG1159160-2 MB								
Antimony (Sb)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Arsenic (As)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Barium (Ba)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Beryllium (Be)-Total			<0.0010		mg/L		0.001	31-AUG-10
Bismuth (Bi)-Total			<0.00020		mg/L		0.0002	31-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-ED	**Water**							
Batch R1454747								
WG1159160-2 MB								
Boron (B)-Total			<0.0040		mg/L		0.004	31-AUG-10
Cadmium (Cd)-Total			<0.000050		mg/L		0.00005	31-AUG-10
Chromium (Cr)-Total			<0.00080		mg/L		0.0008	31-AUG-10
Cobalt (Co)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Copper (Cu)-Total			<0.0010		mg/L		0.001	31-AUG-10
Lead (Pb)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Molybdenum (Mo)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Nickel (Ni)-Total			<0.00020		mg/L		0.0002	31-AUG-10
Selenium (Se)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Silver (Ag)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Thallium (Tl)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Tin (Sn)-Total			<0.00040		mg/L		0.0004	31-AUG-10
Titanium (Ti)-Total			<0.00060		mg/L		0.0006	31-AUG-10
Uranium (U)-Total			<0.00010		mg/L		0.0001	31-AUG-10
Vanadium (V)-Total			<0.00050		mg/L		0.0005	31-AUG-10
Zinc (Zn)-Total			<0.0040		mg/L		0.004	31-AUG-10
WG1159160-8 MS		**L922921-4**						
Aluminum (Al)-Total			100		%		70-130	01-SEP-10
Antimony (Sb)-Total			104		%		70-130	01-SEP-10
Arsenic (As)-Total			116		%		70-130	01-SEP-10
Barium (Ba)-Total			117		%		70-130	01-SEP-10
Beryllium (Be)-Total			116		%		70-130	01-SEP-10
Bismuth (Bi)-Total			129		%		70-130	01-SEP-10
Boron (B)-Total			114		%		70-130	01-SEP-10
Cadmium (Cd)-Total			116		%		70-130	01-SEP-10
Chromium (Cr)-Total			118		%		70-130	01-SEP-10
Cobalt (Co)-Total			120		%		70-130	01-SEP-10
Copper (Cu)-Total			120		%		70-130	01-SEP-10
Lead (Pb)-Total			119		%		70-130	01-SEP-10
Molybdenum (Mo)-Total			105		%		70-130	01-SEP-10
Nickel (Ni)-Total			118		%		70-130	01-SEP-10
Selenium (Se)-Total			114		%		70-130	01-SEP-10
Silver (Ag)-Total			104		%		70-130	01-SEP-10
Strontium (Sr)-Total			119		%		70-130	01-SEP-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-L-MS-ED	**Water**							
Batch R1454747								
WG1159160-8 MS		**L922921-4**						
Thallium (Tl)-Total			111		%		70-130	01-SEP-10
Tin (Sn)-Total			105		%		70-130	01-SEP-10
Titanium (Ti)-Total			104		%		70-130	01-SEP-10
Uranium (U)-Total			122		%		70-130	01-SEP-10
Vanadium (V)-Total			119		%		70-130	01-SEP-10
Zinc (Zn)-Total			115		%		70-130	01-SEP-10
NH4-ED	**Water**							
Batch R1450634								
WG1156875-3 DUP		**L924514-1**						
Ammonia-N		<0.050	<0.050	RPD-NA	mg/L	N/A	10	26-AUG-10
WG1156875-4 MS		**L923543-4**						
Ammonia-N			103		%		75-122	26-AUG-10
NO2-IC-ED	**Water**							
Batch R1449889								
WG1156076-11 DUP		**L924331-1**						
Nitrite (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-3 DUP		**L922913-8**						
Nitrite (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-9 DUP		**L917893-13**						
Nitrite (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	26-AUG-10
WG1156076-2 LCS								
Nitrite (as N)			106		%		85-115	25-AUG-10
WG1156076-1 MB								
Nitrite (as N)			<0.050		mg/L		0.05	25-AUG-10
WG1156076-10 MS		**L917893-13**						
Nitrite (as N)			115		%		75-125	26-AUG-10
WG1156076-12 MS		**L924331-1**						
Nitrite (as N)			101		%		75-125	25-AUG-10
WG1156076-4 MS		**L922913-8**						
Nitrite (as N)			104		%		75-125	25-AUG-10
NO3-IC-ED	**Water**							
Batch R1449889								
WG1156076-11 DUP		**L924331-1**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-3 DUP		**L922913-8**						
Nitrate (as N)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-ED	**Water**							
Batch R1449889								
WG1156076-9 DUP		**L917893-13**						
Nitrate (as N)		2.23	2.22		mg/L	0.20	20	26-AUG-10
WG1156076-2 LCS								
Nitrate (as N)			105		%		85-115	25-AUG-10
WG1156076-1 MB								
Nitrate (as N)			<0.050		mg/L		0.05	25-AUG-10
WG1156076-10 MS		**L917893-13**						
Nitrate (as N)			N/A	MS-B	%		-	26-AUG-10
WG1156076-12 MS		**L924331-1**						
Nitrate (as N)			105		%		75-125	25-AUG-10
WG1156076-4 MS		**L922913-8**						
Nitrate (as N)			107		%		75-125	25-AUG-10
OCSCREEN-CDWP-ED	**Water**							
Batch R1461163								
WG1157198-3 LCS								
pp-DDD			84		%		50-150	03-SEP-10
pp-DDE			83		%		50-150	03-SEP-10
pp-DDT			72		%		50-150	03-SEP-10
op-DDT			73		%		55-145	03-SEP-10
Aldrin			81		%		50-150	03-SEP-10
Dieldrin			83		%		50-150	03-SEP-10
Heptachlor			72		%		50-150	03-SEP-10
Heptachlor epoxide			81		%		50-150	03-SEP-10
Lindane			79		%		50-150	03-SEP-10
Methoxychlor			76		%		50-150	03-SEP-10
a-chlordane			80		%		50-150	03-SEP-10
g-chlordane			81		%		50-150	03-SEP-10
Oxychlordane			80		%		50-150	03-SEP-10
WG1157198-4 LCSD		**WG1157198-3**						
pp-DDD		84	92		%	9.1	50	03-SEP-10
pp-DDE		83	97		%	16	50	03-SEP-10
pp-DDT		72	94		%	27	50	03-SEP-10
op-DDT		73	91		%	22	50	03-SEP-10
Aldrin		81	90		%	11	50	03-SEP-10
Dieldrin		83	93		%	11	50	03-SEP-10
Heptachlor		72	86		%	18	50	03-SEP-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
OCSCREEN-CDWP-ED	**Water**							
Batch R1461163								
WG1157198-4 LCSD		**WG1157198-3**						
Heptachlor epoxide		81	91		%	12	50	03-SEP-10
Lindane		79	90		%	13	50	03-SEP-10
Methoxychlor		76	95		%	22	50	03-SEP-10
a-chlordane		80	90		%	12	50	03-SEP-10
g-chlordane		81	91		%	12	50	03-SEP-10
Oxychlordane		80	91		%	13	50	03-SEP-10
WG1157198-2 MB								
pp-DDD			<0.50		ug/L		0.5	03-SEP-10
pp-DDE			<0.50		ug/L		0.5	03-SEP-10
pp-DDT			<0.50		ug/L		0.5	03-SEP-10
op-DDT			<0.50		ug/L		0.5	03-SEP-10
Aldrin			<0.020		ug/L		0.02	03-SEP-10
Dieldrin			<0.050		ug/L		0.05	03-SEP-10
Heptachlor			<0.10		ug/L		0.1	03-SEP-10
Heptachlor epoxide			<0.10		ug/L		0.1	03-SEP-10
Lindane			<0.40		ug/L		0.4	03-SEP-10
Methoxychlor			<90		ug/L		90	03-SEP-10
a-chlordane			<0.10		ug/L		0.1	03-SEP-10
g-chlordane			<0.20		ug/L		0.2	03-SEP-10
Oxychlordane			<0.40		ug/L		0.4	03-SEP-10
PH/EC/ALK-ED	**Water**							
Batch R1449176								
WG1155742-6 DUP		**L923644-1**						
pH		6.95	6.94	J	pH	0.01	0.2	25-AUG-10
Conductivity (EC)		2520	2530		uS/cm	0.39	10	25-AUG-10
Bicarbonate (HCO3)		1030	1030		mg/L	0.12	25	25-AUG-10
Carbonate (CO3)		<5.0	<5.0	RPD-NA	mg/L	N/A	25	25-AUG-10
Hydroxide (OH)		<5.0	<5.0	RPD-NA	mg/L	N/A	25	25-AUG-10
Alkalinity, Total (as CaCO3)		842	841		mg/L	0.12	6.5	25-AUG-10
WG1155742-8 DUP		**L923896-4**						
pH		7.92	7.92	J	pH	0.01	0.2	25-AUG-10
Conductivity (EC)		8070	8070		uS/cm	0.0	10	25-AUG-10
Bicarbonate (HCO3)		1140	1140		mg/L	0.39	25	25-AUG-10
Carbonate (CO3)		<5.0	<5.0	RPD-NA	mg/L	N/A	25	25-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-ED	**Water**							
Batch R1449176								
WG1155742-8 DUP		**L923896-4**						
Hydroxide (OH)		<5.0	<5.0	RPD-NA	mg/L	N/A	25	25-AUG-10
Alkalinity, Total (as CaCO3)		935	938		mg/L	0.39	6.5	25-AUG-10
WG1155742-9 DUP		**L924030-1**						
pH		9.51	9.51	J	pH	0.00	0.2	25-AUG-10
Conductivity (EC)		8060	8050		uS/cm	0.12	10	25-AUG-10
Bicarbonate (HCO3)		219	238		mg/L	8.3	25	25-AUG-10
Carbonate (CO3)		208	200		mg/L	4.0	25	25-AUG-10
Hydroxide (OH)		<5.0	<5.0	RPD-NA	mg/L	N/A	25	25-AUG-10
Alkalinity, Total (as CaCO3)		526	528		mg/L	0.34	6.5	25-AUG-10
WG1155742-2 LCS								
Conductivity (EC)			100		%		90-110	25-AUG-10
WG1155742-3 LCS								
pH			7.01		pH		6.9-7.1	25-AUG-10
WG1155742-4 LCS								
Alkalinity, Total (as CaCO3)			98		%		85-115	25-AUG-10
WG1155742-5 LCS								
Conductivity (EC)			99		%		90-110	25-AUG-10
WG1155742-1 MB								
Bicarbonate (HCO3)			<5.0		mg/L		5	25-AUG-10
Carbonate (CO3)			<5.0		mg/L		5	25-AUG-10
Hydroxide (OH)			<5.0		mg/L		5	25-AUG-10
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	25-AUG-10
PHENOLS-4AAP-ED	**Water**							
Batch R1451976								
WG1157697-4 DUP		**L922912-2**						
Phenols (4AAP)		0.0075	0.0082		mg/L	8.9	15	27-AUG-10
WG1157697-3 LCS								
Phenols (4AAP)			99		%		85-115	27-AUG-10
WG1157697-2 MB								
Phenols (4AAP)			<0.0010		mg/L		0.001	27-AUG-10
WG1157697-5 MS		**L922913-4**						
Phenols (4AAP)			94		%		75-125	27-AUG-10
SO4-IC-ED	**Water**							

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-ED	**Water**							
Batch R1449889								
WG1156076-11 DUP		**L924331-1**						
Sulfate (SO4)		268	268		mg/L	0.036	20	25-AUG-10
WG1156076-3 DUP		**L922913-8**						
Sulfate (SO4)		<0.50	<0.50	RPD-NA	mg/L	N/A	20	25-AUG-10
WG1156076-5 DUP		**L923785-15**						
Sulfate (SO4)		459	460		mg/L	0.27	20	25-AUG-10
WG1156076-7 DUP		**L923941-1**						
Sulfate (SO4)		1.57	1.56		mg/L	0.34	20	25-AUG-10
WG1156076-2 LCS								
Sulfate (SO4)			111		%		85-115	25-AUG-10
WG1156076-1 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	25-AUG-10
WG1156076-12 MS		**L924331-1**						
Sulfate (SO4)			N/A	MS-B	%		-	25-AUG-10
WG1156076-4 MS		**L922913-8**						
Sulfate (SO4)			111		%		75-125	25-AUG-10
WG1156076-6 MS		**L923785-15**						
Sulfate (SO4)			N/A	MS-B	%		-	25-AUG-10
WG1156076-8 MS		**L923941-1**						
Sulfate (SO4)			107		%		75-125	25-AUG-10
SOLIDS-TDS-ED	**Water**							
Batch R1451390								
WG1156674-3 DUP		**L923888-1**						
Total Dissolved Solids		677	672		mg/L	0.74	20	27-AUG-10
WG1156674-2 LCS								
Total Dissolved Solids			98		%		85-115	27-AUG-10
WG1156674-1 MB								
Total Dissolved Solids			<5.0		mg/L		5	27-AUG-10
Batch R1455814								
WG1160121-1 MB								
Total Dissolved Solids			<5.0		mg/L		5	01-SEP-10
SULPHIDE-ED	**Water**							
Batch R1449662								
WG1155340-4 DUP		**L922059-1**						
Sulphide		0.0106	0.0110		mg/L	3.7	16	25-AUG-10
WG1155340-6 DUP		**L922163-1**						
Sulphide		<0.0020	<0.0020	RPD-NA	mg/L	N/A	16	25-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SULPHIDE-ED	**Water**							
Batch R1449662								
WG1155340-8 DUP		**L922362-1**						
Sulphide		<0.0020	<0.0020	RPD-NA	mg/L	N/A	16	25-AUG-10
WG1155340-2 LCS								
Sulphide			86		%		75-125	25-AUG-10
WG1155340-3 LCS								
Sulphide			95		%		75-125	25-AUG-10
WG1155340-1 MB								
Sulphide			<0.0020		mg/L		0.002	25-AUG-10
WG1155340-5 MS		**L921992-5**						
Sulphide			104		%		42-140	25-AUG-10
WG1155340-7 MS		**L922333-1**						
Sulphide			110		%		42-140	25-AUG-10
THM-ED	**Water**							
Batch R1453344								
WG1158201-1 DUP		**L922913-8**						
Chloroform		0.0037	0.0039		mg/L	5.3	16	29-AUG-10
Bromodichloromethane		<0.0010	<0.0010	RPD-NA	mg/L	N/A	40	29-AUG-10
Dibromochloromethane		<0.0010	<0.0010	RPD-NA	mg/L	N/A	50	29-AUG-10
Bromoform		<0.0050	<0.0050	RPD-NA	mg/L	N/A	50	29-AUG-10
TURBIDITY-ED	**Water**							
Batch R1449472								
WG1155975-2 DUP		**L922913-8**						
Turbidity		<0.10	<0.10	RPD-NA	NTU	N/A	8.8	25-AUG-10
WG1155975-3 DUP		**L923759-1**						
Turbidity		0.59	0.61		NTU	3.3	8.8	25-AUG-10
WG1155975-1 MB								
Turbidity			<0.10		NTU		0.1	25-AUG-10
VOC-DRINKING-ED	**Water**							
Batch R1453344								
WG1158201-1 DUP		**L922913-8**						
Vinyl chloride		<0.00050	<0.00050	RPD-NA	mg/L	N/A	40	29-AUG-10
1,1-Dichloroethylene		<0.0010	<0.0010	RPD-NA	mg/L	N/A	50	29-AUG-10
Methylene chloride		<0.0010	<0.0010	RPD-NA	mg/L	N/A	40	29-AUG-10
Chloroform		0.00370	0.00390		mg/L	5.3	33	29-AUG-10
1,2-Dichloroethane		<0.0010	<0.0010	RPD-NA	mg/L	N/A	40	29-AUG-10
Carbon tetrachloride		<0.00050	<0.00050	RPD-NA	mg/L	N/A	50	29-AUG-10

Quality Control Report

Client: WORLEYPARSONS
705 - 10240 124 ST NW
EDMONTON AB T5N 3W6
Contact: HECTOR ANAYA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-DRINKING-ED	**Water**							
Batch R1453344								
WG1158201-1 DUP		**L922913-8**						
Benzene		<0.00010	<0.00010	RPD-NA	mg/L	N/A	40	29-AUG-10
1,2-Dichlorobenzene		<0.00020	<0.00020	RPD-NA	mg/L	N/A	50	29-AUG-10
Trichloroethene		<0.0010	<0.0010	RPD-NA	mg/L	N/A	40	29-AUG-10
Bromodichloromethane		<0.00050	<0.00050	RPD-NA	mg/L	N/A	40	29-AUG-10
Dibromochloromethane		<0.00060	<0.00060	RPD-NA	mg/L	N/A	40	29-AUG-10
Bromoform		<0.00060	<0.00060	RPD-NA	mg/L	N/A	40	29-AUG-10
Toluene		<0.00010	<0.00010	RPD-NA	mg/L	N/A	40	29-AUG-10
Tetrachloroethylene		<0.0010	<0.0010	RPD-NA	mg/L	N/A	40	29-AUG-10
Chlorobenzene		<0.00010	<0.00010	RPD-NA	mg/L	N/A	50	29-AUG-10
Ethylbenzene		<0.00010	<0.00010	RPD-NA	mg/L	N/A	40	29-AUG-10
m+p-Xylenes		<0.00010	<0.00010	RPD-NA	mg/L	N/A	40	29-AUG-10
o-Xylene		<0.00020	<0.00020	RPD-NA	mg/L	N/A	40	29-AUG-10
1,4-Dichlorobenzene		<0.00020	<0.00020	RPD-NA	mg/L	N/A	40	29-AUG-10
VOC-MISC-ED	**Water**							
Batch R1453344								
WG1158201-1 DUP		**L922913-8**						
MTBE		<0.00050	<0.0050	RPD-NA	mg/L	N/A	50	29-AUG-10

Legend:

Limit	99% Confidence Interval (Laboratory Control Limits)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
G	QC result did not meet ALS DQO. Refer to narrative comments for further information.
J	Duplicate results and limits are expressed in terms of absolute difference.
LCS-L	Lab Control Sample recovery was below ALS DQO. Reference Material and/or Matrix Spike results were acceptable. Non-detected sample results are considered reliable. Other results, if reported, have been qualified.
LCS-ND	Lab Control Sample recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Color, True							
	1	17-AUG-10 14:42	25-AUG-10 00:00	48	177	hours	EHTR
	2	17-AUG-10 18:50	25-AUG-10 00:00	48	173	hours	EHTR
	3	18-AUG-10 11:50	25-AUG-10 00:00	48	156	hours	EHTR
	4	18-AUG-10 20:03	25-AUG-10 00:00	48	148	hours	EHTR
	5	18-AUG-10 20:32	25-AUG-10 00:00	48	147	hours	EHTR
	6	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
	7	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
	8	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
Total Dissolved Solids							
	1	17-AUG-10 14:42	27-AUG-10 00:00	7	9	days	EHT
	2	17-AUG-10 18:50	27-AUG-10 00:00	7	9	days	EHT
	3	18-AUG-10 11:50	27-AUG-10 00:00	7	9	days	EHT
	4	18-AUG-10 20:03	01-SEP-10 00:00	7	13	days	EHT
	5	18-AUG-10 20:32	27-AUG-10 00:00	7	8	days	EHT
	6	18-AUG-10 12:00	01-SEP-10 00:00	7	14	days	EHT
	7	18-AUG-10 12:00	27-AUG-10 00:00	7	9	days	EHT
	8	18-AUG-10 12:00	27-AUG-10 00:00	7	9	days	EHT
Turbidity							
	1	17-AUG-10 14:42	25-AUG-10 00:00	48	177	hours	EHTR
	2	17-AUG-10 18:50	25-AUG-10 00:00	48	173	hours	EHTR
	3	18-AUG-10 11:50	25-AUG-10 00:00	48	156	hours	EHTR
	4	18-AUG-10 20:03	25-AUG-10 00:00	48	148	hours	EHTR
	5	18-AUG-10 20:32	25-AUG-10 00:00	48	147	hours	EHTR
	6	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
	7	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
	8	18-AUG-10 12:00	25-AUG-10 00:00	48	156	hours	EHTR
Anions and Nutrients							
Nitrate as N by IC							
	1	17-AUG-10 14:42	25-AUG-10 06:50	48	184	hours	EHTR
	2	17-AUG-10 18:50	25-AUG-10 06:50	48	180	hours	EHTR
	3	18-AUG-10 11:50	25-AUG-10 06:50	48	163	hours	EHTR
	4	18-AUG-10 20:03	25-AUG-10 06:50	48	155	hours	EHTR
	5	18-AUG-10 20:32	25-AUG-10 06:50	48	154	hours	EHTR
	6	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
	7	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
	8	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
Nitrite as N by IC							
	1	17-AUG-10 14:42	25-AUG-10 06:50	48	184	hours	EHTR
	2	17-AUG-10 18:50	25-AUG-10 06:50	48	180	hours	EHTR
	3	18-AUG-10 11:50	25-AUG-10 06:50	48	163	hours	EHTR
	4	18-AUG-10 20:03	25-AUG-10 06:50	48	155	hours	EHTR
	5	18-AUG-10 20:32	25-AUG-10 06:50	48	154	hours	EHTR
	6	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
	7	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
	8	18-AUG-10 12:00	25-AUG-10 06:50	48	163	hours	EHTR
Hydrocarbons							
F2, F3, F4							
	3	18-AUG-10 11:50	26-AUG-10	7	8	days	EHT
Aldehydes							
Formaldehyde							
	3	18-AUG-10 11:50	26-AUG-10	7	8	days	EHT
Miscellaneous							

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Miscellaneous							
Asbestos TEM Datachem Ohio							
	3	18-AUG-10 11:50	28-AUG-10 10:38	48	239	hours	EHTR
	4	18-AUG-10 20:03	28-AUG-10 10:38	48	231	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L922913 were received on 22-AUG-10 09:49.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Submitted To:

Maureen Olinek
ALS Laboratory Group
9936-67 Avenue
Edmonton AB T6E 0P5

REFERENCE DATA	**Asbestos in Water by TEM**
Sample Type:	Drinking Water
Method Reference:	EPA 600/4-83-043, Method 100.1
Client Sample No.:	L922913-3 Water Reservoir through L922913-4 Final Tap Drinking Water
Sample Location:	L922913
PO No.:	L922913
ALS Work Order No.:	1008560
ALS Sample No.:	1008560-01 through 1008560-02
Sample Receipt Date:	8/25/2010
Preparation Date:	8/27/2010
Analysis Date:	8/28/2010

The samples indicated on the following data sheet(s) were analyzed by Transmission Electron Microscopy (TEM) for asbestos using the method EPA 600/4-83-043, Method 100.1. Each sample was ultrasonically treated in its original container for 15 minutes to suspend the solids. An aliquot of this suspension was added to 100 mL of de-ionized water and filtered onto a 0.1μm pore size polycarbonate filter. Portions of this filter were coated with carbon and mounted on grids for TEM analysis. Analysis was performed on a Philips CM-12 TEM with EDAX Genesis System providing energy dispersive X-ray analysis (EDXA) capabilities.

Results apply only to portions of samples analyzed and are tabulated on the following data sheet(s). Representative EDXA spectra and selected area electron diffraction (SAED) measurements of asbestos types detected (if any) are included and are referenced to the structure identification numbers listed on the count sheets. The limit of detection (LOD) for this method has been determined to be one asbestos fiber in the total number of grid openings analyzed. The number of openings analyzed is dependent on the sample volume filtered (4 minimum).

Pamela Johnson
Analyst

Anna Marie Ristich
Section Manager

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CLIENT: ALS Laboratory Group
SAMPLE LOCATION: L922913

SAMPLE PREP DATA

Date Received:	8/25/2010
Date Filtered:	8/25/2010
Time Filtered:	10:30
Filter Type:	PC, 0.1 μm
Filter Size:	47 mm
Collection Area:	1075 mm^2

ANALYSIS DATA

Date Analyzed:	8/28/2010
Magnification:	10,000 X
Calibration Constant:	1 cm = 1.00 μm
EDXA Resolution:	153.47 eV
Accelerating Voltage:	100 keV
Camera Constant:	31.97 mm-Å

SAMPLE IDENTIFICATION		
Client Sample No.:	L922913-3 Water Reservoir	L922913-4 Final Tap Drinking Water
ALS Sample No.:	1008560-01	1008560-02
Date Sampled:	8/18/2010	8/18/2010
Time Sampled:	Not Available	Not Available
Volume (L):	0.075	0.150
No. Grid Openings Analyzed:	7	4
Average Grid Opening Area:	0.0112	0.0112
LOD (MFL):	0.18	0.16
Asbestos Fibers ≥ 10 microns		
Chrysotile:	0	0
Amosite:	0	0
Crocidolite:	0	0
Actinolite-Tremolite:	0	0
Anthophyllite:	0	0
TOTAL ASBESTOS		
Count:	**0**	**0**
Concentration (MFL):	**<LOD**	**<LOD**

ND = None Detected LOD = Limit of Detection MFL = Millions of Fibers per Liter

Comments: Samples L922913-3 Water Reservoir and L922913-4 Final Tap Drinking Water were received past the EPA Method 100.1 48-hour hold time; samples were analyzed per client request, because next day delivery is not possible from this location.

Pamela Johnson
Analyst

Anna Marie Ristich
Section Manager

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ALS Laboratory Group
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A Campbell Brothers Limited Company

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T10-01097.0

Date: 16-Sep-2010

ALS Laboratory Group
Environmental Div.
9936-67th Avenue
Edmonton, AB, T6P 0P5

Phone: (780) 413-8441
FAX: (780) 437-2680

Client Ref.L922913

attn: Christine Potts

2 water samples Sampled: 18-Aug-2010 Received: 25-Aug-2010

Results of Analysis

Sample	Test		Result	Units	Date	Method
L922913-3	Cs-134	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-4	Cs-134	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-3	Cs-137	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-4	Cs-137	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-3	I-125	<	5	Bq/l	03-Sep-2010	GAMMA
L922913-4	I-125	<	5	Bq/l	03-Sep-2010	GAMMA
L922913-3	I-131	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-4	I-131	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-3	Mo-99	<	10	Bq/l	03-Sep-2010	GAMMA
L922913-4	Mo-99	<	10	Bq/l	03-Sep-2010	GAMMA
L922913-3	Sr-90	<	1	Bq/l	03-Sep-2010	GFPC
L922913-4	Sr-90	<	1	Bq/l	02-Sep-2010	GFPC
L922913-3	Tritium	<	1000	Bq/l	01-Sep-2010	LSC
L922913-4	Tritium	<	1000	Bq/l	01-Sep-2010	LSC
L922913-3	Pb-210	<	0.05	Bq/l	10-Sep-2010	GFPC
L922913-4	Pb-210	<	0.06	Bq/l	10-Sep-2010	GFPC
L922913-3	Ra-224	<	0.01	Bq/l	27-Aug-2010	ALPHA
L922913-4	Ra-224	<	0.01	Bq/l	27-Aug-2010	ALPHA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T10-01097.0

Date: 16-Sep-2010

Results of Analysis

Sample	Test		Result	Units	Date	Method
L922913-3	Ra-226	<	0.01	Bq/l	27-Aug-2010	ALPHA
L922913-4	Ra-226	<	0.01	Bq/l	27-Aug-2010	ALPHA
L922913-3	Ra-228	<	0.1	Bq/l	03-Sep-2010	GAMMA
L922913-4	Ra-228	<	0.1	Bq/l	09-Sep-2010	GAMMA
L922913-3	Th-228	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-4	Th-228	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-3	Th-230	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-4	Th-230	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-3	Th-232	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-4	Th-232	<	0.01	Bq/l	04-Sep-2010	ALPHA
L922913-3	Th-234	<	1	Bq/l	03-Sep-2010	GAMMA
L922913-4	Th-234	<	1	Bq/l	09-Sep-2010	GAMMA
L922913-3	U-234	<	0.02	Bq/l	03-Sep-2010	ALPHA
L922913-4	U-234	<	0.01	Bq/l	03-Sep-2010	ALPHA
L922913-3	U-235	<	0.01	Bq/l	03-Sep-2010	ALPHA
L922913-4	U-235	<	0.01	Bq/l	03-Sep-2010	ALPHA
L922913-3	U-238	<	0.01	Bq/l	03-Sep-2010	ALPHA
L922913-4	U-238	<	0.01	Bq/l	03-Sep-2010	ALPHA
L922913-3	Rn-222	<	10	Bq/l	25-Aug-2010	GAMMA
L922913-4	Rn-222	<	10	Bq/l	25-Aug-2010	GAMMA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T10-01097.0

Date: 16-Sep-2010

Sample	Client ID
L922913-3	WATER RESERVOIR
L922913-4	FINAL TAP DRINKING WATER

Methods:	GAMMA	BQ-RAD-GAMMA	gamma-ray spectrometry
	ALPHA	BQ-RAD-ALPHA	alpha-particle spectrometry
	GFPC	BQ-RAD-GFPC	gas-flow proportional counting
	LSC	BQ-RAD-LSC	liquid scintillation counting
Units:	Bq/l	Becquerels per litre	

These results relate only to the samples analysed and only to the items tested.
Ra-228 was estimated from Ac-228.

16-Sep-2010 approved by: _____
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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APPENDIX A

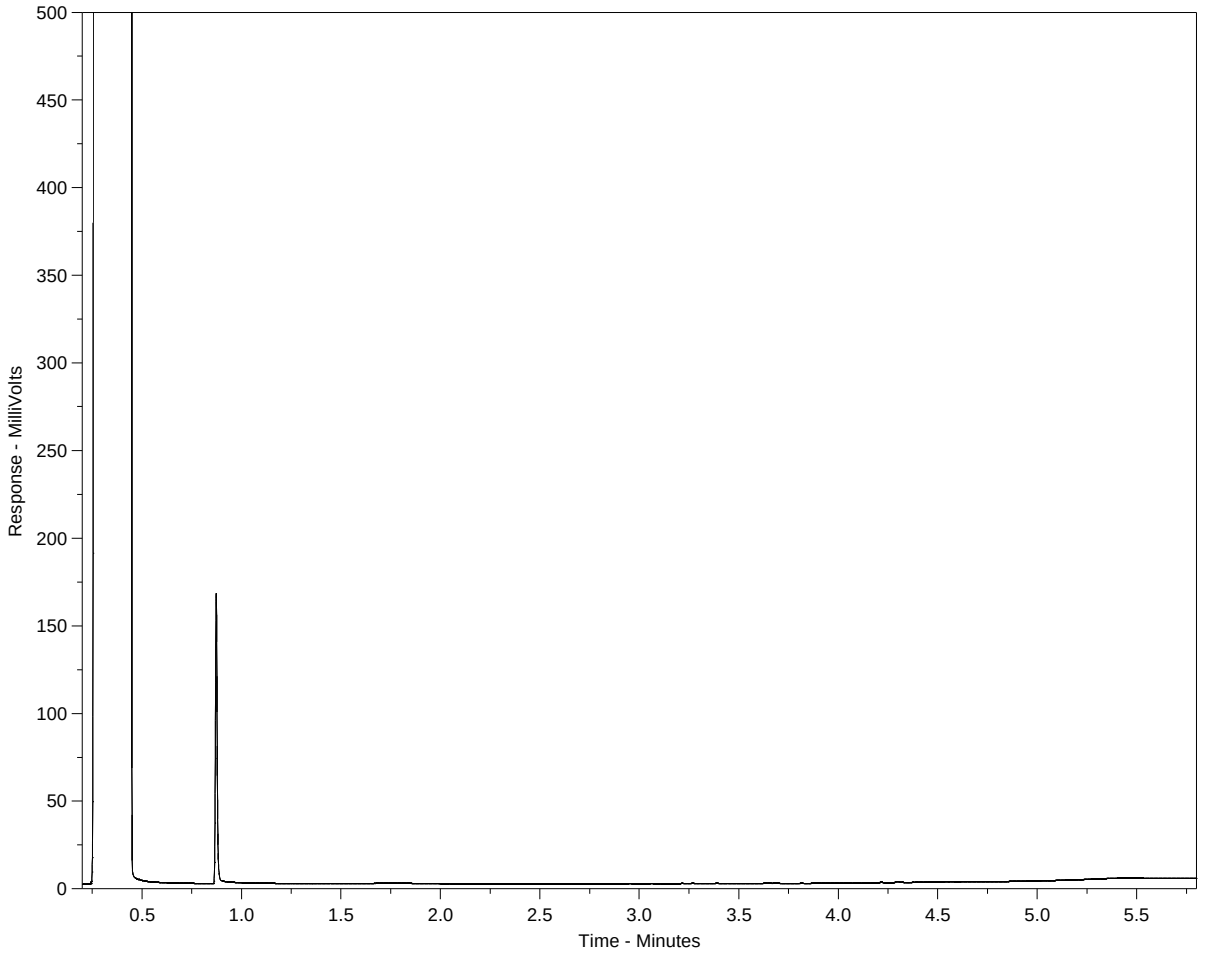
LAB SAMPLE #: L922913-3 CLIENT I.D.: WATER RESERVOIR

LAB SAMPLE #: L922913-4 CLIENT I.D.: FINAL TAP DRINKING WATER

A portion of these two water samples were extracted by employing the CCME shake method for petroleum hydrocarbons and analyzed on a Gas Chromatograph equipped with a Flame Ionization Detector (GC/FID). The chromatograms of these two samples do not show any hydrocarbon pattern.

Hydrocarbon Distribution Report

ALS Sample ID: **L922913-3**
Client ID: **WATER RESERVOIR**



<-nC10----------nC16----------nC34----------nC50->
<----------Gasoline----------> <----------Heavy Oils---------->
|----------Diesel----------|

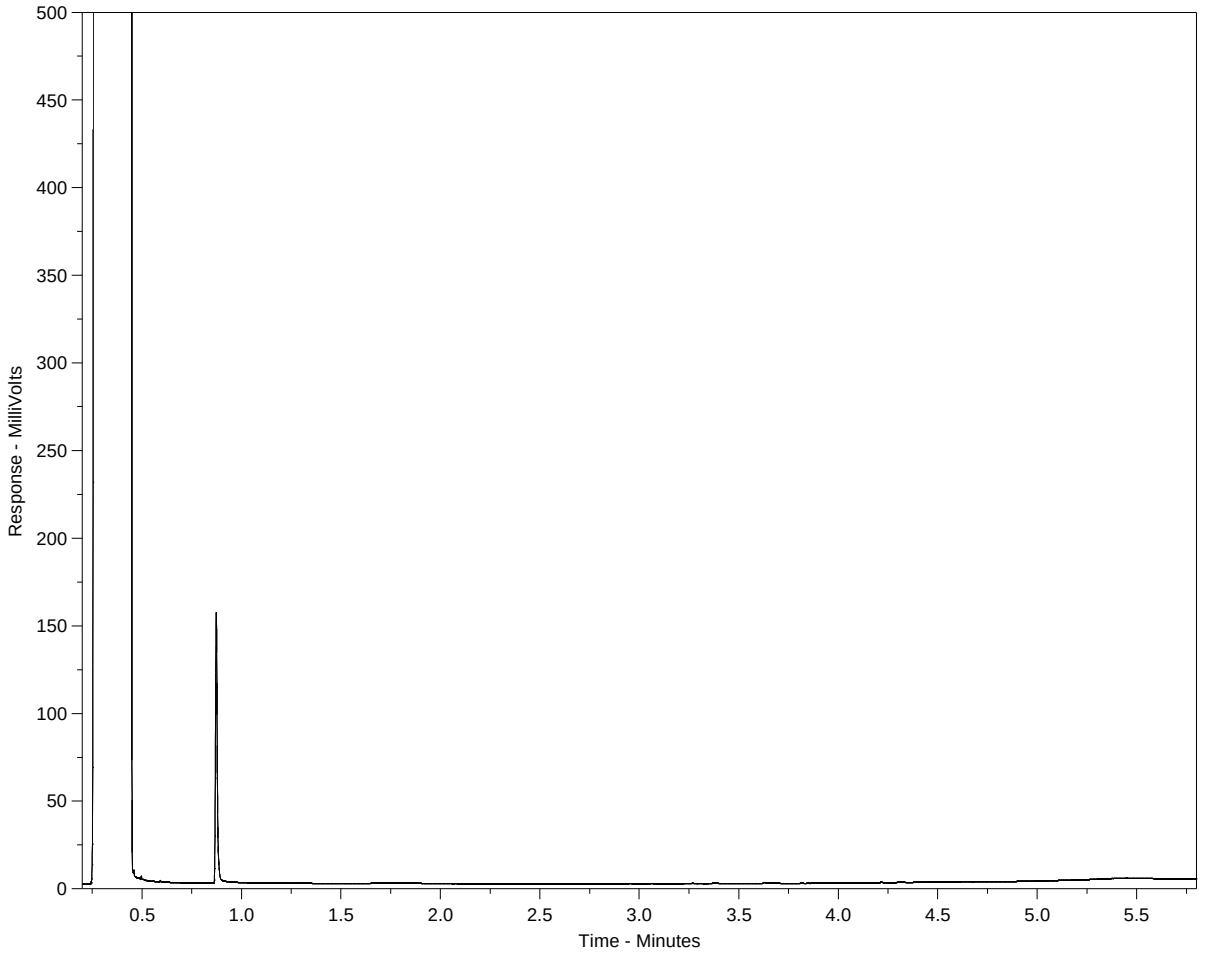
The Canada Wide Standard Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products as well as a number of specified n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced with a high temperature GC method that is specific to the Canada-Wide Standard method (December 2007 version). Note that retention times and distribution profiles from reports produced using different GC programs will differ.

Hydrocarbon Distribution Report

ALS Sample ID: L922913-4
Client ID: FINAL TAP DRINKING WATER



<-nC10----------nC16----------nC34----------nC50->
<----------Gasoline----------> <----------Heavy Oils---------->
|----------Diesel----------|

The Canada Wide Standard Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products as well as a number of specified n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced with a high temperature GC method that is specific to the Canada-Wide Standard method (December 2007 version). Note that retention times and distribution profiles from reports produced using different GC programs will differ.

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10-062841

Page 1 of 2

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Company: WorleyParsons	Standard: ✓ Other (specify):	✓ Regular (Standard Turnaround Times))
Contact: Hector Anaya	Select: PDF ✓ Excel ✓ Digital ✓ Fax	Priority, Date Req'd: _____ (Surcharges apply)
Address: Suite 705 10240 - 124th Street	Email 1: hector.anaya@worleyparsons.com	Emergency (1 Business Day) - 100% Surcharge
Edmonton, Alberta, T5N 3W6	Email 2: edm.chemistry@worleyparsons.com	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone: 780-496-9055 Fax: 780-496-9575	Ken.sommerstad@worleyparsons.com	
Invoice To Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**	**Analysis Request**
Copy of Invoice with Report? (circle) (Yes) or No	Job #: C71130000	(Indicate Filtered or Preserved, F/P)
Company:	PO / AFE:	
Contact:	LSD: Eureka, NU	
Address:		
Phone: Fax:	Quote #: Q25949	
Lab Work Order # (lab use only) L9202913	**ALS Contact:** Maureen Olinek **Sampler:** KS/HA	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine	Total Metals	Dissolved Metals	TOC	DOC	Radiological Parms	Radon	Pesticides	Paraquat/Diquat	Asbestos	BTEX, F1-F4	THM	Number of Containers
	Blacktop Creek	17-Aug-10	14:42	Water	X	X	X	X	X								5
	Slidre Fiord	17-Aug-10	18:50	Water	X	X	X	X	X								5
	Water Reservoir	18-Aug-10	11:50	Water	X	X		X	X	X	X	X	X	X	X	X	25
	Final Tap Drinking Water	18-Aug-10	20:03	Water	X	X		X		X	X	X	X	X	X	X	22
	Non-Drinking Final Tap	18-Aug-10	20:32	Water	X	X		X									3
	DUP 1	18-Aug-10	12:00	Water	X	X										X	5
	DUP 2	18-Aug-10	12:00	Water	X	X										X	5
	Trip Blank	18-Aug-10	12:00	Water	X	X		X								X	6

Special Instructions / Regulations / Hazardous Details

Use Canadian Drinking Water Quality Guidelines
Water Reservoir has 5 THM vials and 4 BTEX vials

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / (No) ? If Yes add SIF
Hector Anaya	Aug 21	8:32 PM	DOC	22 AUG 10	09:49	6.4 °C				

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Contact: Hector Anaya	Select: PDF ✓ Excel ✓ Digital ✓ Fax	Priority, Date Req'd: _____ (Surcharges apply)
Address: Suite 705 10240 - 124th Street	Email 1: hector.anaya@worleyparsons.com	Emergency (1 Business Day) - 100% Surcharge
Edmonton, Alberta, T5N 3W6	Email 2: edm.chemistry@worleyparsons.com	For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone: 780-496-9055 Fax:	ken.sommerstad@worleyparsons.com	
Invoice To Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**	**Analysis Request** (Indicate Filtered or Preserved, F/P)
Copy of Invoice with Report? (circle) (Yes) or No	Job #: C71130000	
Company:	PO / AFE:	
Contact:	LSD: Eureka, NU	
Address:		
Phone: Fax:	Quote #: Q25949	
Lab Work Order # (lab use only)	ALS Contact: Maureen Olinek Sampler: KS/HA	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	VOC	PAH	Bromate	Chlorite/Chlorate	Cyanide	Formaldehyde						Number of Containers
	Water Reservoir	18-Aug-10	11:50	Water	X	X	X	X	X	X						11
	Final Tap Drinking Water	18-Aug-10	20:03	Water	X	X	X	X	X	X						11
	DUP 1	18-Aug-10	12:00	Water	X											3
	DUP 2	18-Aug-10	12:00	Water	X											3
	Trip Blank	18-Aug-10	12:00	Water	X											3

Special Instructions / Regulations / Hazardous Details

Use Canadian Drinking Water Quality Guidelines

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Hector Anaya	Aug 21	8:32 pm	DSR	20 Aug 10	09:49	6.4 °C				

Appendix 1.4 Review of Soil Contamination and Potential Options in Relation to the Water Supply Reservoir – Eureka High Arctic Weather Station

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INTERNAL MEMORANDUM

DATE	12 October 2010
TO	Hector Anaya, Rob Wirtz
FROM	Gregory Haryett, P.Geol.
COPY	File
PROJECT NAME	Civil Consulting Services / Eureka, NU
PROJECT NO.	C71130000
SUBJECT	Review of Soil Contamination and Protential Remedial Options in Relation to the Fresh Water Supply Reservoir - Eureka High Artic Weather Station
FILE LOC.	Edmonton

1 OBJECTIVE

The objective of this task is to review the Phase III Environmental Site Assessment report prepared by Franz Environmental Inc. (Franz; 2009) for the Eureka High Arctic Weather Station, located in Nunavut Canada, in order to assess potential issues with contaminated soils that may be encountered during the construction/upgrade of a fresh water reservoir and provide potential options for mitigative measures, as required.

2 BACKGROUND

WorleyParsons has proposed a number of options for the location of a new fresh water reservoir. These are discussed separately and are identified as Options 3 to 5 herein. The existing fresh water reservoir as well as proposed Option 3 location are adjacent to the In-situ Landfarm (area of environmental concern [AEC B-2] and the Powerhouse (AEC D-1), as defined by Franz (2009). Option 4 is located west of Station Creek away from historical activities. Option 5 is located east of the Fuel Tank Farm (AEC B-1) and the DND HADCS Warehouse (AEC C-1) and northwest of the Hydrogen Building (AEC E-1).

The attached drawing 27 illustrates the proposed locations of each of the options in relation to the AECs identified above. A summary of these AECs are provided below.

2.1 Fuel Tank Farm (AEC B-1)

The fuel tank farm was constructed in 1992 and contains one single vertical walled 7770,000 L diesel tank and nine single walled 60,000 L diesel tank in a bermed area. One 9,000 L gasoline tank is located outside the bermed area on a gravel pad southeast of the tank farm. A tank inspection

completed in 2006 concluded that the walls of some of the tanks were thinning and it was recommended at that time that the tanks be repainted to prevent further rusting; it is unknown whether this was completed. The contaminants of concern (COCs) in this area include benzene, toluene ethylbenzene, xylenes (BTEX), petroleum hydrocarbon (PHC) fractions (F)1 and F2, and arsenic. It is conservatively estimated that the volume of impacted soil in this area is 1,100 m^3; delineation is not complete in this area due to existing infrastructure. The soil impacts identified in this area may be associated with a potential landfill in the area, the current tank farm and/or the historical tank farm (AEC B-2; Franz 2009).

2.2 In-situ Landfarm (AEC B-2)

The In-situ Landfarm (AEC B-2) was historically a tank farm, which had two major spill events: 40,000 L of diesel in 1973/74 and between 37,000 to 40,000 L of diesel in 1990. The tank farm was decommissioned in 1992. The In-situ Landfarm is approximately 60 m x 15 m (Figure 13 of Franz 2009). The COCs in this area include BTEX, PHC F1 and F2, naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene, and phenanthrene. Historical remedial activities in this area include the removal of 350 m^3 of soil, which was transferred to the landfarm at the airstrip in 1997, and tilling and nutrient application across the area in 2000, 2002, and 2003. The 2009 estimated volume of soil with parameters exceeding guidelines is 8,600 m^3; however, delineation to the north was not completed due to underground lines or to south beneath the maintenance garage (Franz 2009).

Testing completed in 2009 suggest that the PHC impacts may be migrating to the south and west, likely via groundwater and surface water drainage (Franz 2009). The area of contamination extends down slope to the west into the drainage pond which may act as an interceptor trench for contaminated runoff; however, there is a possibility that diffusion of contaminants may occur if a hydraulic connection exists between the drainage pond and the reservoir (Franz 2009).

2.3 DND HADCS Warehouse (AEC C-1)

The DND HADCS Warehouse (AEC C-1) is located just north of the main complex and south of the Fuel Tank Farm (AEC B-1) and is a single bay metal structure. A 2,250 L aboveground storage tank (AST) is located at the southwest corner of this building. Surface soil staining was noted around the tank. The COCs in this area include toluene and PHC F2. These impacts appear to be localized, with an estimated volume of approximately 15 m^3.

2.4 Powerhouse (AEC D-1)

The Powerhouse (AEC D-1) is located east of the existing fresh water reservoir and south of In-situ Landfarm (AEC B-2). Surface staining and hydrocarbon odours are evident along western side of the building near the location of a former day tank. The COCs in this area include BTEX, PHC F1 to F4, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, phenanthrene, pyrene, arsenic, and/or zinc in the soil and sediment, and iron, aluminum, and chromium in the surface water. The metal parameters may represent natural concentrations; additional sampling is required for confirmation. The 2009 estimated volume of soil with parameters exceeding guidelines is 3,200 m^3; however, complete delineation was not obtained. The concentrations of PHC parameters suggest that free product may be

present in the soil and sediment in AEC D-1. The 2009 results also suggest that the contamination may be migrating south towards Slidre Fiord. As indicated above the drainage pond may be acting as an interceptor trench.

2.5 Hydrogen Building (AEC E-1)

The Hydrogen Building (AEC E-1) is located north of the sewage lagoon and consists of a 6.0 m by 9.0 m metal framed building. The building contains a hydrogen generator tank and weather monitoring equipment. The COCs in this area include BTE, PHC F2, and arsenic. The 2009 estimated volume of soil with parameters exceeding guidelines is 220 m^3; however, complete delineation was not obtained. Franz indicated that there were no visible evidence of PHC impacted soil and it is believed the contamination may be localized.

3 MITIGATIVE MEASURES

3.1 Option 3

Option 3 assumes that a second fresh water reservoir will be built north of the existing reservoir. The new reservoir would be deeper and the area larger than the existing reservoir. As indicated the east edge of the proposed location for Option 3 is adjacent to AECs B-2 and D-1, with AEC B-1 upgradient of the proposed site. The Option 3 location is also situated over a portion of the impacted soil associated with AEC B-2. Issues that will need to be addressed during the design stage of Option 3 include:

- Surface water drainage: Franz indicated that the drainage pond located at the eastern edge of the existing reservoir may act as an interceptor trench for contaminated runoff; however, there is a possibility that diffusion of contaminants may occur if a hydraulic connection exists between the drainage pond and the reservoir. Based on the preliminary layout sketch, the proposed reservoir location recommended in Option 3 will cover a portion of the drainage ditch and therefore the natural interceptor trench may not be available to divert surface water that may come into contact with the contaminated soils in this area.
- Free product and elevated concentrations of PHC parameters: The concentrations of PHC parameters suggest that free product may be present in the soil and sediment in AEC D-1. Not only has there been 80,000 L of diesel spilled in AEC B-2, there has been unreported quantities lost in AEC D-1. As indicated above, a portion of the Option 3 reservoir is proposed to be built over contaminated soils associated with AEC B-2. Data suggests that the PHC contaminants are migrating towards the east and south from these AECs. The design of the pond and liner system would need to take into account the potential presence of free product as well as impacted soils and groundwater above the permafrost.
- Potential Future Spills: The existing tank farm is located at a topographically higher elevation than the existing and the proposed Option 3 fresh water reservoirs. It is unclear whether the base of the tank farm is lined or whether the base is gravel or what the berms of the tank farm are composed of. If adequate protection is not in places, spills within the tank farm have the potential of infiltrating into the shallow groundwater system and migrating down slope towards

the fresh water reservoir. In the winter months or if a major spill occurs product may flow overland down slope and towards the reservoir.

To address the issues above the following mitigative measure could be considered.

- Removal of impacted soils adjacent to the footprint of the reservoir: Removal of the impacted soil from the area, depending on the volume removed, would limit the risk that the existing contamination has on the reservoir.

  Based on the Franz report impacts are relative shallow extending to the top of the permafrost zone at 1.0 to 1.2 mbgs. The impacted soil near the footprint of the reservoir could be removed during earth work activities associated with the construction of the new fresh water reservoir. The impacted soil could then be placed into a biopile for remediation purposes. Remediation of the PHC impacted soils within the biopile is accomplished through bioremediation technology. A feasibility study for a biopile should be completed to determine design criteria and operational issues. The design of the biopile should include but not limited to the following: identifying a suitable location for construction, determining the type and quantity of soil amendments required for augmenting biodegradation of the PHCs, designing an appropriate aeration and irrigation/nutrient and a leachate collection system.

- Installation of a cut off trench along the western extent of AECs B-2 and D-1 impacted soils. A cut-off trench would help manage potential migration of PHC towards the reservoir; however it will not provide any protection or remediate contaminated soils beneath the proposed footprint of Option 3 reservoir. The cut-off trench will not remediate soil contamination.

  A cut-off trench may consist of a trench seated into the permafrost or bedrock material with a hydrocarbon resistant HDPE liner installed along the down gradient wall. The trench could be backfilled with native material or coarse granular material. If coarse granular material is used as backfill, recovery wells evenly spaced down the length of the wall could be installed. The recovery wells would allow for the removal of free-product, if present, as well as impacted groundwater, during summer months only. A berm to direct surface water, which may come into contact with the impacted soil, away from the reservoir should also be part of the design.

- Installation of an HDPE liner at the base of the reservoir: The HDPE liner would help prevent but possibly not eliminate leakage out of the pond as well as potential diffusion issues of contaminants into the pond. Since free-product is suspected in the area the type of liner must be resistant to PHC. Once installed there will be no access to the contaminated soils beneath the footprint and therefore soil remediation, apart from natural degradation, will not be possible (i.e. a source of contamination will remain beneath the proposed reservoir). It recommended that at minimum the contaminant material beneath the footprint of the proposed reservoir be removed.

- Potential surface water: As discussed above, surface water drainage should be reviewed to protect the reservoir against surface water run-off that potential has been contaminated by coming into contact with existing contaminated soils, potential future spills at the existing tank farm or other potential source areas.

The removal of contaminated soils beneath the footprint of the reservoir and protective measure to prevent potential contaminated surface waters from for migrating towards the pond is the recommended approach for the Option 3 reservoir design.

3.2 Option 4

Option 4 involves the construction of a new fresh water reservoir west of Station Creek. Based on information reviewed there have been no historical activities in this area and, therefore, no concerns regarding the contamination identified at the Eureka High Arctic Weather Station.

3.3 Option 5

Option 5 involves the construction of a new fresh water reservoir east of the Fuel Tank Farm (AEC B-1) and DND HADCS Warehouse (AEC C-1) and northwest of the Hydrogen Building (AEC E-1). The contaminated soils associated with AEC C-1 and E-1 are considered to be localized and not extensive. As a result, if impacts are encountered during construction of the reservoir at this location it is expected to be localized within a limited area and therefore could potential be removed and placed in the contaminated soils area (AEC A-8; Franz 2009) near the airstrip or some other suitable location.

The main concern associated with this area is the potential for future spills at the Fuel Tank Farm AEC B-1 which is located upgradient of the proposed location for Option 5. As discussed above the current design tank farm should be reviewed and potential upgrade made to prevent future spills in the area from impacted the surrounding environment.

4 REFERENCES

Franz Environmental Inc. 2009. Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada. Report prepared for Public Works Government Services Canada on Behalf of Environment Canada. March, 2009.

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

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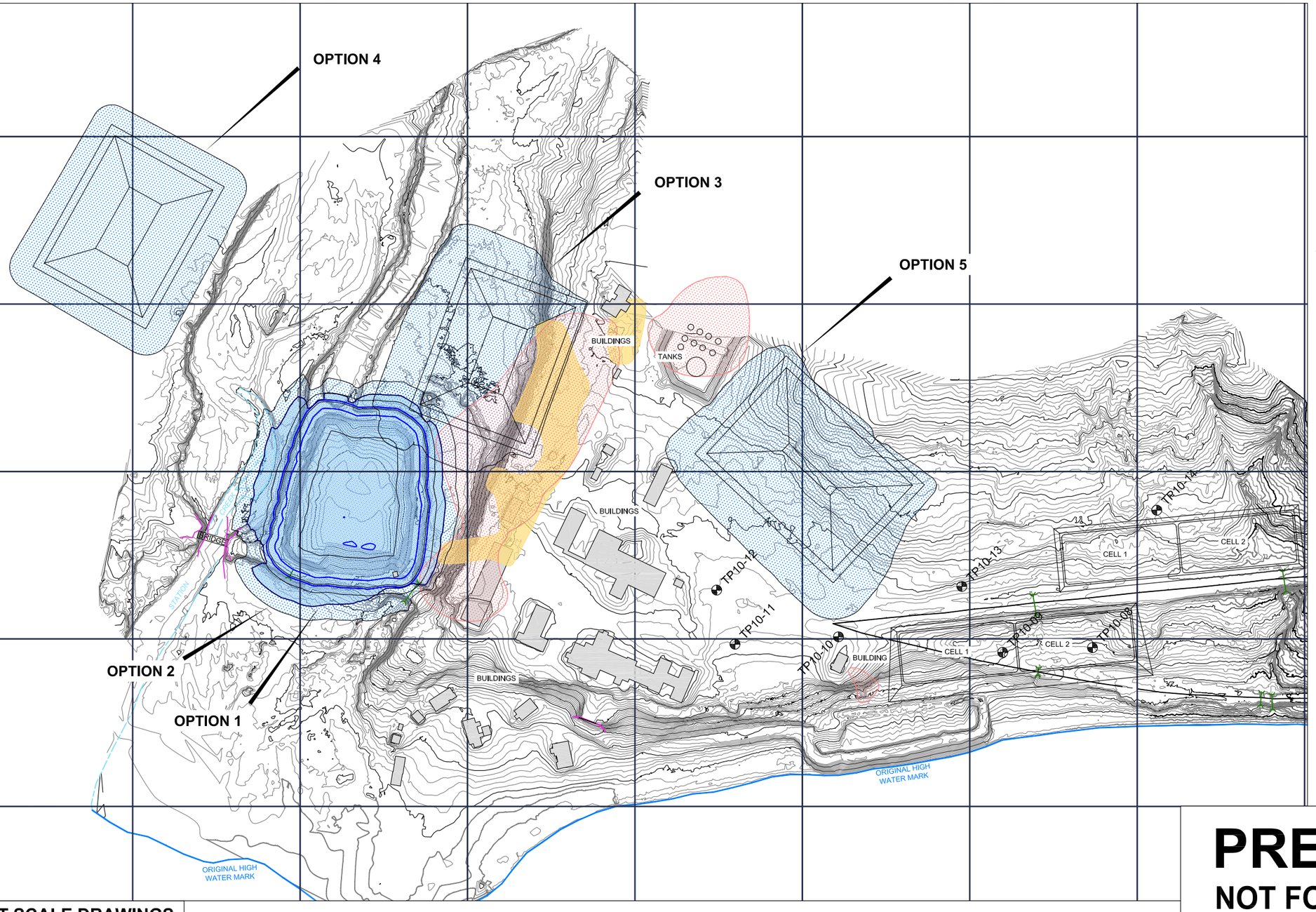
Western Region / Région de l'ouest

520200mE 520400mE 520600mE 520800mE 521000mE

8880800mN

8880600mN

8880400mN



N

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION
- INFERRED EXTENT OF ENVIRONMENTAL IMPACTED ZONE (Others; Franz 2009)
- INFERRED EXTENT OF CONTAMINATION (Franz 2009)

Franz Environmental Inc. 2009. Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada. Report prepared for Public Works Government Services Canada on Behalf of Environment Canada. March, 2009.

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

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Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet EUREKA, NUNAVUT CANADA **EUREKA ENGINEERING SERVICES**	Drawing title/Titre du dessin **AREAS OF ENVIRONMENTAL CONCERN**	Approved by/Approuve par S.T. Designed by/Concept par G.H. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-14	Project No./No. du projet R.015446.001 Sheet/Feuille 27 OF 27 Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-Environmental Concern.dwg

Appendix 1.5 Cost Estimate Information

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EcoNomics

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EUREKA CIVIL CONSULTING SERVICES
WATER RESERVOIR BASIS OF ESTIMATE

Eureka Civil Consulting Services

Water Reservoir Basis of Estimate

C71130000 – Document No: C71130000-WW-REP-0003

15 December 2010

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resources & energy

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EUREKA CIVIL CONSULTING SERVICES
WATER RESERVOIR BASIS OF ESTIMATE

PROJECT C71130000 - EUREKA CIVIL CONSULTING SERVICES

FILE LOC.: CALGARY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	G. Gagnon	C. Cancino	P. Songhurst-Thonet	18-Oct-10		
B	Issued for client review	G. Gagnon	C. Cancino	P. Songhurst-Thonet	21-Oct-10		
0	Issued as Final	G. Gagnon	C. Cancino	T. Button	15-Dec-10		

EcoNomics™

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Any questions concerning the information or its interpretation should be directed to Frankie Freckleton or Richard MacDonald.

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APPENDIX 1 TOTAL CONSTRUCTION COST (TCC) SUMMARY

APPENDIX 2 TOTAL CONSTRUCTION COST (TCC) DETAILS

1. INTRODUCTION

1.1 Purpose and Objectives

This document provides the basis of estimate, the definition of work methodology and approach used to develop an estimate for the Public Works and Government Services Canada (PWGSC) Eureka Civil Consulting Services project (R.015466.001).

1.2 Scope of Work

The scope of work comprises completing a high level cost estimate for the construction or rehabilitation of a water reservoir at the Eureka High Arctic Weather Station (the Station).

Five different options were identified as being feasible during the preliminary option review and have been developed into conceptual designs for further consideration (WorleyParsons 2010). The five options are detailed below. A summary of the Total Construction Cost (TCC) estimates are found in Appendix 1. The detailed TCCs are found in Appendix 2.

1.2.1 Option 1 – Increase Stability of Existing Reservoir

This option consists of upgrading the existing reservoir by flattening the outside slopes of the reservoir to 4 horizontal to 1 vertical, by placing fill material around the reservoir. The crest of the reservoir would be raised by approximately 0.7 m to an elevation of 3.5 m to increase the amount of freeboard from 0.2 m to 0.9 m.

1.2.2 Option 2 – Raise Existing Reservoir Berms

This option consists of taking the reservoir out of service and upgrading the interior and exterior reservoir slopes by flattening to 4 horizontal to 1 vertical. Steeper side slopes may be possible (e.g. 3H:1V), however this depends on the material properties of the existing berms. The crest of the reservoir would be raised by approximately 1.7 m to an elevation of 4.5 m. This would increase the storage depth and freeboard.

1.2.3 Option 3 – Construct New Reservoir North of Existing Reservoir

This option consists of construction of a new reservoir north of the existing reservoir. The reservoir would be constructed with 4 m active storage depth which would maximize the ratio of active storage to ice allowance.

1.2.4 Option 4 – Construct New Reservoir West of Station Creek

This option consists of construction of a new reservoir on the west side of Station Creek. The reservoir would be constructed with 4 m active storage depth which would maximize the ratio of active storage to ice allowance.

1.2.5 Option 5 – Construct New Reservoir East of the Station

This option consists of construction of a new reservoir east of the Station. The reservoir would be constructed with 4 m active storage depth which would maximize the ratio of active storage to ice allowance.

2. DESCRIPTION

2.1 Type of Estimate – Class and Accuracy

The TCCs provided are considered high level Class D cost estimates with a +/-50% accuracy.

2.2 General Assumptions and Background Information

The following general assumptions are considered the basis of the TCCs provided for each of the selected options:

- all costs are in 2010, present day Canadian (CDN) dollars, without escalation for inflation;
- construction labour and equipment rates were derived from using the current Alberta Roadbuilders & Heavy Construction Association (ARHCA) rates with a multiplier of 1.5;
- where applicable, Environment Canada's Eureka Weather Station User Rates were used for specific aspects of the construction cost estimate such as the Comprehensive Daily Charge (subsistence), on-site equipment rentals, aircraft movements and diesel fuel;
- it is assumed that Option 1 would be constructed from unprocessed, select granular materials excavated from the proposed granular materials source;
- the construction of all other raw water reservoirs options (Options 2 to 5) assumes that only processed gravel would be used to construct the reservoir earthworks;
- the source of granular materials is located 7.1 kilometres (km) east of the existing raw water reservoir, therefore, it is assumed that the gravel processing equipment would also be located at the gravel source;
- it is assumed that gravel processing can occur in the June-July-August timeframe, while earthworks construction activities can only occur in the July-August timeframe;
- it is assumed that reservoir earthworks construction activities will be executed on a twenty (20) hour per day basis using two (2) – ten (10) hour shifts;
- all excavation (cut) and embankment (fill) volumes for all reservoir options were calculated and derived from AutoCAD Civil 3D 2010 software;
- earthworks (excavation and fill) quantities derived from AutoCAD were "bulked" by a factor of 1.2 to reflect the assumed change in volume from the in-situ (in-place) condition to the excavated, loaded condition;

- surface areas for geosynthetics installations (geomembrane and drainage geocomposite) and related earthworks were calculated and derived from AutoCAD Civil 3D 2010 software;
- gravel processing equipment type and capacity were selected on the basis that the gravel required for the largest quantity (Option 3) could be processed within ninety (90) days of commissioning and start-up;
- construction equipment fleet type and capacity were selected on the basis of having the ability to construct the earthworks for any of the reservoir options in sixty (60) calendar days or less; and
- engineering cost is not included.

2.3 Specific Assumptions and Background Information

2.3.1 Heavy Equipment

The following assumptions were made regarding the heavy equipment required to complete the proposed scope of work:

- variable construction equipment fleet, depending on the volume of earthwork, structured to have the ability to load, haul and deposit (dump) earthen soil materials, to spread level and compact earthen fill materials and to trim and shape completed earthworks;
- the equipment fleets were chosen so that the same equipment is also suitable for the construction of other engineered earthworks contemplated in the future (i.e.: airstrip reconstruction / rehabilitation);
- equipment fleet costs were obtained from Finning Canada of Calgary, Alberta;
- equipment fleets include crew cab type pickup trucks for personnel movements and for light support duties;
- assume that equipment is good quality, five (5) to six (6) years old in good running order;
- all equipment is to have an enclosed operator cab;
- assume that equipment is equipped with standard features (i.e.: standard or general purpose blades, buckets, etc.);
- assume fair market value at present; and
- an allowance for spare parts was included, with the value for spare parts ranging from $50,000 to $150,000 depending on the size of the proposed fleet.

2.3.2 Freight

The following assumptions were made regarding the estimated freight cost required to complete the proposed scope of work:

- assumes that all heavy equipment will be transported by ship to Eureka, Nunavut;
- Nunavut Eastern Arctic Shipping Inc.'s (NEAS) Area A shipping rates for the 2010 season for heavy equipment and sea container transport;
- assumes that NEAS's MV Umiavut is to be used for the sealift – the ship is rated Lloyd's 100 A1 – Ice Class 1;
- assumes that the MV Umiavut will be escorted by a Canadian Coast Guard (CCG) icebreaker, either the Des Groseilliers (Medium Icebreaker) or the Terry Fox (Heavy Icebreaker);
- cost includes a "Deviation" surcharge of $250,000 as indicated by NEAS's correspondence to WorleyParsons;
- cost includes land transportation of purchased heavy and light support equipment from western Canada to NEAS's dockyard at Valleyfield, QC; and
- cost includes shipping of one (1) to five (5) sea containers as part of the load destined for Eureka.

2.3.3 Reservoir Embankment Fill (Reservoir Option 1 Only)

The following assumptions were made regarding the reservoir embankment fill for the reservoir Option 1:

- smallest equipment fleet of all of the options;
- smallest amount of embankment fill;
- costs based on estimated production rate using two (2) articulated trucks, each with a capacity of 17 cubic metres (m^3), hauling unprocessed gravel material over a distance of 7.1 km;
- construction is supported by both the equipment sealifted into Eureka and Environment Canada's own on-site equipment (dozer and front end loader); and
- cost assumes there is downtime on critical hauling equipment 15% of the time.

2.3.4 Reservoir Embankment Fill (Reservoir Option 2 to 5)

The following assumptions were made regarding the reservoir embankment fill for the reservoir Option 2 to 5:

- options 3, 4 and 5 have the largest equipment fleets;
- option 3 has the largest amount of embankment fill;
- the Option 2 fleet represents an upgrade to the Option 1 fleet by substituting purchased / sealifted dozer and front end loader (tracked) for the Environment Canada's dozer and front end loader;
- depending on the option, costs based on estimated production rate using three (3) to six (6) articulated trucks, each with a capacity of 17 m3, hauling processed gravel material over a distance of 7.1 km;
- construction is supported only by the equipment sealifted into Eureka; and
- cost assumes there is downtime on critical hauling equipment 10% to 12.5% of the time, depending on the option.

2.3.5 Reservoir Excavation to Waste Pile (All Reservoir Options)

The following assumptions were made regarding the reservoir excavation to the waste pile for all of the reservoir options:

- assumes that all materials excavated from the reservoir cross-section will be hauled away from the reservoir location and stockpiled locally in a suitable location that does not effect the operation of the Environment Canada Weather Station site or the operation of the existing airstrip;
- depending on the option, costs based on estimated production rate using two (2) to a maximum of five (5) articulated trucks, each with a capacity of 17 m^3;
- excavation is supported only by the equipment sealifted into Eureka; and
- option 1 has the least amount of excavation, while Option 5 has the greatest amount of excavation; therefore, the portion of the fleet dedicated to this operation is variable depending on the option.

2.3.6 Final Shaping / Trip (Reservoir Option 1 only)

The following assumptions were made regarding the final shaping/trip for the reservoir Option 1 only:

- this component of construction involves the final shaping and trimming of all reservoir earthworks surfaces (i.e.: reservoir floor, inside sideslopes, embankment (berm) top or crest and outside backslopes);
- final shaping and trimming is performed and supported by a combination of using the equipment sealifted into Eureka and Environment Canada's on-site equipment (i.e.: dozer); and
- reservoir Option 1 has the same quantity (12,600 m3) of earthwork shaping and trimming as Options 2 to 4.

2.3.7 Final Shaping / Trip (Reservoir Option 2 to 5)

The following assumptions were made regarding the final shaping/trip for the reservoir option 2 to 5:

- final shaping and trimming is performed and supported by using only the equipment sea-lifted into Eureka; and
- option 5 has the greatest amount (14,600 m^2) of surface area requiring shaping and trimming.

2.3.8 Reservoir Underdrain System

The following assumptions were made regarding the reservoir underdrain system:

- reservoir Option 1 does not have a geomembrane liner, therefore, a reservoir underdrain system is not required in this case;
- reservoir Options 2, 3 and 4 have similar footprints, therefore, the proposed underdrain systems are also similar in layout and size;
- reservoir Option 5 has the largest underdrain system in terms of size;
- all proposed systems incorporate the use of 150 mm diameter Boss 2000 perforated, corrugated HDPE pipe complete with filter sock, gravel pack and drainage gravel pack;
- all proposed systems incorporate the use of 250 mm diameter Boss 2000 non-perforated, corrugated HDPE pipe to convey collected groundwater to a pumpwell;
- the proposed pumpwell is to be fabricated from 600 mm diameter Boss 2000 non-perforated, corrugated HDPE pipe complete with integral tie-in tee, welded bottom cap and removable top cap;

- piping pricing obtained from Armtec Limited of Calgary, Alberta and includes freight to the First Air receiving area at the City of Yellowknife, NWT airport;
- costs include allowances for Hercules C130 airlift from Yellowknife, NWT to Eureka, Nunavut;
- first Air of Yellowknife, NWT were consulted for a budget rate for the airlift from Yellowknife to Eureka; and
- costs include all trench excavation, materials, backfilling and compaction where required, utilizing a portion of the equipment fleet identified previously.

2.3.9 Double-Sided (DS) Geocomposite (Reservoir Options 2 to 5)

The following assumptions were made regarding the reservoir geocomposite requirements (floor only):

- double-sided (DS) geocomposite is a drainage composite material that utilizes two (2) non-woven geotextiles heat bonded to either side of an HDPE geonet drainage medium and is used to collect groundwater over a relatively large area and convey this water to the reservoir underdrain system;
- the DS geocomposite is to be installed on the reservoir subgrade in the general base area and shall be located directly below the geomembrane liner installation;
- geocomposite pricing obtained from the Layfield Group of Edmonton, Alberta and includes freight to the First Air receiving area at the City of Yellowknife, NWT airport;
- costs include allowances for Hercules C130 airlift from Yellowknife, NWT to Eureka, Nunavut;
- first Air of Yellowknife, NWT were consulted for a budget rate for the airlift from Yellowknife to Eureka; and
- costs include material off-loading by Environment Canada's personnel, air transport of the installer's (Layfield) personnel and equipment from Layfield's home base to Eureka, daily crew charges for the estimated time to install the product on-site, an allowance for weather delays, installer personnel subsistence at the Eureka Weather Station and Environment Canada's equipment and labour support.

2.3.10 40 mil Polypropylene (PP) Geomembrane Liner (Reservoir Options 2 to 5)

The following assumptions were made regarding the reservoir geomembrane liner requirements.

- based on the requirement to store raw water and to limit the liability with respect to on-site installation time, 40 mil PP geomembrane is a suitable, long term choice for a proposed liner

installation – the material can be factory welded into large panels and shipped on pallets to the site;

- due to the intended use of prefabricated 40 mil PP geomembrane liner panels, the amount of field seaming is limited to the absolute minimum;
- 40 mil PP geomembrane is UV stable and is compatible with the intended use (storage of raw water to be used for drinking water once treated on-site);
- the 40 mil PP geomembrane liner is to be installed on a prepared subgrade and shall be anchored along the top of the embankment or perimeter berm by using a standard, excavated and backfilled anchor trench;
- 40 mil PP geomembrane pricing obtained from the Layfield Group of Edmonton, Alberta and includes freight to the First Air receiving area at the City of Yellowknife, NWT airport;
- costs include allowances for Hercules C130 airlift from Yellowknife, NWT to Eureka, Nunavut;
- first Air of Yellowknife, NWT were consulted for a budget rate for the airlift from Yellowknife to Eureka; and
- costs include material off-loading by Environment Canada's personnel, return air transport of the installer's (Layfield) personnel and equipment from Eureka to Layfield's home base, daily crew charges for the estimated time to install the product on-site, an allowance for weather delays, installer personnel subsistence at the Eureka Weather Station and Environment Canada's equipment and labour support.

2.3.11 Gravel Processing Equipment (Reservoir Options 2 to 5)

The following assumptions were made regarding the gravel processing equipment required to complete the proposed scope of work.

- ELRUS (gravel processing material supplier) of Calgary, Alberta were consulted in terms of portable gravel processing equipment types and capacities and ultimately provided a preliminary design and cost information for a portable screening and crushing plant that can be airlifted by C130 Hercules to Eureka, Nunavut;
- the proposed (preliminary) portable gravel screening and crushing plant consists of a grizzly screen (coarse, oversize), belt feeder, cone crusher skid, screening skid, materials handling and stacking conveyors and a electrical / generator container;
- costs include the cost of purchasing new equipment modules as indicated above, road transport to First Air's receiving area at the Yellowknife airport and C130 Hercules air transport from Yellowknife to Eureka;

- cost also includes the purchase of a crane truck support unit (to assist and support the assembly of the screening / crusher plant), road transport to First Air's receiving area at the Yellowknife airport and C130 Hercules air transport from Yellowknife to Eureka; and
- a spare parts allowance was also included in the cost estimate for this component of the work.

2.3.12 Gravel Processing Equipment Setup (Reservoir Options 2 to 5)

The following assumptions were made regarding the gravel processing equipment setup required to complete the proposed scope of work.

- ELRUS of Calgary, Alberta were consulted in terms of the amount of time and labour requirements to assembly, start-up and commission the portable screening and crushing plant;
- costs include air transport for an ELRUS technician, gravel processing equipment operator and crane truck operator from Calgary to Eureka and return flight to Calgary for the ELRUS technician only;
- costs include moving the portable plant modules from the Eureka airstrip to the location of the proposed gravel deposit, assembly of the modules and materials handling equipment, test processing (10 hours) and crew subsistence; and
- the portable plant module loading, movements and assembly are supported by Environment Canada's on-site equipment (light duty truck and wheeled front end loader).

2.3.13 Gravel Processing (Reservoir Options 2 to 5)

The following assumptions were made regarding the gravel processing requirements for Options 2 to 5.

- ELRUS of Calgary, Alberta were consulted in terms of anticipated production rates of the portable gravel screening and crushing plant;
- costs include crane truck support and rental of Environment Canada's wheeled front end loader, dozer and light duty truck to support the gravel processing operation;
- costs include plant operator and operator assistant for two (2) shifts per day;
- it is assumed that the operator assistant performs dual functions, the first to assist with the day-to-day operations of the portable plant, and the second, to operate the crane truck;
- production is governed by the usable material output rate and not the input rate to the portable plant; and
- costs include crew subsistence, diesel fuel consumed and the return flights from Eureka to the home base of the operator and operator assistant.

2.3.14 Indirect (Support) Costs

In addition to the direct cost of construction, the cost estimates for all reservoir options include costs for labour, services, materials, consumables, transportation and contract security that serve to indirectly support the initiation and sustainment of earthworks construction activities. Indirect costs include:

- temporary power services;
- telecommunications charges;
- earthworks construction crew subsistence;
- diesel fuel consumed by the earthworks equipment fleet;
- consumables, small tools and other miscellaneous hardware items;
- C130 Hercules sustainment cargo flights (variable from 1 to 3 flights, depending on the reservoir option);
- aircraft movement costs at the Eureka airstrip;
- crew change flights if the time of construction of a particular reservoir option exceeds thirty (30) days;
- contract security (bond premiums);
- travel time for equipment operators to/from Eureka to home base; and
- additional profit margin for northern, remote work.

3. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Report Prepared by
WorleyParsons

Gilbert J. Gagnon, C.E.T.
Senior Technical Specialist

Senior Review by

Tim Button, P.Eng.
Vice President of Engineering

4. REFERENCES

WorleyParsons 2010. Eureka Nunavut – Water Supply and Distribution Study. C71130000-WW-REP-0002. October 2010.

Appendices

Appendix 1 Total Construction Cost (TCC) Summary

WorleyParsons
resources & energy

OPTION 1 POND

ESTIMATE SUMMARY

Bid item	Description	Payment Clause	Unit	Quantity	Unit Price	Total Price
1	Heavy Equipment Purchase		LS	1	$1,111,619.40	$1,111,619.40
2	Heavy Equipment Sealift		LS	1	$490,146.64	$490,146.64
3	Pond Embankment Fill		m3	4,740	$109.47	$518,911.40
4	Pond Excavation to Waste Pile		m3	120	$173.09	$20,770.68
5	Pond - Final Shaping/Trim		m2	12,600	$1.87	$23,624.07
6						
7						
8						
35						
	Grand Total					**$2,165,072.19**

Check	$2,165,072.19
Variance	
From Indirects	$2,165,072.22
Variance	($0.03)

WorleyParsons
resources & energy

OPTION 2 POND

ESTIMATE SUMMARY

Bid item	Description	Payment Clause	Unit	Quantity	Unit Price	Total Price
1	Heavy Equipment Purchase		LS	1	$1,795,048.50	$1,795,048.50
2	Heavy Equipment Sealift		LS	1	$539,667.55	$539,667.55
3	Pond Embankment Fill		m3	17,042	$76.53	$1,304,140.00
4	Pond Excavation to Waste Pile		m3	620	$79.47	$49,268.98
5	Pond - Final Shaping/Trim		m2	12,600	$2.80	$35,236.13
6						
7						
8	Pond Underdrain System		LS	1	$142,552.37	$142,552.37
9	DS Geocomposite (Floor Only)		m2	4,125	$47.80	$197,168.06
10	40 mil PP Geomembrane Liner		m2	10,323	$47.59	$491,249.45
11	Gravel Processing Equipment		LS	1	$2,486,474.58	$2,486,474.58
12	Processing Equipment Setup		LS	1	$195,289.18	$195,289.18
13	Gravel Processing		m3	40,450	$43.39	$1,755,116.98
14						
35						
	Grand Total					**$8,991,211.78**

Check	$8,991,211.78
Variance	
From Indirects	$8,991,211.78
Variance	$0.00

WorleyParsons
resources & energy

OPTION 3 POND

ESTIMATE SUMMARY

Bid item	Description	Payment Clause	Unit	Quantity	Unit Price	Total Price
1	Heavy Equipment Purchase		LS	1	$3,084,438.47	$3,084,438.47
2	Heavy Equipment Sealift		LS	1	$696,243.69	$696,243.69
3	Pond Embankment Fill		m3	36,755	$65.86	$2,420,568.14
4	Pond Excavation to Waste Pile		m3	1,544	$77.72	$119,998.04
5	Pond - Final Shaping/Trim		m2	12,600	$2.91	$36,653.64
6						
7						
8	Pond Underdrain System		LS	1	$142,579.42	$142,579.42
9	DS Geocomposite (Floor Only)		m2	2,925	$65.65	$192,030.07
10	40 mil PP Geomembrane Liner		m2	6,789	$64.40	$437,216.35
11	Gravel Processing Equipment		LS	1	$2,586,502.24	$2,586,502.24
12	Processing Equipment Setup		LS	1	$203,145.43	$203,145.43
13	Gravel Processing		m3	64,100	$44.62	$2,860,419.03
14						
35						
	Grand Total					**$12,779,794.52**

Check	$12,779,794.52
Variance	
From Indirects	$12,779,794.54
Variance	($0.02)

WorleyParsons
resources & energy

OPTION 4 POND

ESTIMATE SUMMARY

Bid item	Description	Payment Clause	Unit	Quantity	Unit Price	Total Price
1	Heavy Equipment Purchase		LS	1	$3,417,086.50	$3,417,086.50
2	Heavy Equipment Sealift		LS	1	$739,974.89	$739,974.89
3	Pond Embankment Fill		m3	28,500	$69.55	$1,982,181.35
4	Pond Excavation to Waste Pile		m3	5,588	$58.69	$327,954.74
5	Pond - Final Shaping/Trim		m2	12,600	$3.37	$42,405.49
6						
7						
8	Pond Underdrain System		LS	1	$144,381.78	$144,381.78
9	DS Geocomposite (Floor Only)		m2	2,925	$66.47	$194,430.38
10	40 mil PP Geomembrane Liner		m2	6,789	$65.21	$442,681.42
11	Gravel Processing Equipment		LS	1	$2,618,832.69	$2,618,832.69
12	Processing Equipment Setup		LS	1	$205,684.68	$205,684.68
13	Gravel Processing		m3	54,200	$45.52	$2,467,143.46
14						
35						
	Grand Total					**$12,582,757.38**

Check	$12,582,757.38
Variance	
From Indirects	$12,582,757.34
Variance	$0.04

WorleyParsons
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OPTION 5 POND

ESTIMATE SUMMARY

Bid item	Description	Payment Clause	Unit	Quantity	Unit Price	Total Price
1	Heavy Equipment Purchase		LS	1	$3,471,821.68	$3,471,821.68
2	Heavy Equipment Sealift		LS	1	$751,827.89	$751,827.89
3	Pond Embankment Fill		m3	23,600	$70.70	$1,668,490.85
4	Pond Excavation to Waste Pile		m3	9,400	$59.34	$557,791.42
5	Pond - Final Shaping/Trim		m2	14,600	$3.42	$49,923.58
6						
7						
8	Pond Underdrain System		LS	1	$157,385.87	$157,385.87
9	DS Geocomposite (Floor Only)		m2	4,000	$58.73	$234,906.30
10	40 mil PP Geomembrane Liner		m2	8,100	$59.25	$479,904.17
11	Gravel Processing Equipment		LS	1	$2,660,781.37	$2,660,781.37
12	Processing Equipment Setup		LS	1	$208,979.34	$208,979.34
13	Gravel Processing		m3	48,320	$46.38	$2,240,918.60
14						
35						
	Grand Total					**$12,482,731.07**

Check	$12,482,731.07
Variance	
From Indirects	$12,482,731.10
Variance	($0.03)

Appendix 2 Total Construction Cost (TCC) Details

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3																					
4	**1.0**	**Heavy Equipment Purchase**		**1.0**	**LS**																
5		Cat 330 Hoe		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							267,077.39	267,077
6		Cat CS 563 Packer		1.0	ea	85,000.00	85,000	1.0	1			85,000.00	85,000							122,711.23	122,711
7		Cat 730 Rock Trucks		2.0	ea	200,000.00	400,000	1.0	2			200,000.00	400,000							288,732.31	577,465
8		GMC 3500 Pickups		2.0	ea	25,000.00	50,000	1.0	2			25,000.00	50,000							36,091.54	72,183
9																					
10		Spare Parts Allowance		1.0	LS	50,000.00	50,000							50,000.00	50,000					72,183.08	72,183
11																					
12																					
13																					
14																					
15																					
16		(* Assumes Eureka EC Site dozer,																			
17		front end loader and grader used)																			
18																					
19		(Use multiplier of 1.5 x ARA rates)																			
20		**Subtotal**		**1.0**	**LS**		**770,000**		*6*				**720,000**		**50,000**					**1,111,619.40**	**1,111,619**
21																					
22	**2.0**	**Heavy Equipment Sealift**		**1.0**	**LS**																
23		(Assume MV Umiavut - NEAS)																			
24																					
25																					
26		1 - Cat 330 Hoe		48.9	RT	409.25	20,012									409.25	20,012			590.82	28,891
27		1 - Cat CS 563 Packer		17.7	RT	409.25	7,236									409.25	7,236			590.82	10,446
28		2 - Cat 730 Rock Trucks (31.75 ea)		63.5	RT	409.25	25,987									409.25	25,987			590.82	37,517
29		2 - GMC 3500 Pickups (11.95 ea)		23.9	RT	409.25	9,781									409.25	9,781			590.82	14,121
30		Deviation - Nanisivik to Eureka		1.0	LS	250,000.00	250,000									250,000.00	250,000			360,915.39	360,915
31		Transport to Valleyfield, QC		4.0	LDS	5,000.00	20,000									5,000.00	20,000			7,218.31	28,873
32																					
33		1 - Sea Container		1.0	ea	6,500.00	6,500									6,500.00	6,500			9,383.80	9,384
34																					
35																					
36																					
37		(Revenue Ton = RT)																			
38		**Subtotal**		**1.0**	**LS**		**339,516**										**339,516**			**490,146.64**	**490,147**
39																					
40	**3.0**	**Pond Embankment Fill**		**4,740.0**	**m3**																
41		(No Gravel Processing - Bulk)																			
42		1 - Hoe to Load		5,832.0	m3	10.38	60,540	28.9	202	100.00	20,180	200.00	40,360							14.99	87,399
43		2 (1.7) - Rock Trucks to Haul/Dump		5,832.0	m3	19.72	115,026	28.9	202	150.00	30,270	420.00	84,756							28.47	166,058
44		1 - * EC Dozer to spread		5,832.0	m3	9.34	54,486	28.9	202			270.00	54,486							13.49	78,659
45		1 - Packer to Compact		5,832.0	m3	6.92	40,360	28.9	202	75.00	15,135	125.00	25,225							9.99	58,266
46		2 - PU trucks to support + Foreman		5,832.0	m3	6.92	40,360	28.9	202	100.00	20,180	100.00	20,180							9.99	58,266
47		1 - * EC FEL to assist hoe @ deposit		5,832.0	m3	7.96	46,414	28.9	202			230.00	46,414							11.49	67,006
48																					
49		mob/demob hoe to gravel deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,593.40	2,593
50		mob/demob EC FEL to deposit		1.0	ea	460.00	460	0.5	2			230.00	460							664.08	664
51																					
52																					
53																					
54																					
55		(17.0 m3/hr x 1.7 R.T.'s = 28.9 m3/hr)																			
56		**Subtotal**		**4,740.0**	**m3**	**75.83**	**359,441**	**0.3**	*1,219*	**18.22**	**86,364**	**57.61**	**273,078**							**109.47**	**518,911**
57																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
58	**4.0**	**Pond Excavation to Waste Pile**		**120.0**	**m3**																
59		(Waste Locally in Stockpile - Bulk)																			
60		1 - Hoe to excavate/rough in		144.0	m3	21.43	3,086	14.0	10	100.00	1,029	200.00	2,057							30.94	4,455
61		1 - * EC Dozer to move to spoil		144.0	m3	19.29	2,777	14.0	10			270.00	2,777							27.84	4,009
62		1 - * EC FEL to load RT's		144.0	m3	6.76	974	34.0	4			230.00	974							9.77	1,406
63		2 - Rock Trucks to Stockpile		144.0	m3	16.76	2,414	34.0	4	150.00	635	420.00	1,779							24.20	3,485
64		2 - PU trucks to support + Foreman		144.0	m3	20.00	2,880	10.0	14	100.00	1,440	100.00	1,440							28.87	4,158
65																					
66		mob/demob hoe from deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,593.40	2,593
67		mob/demob EC FEL from deposit		1.0	ea	460.00	460	0.5	2			230.00	460							664.08	664
68																					
69																					
70																					
71																					
72																					
73																					
74		**Subtotal**		**120.0**	**m3**	**119.90**	**14,387**	**0.4**	*51*	**30.86**	**3,703**	**89.04**	**10,685**							**173.09**	**20,771**
75																					
76	**5.0**	**Pond - Final Shaping/Trim**		**12,600.0**	**m2**																
77		1 - Hoe to assist / trim		12,600.0	m2	0.60	7,560	500.0	25	100.00	2,520	200.00	5,040							0.87	10,914
78		1 - * EC Dozer to assist / trim		12,600.0	m2	0.54	6,804	500.0	25			270.00	6,804							0.78	9,823
79		1 - Packer to Finish Slopes		12,600.0	m2	0.16	2,000	1,260.0	10	75.00	750	125.00	1,250							0.23	2,887
80																					
91																					
92		**Subtotal**		**12,600.0**	**m2**	**1.30**	**16,364**	**0.0**	*60*	**0.26**	**3,270**	**1.04**	**13,094**							**1.87**	**23,624**
93																					
94	**6.0**	**50 mm Urecon Insulated Pipe**		**30.0**	**m**																
95		(To pump from Creek to Pond)																			
96																					
109																					
110		**Subtotal**		**30.0**	**m**			**-**													
111																					
112	**7.0**	**150 mm Urecon Insulated Pipe**		**55.0**	**m**																
113		(To pump from Pond to Treatment)																			
114																					
127																					
128		**Subtotal**		**55.0**	**m**			**-**													
129																					
130	**8.0**																				
131																					
145																					
146		**Subtotal**																			
147																					
148	**9.0**																				
149																					
630																					
631																					
632		**Subtotal**																			
633																					
634																					
635																					
636		**Grand Total**					**1,499,709**		*1,337*		**93,336**		**1,016,857**		**50,000**		**339,516**				**2,165,072**
637																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3	**10.0**	**General Conditions I**																	
4	**11.0**	**Site**																	
5	11.1	Access roads, clearing, drainage																	
6	12.2	Locates																	
7	**12.0**	**Buildings**																	
8	12.1	Sheds, shops, offices, camp																	
9	12.2	Signs, fencing, barricades																	
10	**13.0**	**Temporary Services**																	
11	13.1	Water - install and operate																	
12	13.2	Power - install and operate		1,000.0	kwh	1.15	1,150											1.15	1,150
13	13.3	Heat - install and operate																	
14	13.4	Telephone and Telegraph		1.0	LS	1,000.00	1,000											1,000.00	1,000
15	**14.0**	**Camp**																	
16	14.1	Equipment, cooks, bullcooks		150.0	mdays	480.00	72,000											480.00	72,000
17	14.2	Supplies																	
18	**15.0**	**Equipment**																	
19	15.1	Unassigned rentals																	
20	15.2	Outside rentals																	
21	15.3	Plant set up																	
22	15.4	Gas and oil		27,240.0	litres	4.50	122,580											4.50	122,580
23	15.5	Repair and Maintenance																	
24	15.6	Expendable Supplies, First Aid		1.0	LS	500.00	500							500.00	500				
25	15.7	PPE																	
26	15.8	Small Tools, Hardware		1.0	LS	1,500.00	1,500							1,500.00	1,500				
27	**16.0**	**Misc.**																	
28	16.1	Concrete and Materials Tests																	
29	16.2	Rentals - Parking																	
30	16.3	Cleanup																	
31	16.4	Legal Surveys																	
32	16.5	Photos, plans, office supplies																	
33	16.6	Patent Fees, Royalties, Advertising																	
34	16.7	Special Taxes, Licenses																	
35	**17.0**	**Transport**																	
36	17.1	Car and Expense																	
37	17.2	Trucking, Cartage Freight		1.0	Herc	130,000.00	130,000											130,000.00	130,000
38	17.3	Materials Handling		2.0	ea	415.00	830											415.00	830
39	17.4	Move In and Out		1.0	air	30,000.00	30,000											30,000.00	30,000
40	**18.0**	**Supervision**																	
41	18.1	Superintendent																	
42	18.2	Engineer																	
43	18.3	Foreman																	
44	18.4	Surveyour																	
45	18.5	Accountant																	
46	18.6	Mechanics, Electricians																	
47	18.7	Drivers, Flagmen, Watchmen																	
48																			
49		**Subtotal**					**359,560**								**2,000**				**357,560**
50																			
51	**20.0**	**General Conditions II**																	
52	21.0	**WCB - UIC - HP**																	
53	21.1	Contract Security		2,165.0	thou	8.50	18,403											8.50	18,403
54	21.2	Subcontract Security																	
55	21.3	Building Permit																	
56	21.4	Fire Insurance																	
57	21.5	Other Insurance																	
58	22.0	**Subsistence**																	
59	22.1	L.O.A.																	
60	22.2	Travelling Time		100.0	mhrs	50.00	5,000	1.0	100	50.00	5,000								
61	23.0	**Contingency**																	
62	23.1	Labor																	
63	23.2	Overtime																	
64	23.3	Material																	
65	23.4	Subcontracts																	
66	24.0	**PC Sums**																	
67	24.1	Landscape																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
68	24.2	Other																	
69	25.0	**Head Office Inspection**																	
70	25.1	Overhead, Administration																	
71	26.0	**Salvage**																	
72																			
73																			
74		**Subtotal**					**23,403**		*100*		**5,000**								**18,403**
75																			
76		**TOTAL ALL INDIRECT COSTS**					382,963		100		5,000				2,000				375,963
77		**TOTAL ALL DIRECT COSTS**					1,499,709		1,337		93,336		1,016,857		50,000		339,516		
78		**Subtotal**					**1,882,671**		*1,437*		**98,336**		**1,016,857**		**52,000**		**339,516**		**375,963**
79																			
80		**MARK UP**		**15%**		15%	282,401				14,750		152,528		7,800		50,927		56,394
81		**ADJUSTMENTS**																	
82		**Subtotal**					**282,401**				**14,750**		**152,528**		**7,800**		**50,927**		**56,394**
83																			
84		**Final Total**					**2,165,072**		***1,437***		**113,087**		**1,169,385**		**59,800**		**390,444**		**432,357**
85																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3																					
4	**1.0**	**Heavy Equipment Purchase**		**1.0**	**LS**																
5		Cat 330 Hoe		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							245,988.13	245,988
6		Cat CS 563 Packer		1.0	ea	85,000.00	85,000	1.0	1			85,000.00	85,000							113,021.57	113,022
7		Cat 730 Rock Trucks		3.0	ea	200,000.00	600,000	1.0	3			200,000.00	600,000							265,933.11	797,799
8		GMC 3500 Pickups		3.0	ea	25,000.00	75,000	1.0	3			25,000.00	75,000							33,241.64	99,725
9		add - Cat 963 TFEL		1.0	ea	145,000.00	145,000	1.0	1			145,000.00	145,000							192,801.50	192,802
10		add - Cat D7R Dozer		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							245,988.13	245,988
11																					
12																					
13																					
14		Spare Parts Allowance		1.0	LS	75,000.00	75,000							75,000.00	75,000					99,724.92	99,725
15																					
16																					
17																					
18																					
19		(Use multiplier of 1.5 x ARA rates)																			
20		**Subtotal**		**1.0**	**LS**		**1,350,000**		*10*				**1,275,000**		**75,000**					**1,795,048.50**	**1,795,049**
21																					
22	**2.0**	**Heavy Equipment Sealift**		**1.0**	**LS**																
23		(Assume MV Umiavut - NEAS)																			
24																					
25																					
26		1 - Cat 330 Hoe		48.9	RT	409.25	20,012									409.25	20,012			544.17	26,610
27		1 - Cat CS 563 Packer		17.7	RT	409.25	7,236									409.25	7,236			544.17	9,621
28		3 - Cat 730 Rock Trucks (31.75 ea)		95.3	RT	409.25	38,981									409.25	38,981			544.17	51,832
29		3 - GMC 3500 Pickups (11.95 ea)		35.9	RT	409.25	14,672									409.25	14,672			544.17	19,508
30		1 - Cat 963 TFEL		22.7	RT	409.25	9,294									409.25	9,294			544.17	12,358
31		1 - D7R Dozer		27.3	RT	409.25	11,173									409.25	11,173			544.17	14,856
32		Diversion - Nanisivik to Eureka		1.0	LS	250,000.00	250,000									250,000.00	250,000			332,416.39	332,416
33		3 - Sea Containers		3.0	ea	6,500.00	19,500									6,500.00	19,500			8,642.83	25,928
34																					
35		Transport to Valleyfield, QC		7.0	LDS	5,000.00	35,000									5,000.00	35,000			6,648.33	46,538
36																					
37		(Revenue Ton = RT)																			
38		**Subtotal**		**1.0**	**LS**		**405,867**										**405,867**			**539,667.55**	**539,668**
39																					
40	**3.0**	**Pond Embankment Fill**		**17,042.0**	**m3**																
41		(Gravel Processing Req'd - Bulk)																			
42		1 - Hoe to Load		20,450.0	m3	6.54	133,660	45.9	446	100.00	44,553	200.00	89,107							8.69	177,723
43		3 (2.7) - Rock Trucks to Haul/Dump		20,450.0	m3	18.63	380,931	45.9	446	225.00	100,245	630.00	280,686							24.77	506,511
44		1 - D7R to spread		20,450.0	m3	7.08	144,798	45.9	446	85.00	37,870	240.00	106,928							9.41	192,534
45		1 - Packer to Compact		20,450.0	m3	4.36	89,107	45.9	446	75.00	33,415	125.00	55,692							5.79	118,482
46		3 - PU trucks to support + Foreman		20,450.0	m3	5.45	111,383	45.9	446	100.00	44,553	150.00	66,830							7.24	148,103
47		1 - 963 TFEL to assist		20,450.0	m3	5.77	118,066	45.9	446	85.00	37,870	180.00	80,196							7.68	156,989
48																					
49																					
50																					
51																					
52		mob/demob hoe to gravel deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,388.62	2,389
53		mob/demob TFEL to deposit		1.0	ea	1,060.00	1,060	0.25	4	85.00	340	180.00	720							1,409.45	1,409
54																					
55		(17.0 m3/hr x 2.7 R.T.'s = 45.9 m3/hr)																			
56		**Subtotal**		**17,042.0**	**m3**	**57.55**	**980,803**	**0.2**	*2,683*	**17.57**	**299,446**	**39.98**	**681,357**							**76.53**	**1,304,140**
57																					
58	**4.0**	**Pond Excavation to Waste Pile**		**620.0**	**m3**																
59		(Waste Locally in Stockpile - Bulk)																			
60		1 - Hoe to excavate/rough in		744.0	m3	8.82	6,565	34.0	22	100.00	2,188	200.00	4,376							11.73	8,729
61		1 - D7R Dozer to move to spoil		744.0	m3	9.56	7,112	34.0	22	85.00	1,860	240.00	5,252							12.71	9,456
62		1 - 963 TFEL to load RT's		744.0	m3	3.90	2,899	68.0	11	85.00	930	180.00	1,969							5.18	3,855
63		3 - Rock Trucks to Stockpile		744.0	m3	12.57	9,355	68.0	11	225.00	2,462	630.00	6,893							16.72	12,439
64		3 - PU trucks to support + Foreman		744.0	m3	11.11	8,267	22.5	33	100.00	3,307	150.00	4,960							14.77	10,992
65																					
66		mob/demob hoe from deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,388.62	2,389

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
67		mob/demob 963 TFEL from deposit		1.0	ea	1,060.00	1,060	0.3	4	85.00	340	180.00	720							1,409.45	1,409
68																					
69																					
70																					
71																					
72																					
73																					
74		**Subtotal**		**620.0**	**m3**	**59.76**	**37,054**	**0.2**	*109*	**18.85**	**11,685**	**40.92**	**25,368**							**79.47**	**49,269**
75																					
76	**5.0**	**Pond - Final Shaping/Trim**		**12,600.0**	**m2**																
77		1 - Hoe to assist / trim		12,600.0	m2	0.60	7,560	500.0	25	100.00	2,520	200.00	5,040							0.80	10,052
78		1 - D7R Dozer to assist / trim		12,600.0	m2	0.65	8,190	500.0	25	85.00	2,142	240.00	6,048							0.86	10,890
79		1 - Packer to Finish Slopes		12,600.0	m2	0.16	2,000	1,260.0	10	75.00	750	125.00	1,250							0.21	2,659
80		3 - PU trucks to support + Foreman		12,600.0	m2	0.69	8,750	360.0	35	100.00	3,500	150.00	5,250							0.92	11,635
91																					
92		**Subtotal**		**12,600.0**	**m2**	**2.10**	**26,500**	**0.0**	*95*	**0.71**	**8,912**	**1.40**	**17,588**							**2.80**	**35,236**
93																					
94	**6.0**	**100 mm Urecon Insulated Pipe**		**30.0**	**m**																
95		(To pump from Creek to Pond)																			
96																					
109																					
110		**Subtotal**		**30.0**	**m**			**-**													
111																					
112	**7.0**	**150 mm Urecon Insulated Pipe**		**55.0**	**m**																
113		(To pump from Pond to Treatment)																			
114																					
127																					
128		**Subtotal**		**55.0**	**m**			**-**													
129																					
130	**8.0**	**Pond Underdrain System**		**1.0**	**LS**																
131		Boss 2000 - Freight to Yellowknife		1.0	LS	4,500.00	4,500									4,500.00	4,500			5,983.49	5,983
132		Matl's - 150mm perf (235m + bulk)		270.0	m	10.23	2,762							10.23	2,762					13.60	3,673
133		250mm nonperf (20m + bulk)		30.0	m	23.51	705							23.51	705					31.26	938
134		1 cross, 1 increaser, 2 ells, 3 caps		1.0	LS	300.00	300							300.00	300					398.90	399
135		600 x 250 Fabricated Manhole		1.0	ea	1,150.00	1,150							1,150.00	1,150					1,529.12	1,529
136		Geotextile Wrap (2 rolls @ 418 m2)		836.0	m2	4.00	3,344							4.00	3,344					5.32	4,446
137		Coarse Gravel (gravel processing)		60.0	m3	32.63	1,958							32.63	1,958					43.39	2,603
138																					
139		1 - Hoe to excavate trench		255.0	m	35.29	9,000	8.500	30	100.00	3,000	200.00	6,000							46.93	11,967
140		1 - 963 TFEL to assist		255.0	m	31.18	7,950	8.500	30	85.00	2,550	180.00	5,400							41.45	10,571
141		2 - RT's to Stockpile / Haul Gravel		255.0	m	67.06	17,100	8.500	30	150.00	4,500	420.00	12,600							89.17	22,737
142		3 - PU trucks to support + Foreman		255.0	m	29.41	7,500	8.500	30	100.00	3,000	150.00	4,500							39.11	9,972
143		3 - operator / labourers		255.0	m	30.00	7,650	8.500	30	255.00	7,650									39.89	10,172
144		(1/3 of added Hercules C130 flight)		0.333	LS	130,000.00	43,290									130,000.00	43,290			172,856.52	57,561
145																					
146		**Subtotal**		**1.0**	**LS**		**107,209**		*150*		**20,700**		**28,500**		**10,219**		**47,790**			**142,552.37**	**142,552**
147																					
148	**9.0**	**DS Geocomposite (Floor Only)**		**4,125.0**	**m2**																
149		C130 - DS Comp + Liner Panels		0.6	LS	130,000.00	78,000									130,000.00	78,000			172,856.52	103,714
150		Supply Only - TN-220-2-6 DS Comp		4,715.0	m2	5.75	27,111							5.75	27,111					7.65	36,049
151		Crew flight In (10 hrs @ $195)		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			29,186.16	29,186
152		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			551.81	1,104
153		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,223.29	1,223
154		Crew to Install (@ $230 per hour)		4,715.0	m2	0.73	3,443	315.0	15	200.00	2,994	30.00	449							0.97	4,578
155		Weather Standby		1.0	ea	1,950.00	1,950	0.1	10	195.00	1,950									2,592.85	2,593
156																					
157		Crew Subsistence (2 Layfield)		8.0	mdays	480.00	3,840											480.00	3,840	638.24	5,106
158		* EC Vehicle Support		4.0	days	600.00	2,400	0.25	16			150.00	2,400							797.80	3,191
159		* EC Loader to Support		2.0	days	920.00	1,840	0.25	8			230.00	1,840							1,223.29	2,447
160		* EC Labour (2) to Support		2.0	days	3,000.00	6,000	0.1	20	300.00	6,000									3,989.00	7,978
161																					
162																					
163																					
164		**Subtotal**		**4,125.0**	**m2**	**35.95**	**148,284**	**0.0**	*83*	**3.13**	**12,894**	**1.36**	**5,609**	**6.57**	**27,111**	**23.96**	**98,830**	**0.93**	**3,840**	**47.80**	**197,168**
165																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
166	**10.0**	**40 mil PP Geomembrane Liner**		**10,323.0**	**m2**																
167		C130 - remaining Liner Panels		1.4	LS	130,000.00	182,000									130,000.00	182,000			172,856.52	241,999
168		Supply Only - 40 mil Geoflex		11,523.0	m2	8.20	94,489							8.20	94,489					10.90	125,638
169																					
170		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			551.81	1,104
171		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,223.29	1,223
172		Crew to Install (@ $230 per hour)		11,523.0	m2	1.60	18,405	144.0	80	200.00	16,004	30.00	2,401							2.12	24,472
173		Weather Standby		1.0	ea	3,900.00	3,900	0.050	20	195.00	3,900									5,185.70	5,186
174		Crew Flight Out		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			29,186.16	29,186
175																					
176		Crew Subsistence (2 Layfield)		20.0	mdays	480.00	9,600											480.00	9,600	638.24	12,765
177		* EC Vehicle Support		10.0	days	600.00	6,000	0.25	40			150.00	6,000							797.80	7,978
178		* EC Loader to Support		8.0	days	920.00	7,360	0.25	32			230.00	7,360							1,223.29	9,786
179		* EC Labour (2) to Support		8.0	days	3,000.00	24,000	0.1	80	300.00	24,000									3,989.00	31,912
180																					
181																					
182		**Subtotal**		**10,323.0**	**m2**	**35.79**	**369,453**	**0.0**	*266*	**4.44**	**45,854.17**	**1.62**	**16,681**	**9.15**	**94,489**	**19.65**	**202,830**	**0.93**	**9,600**	**47.59**	**491,249**
183																					
184	**11.0**	**Gravel Processing Equipment**		**1.0**	**LS**																
185		Elrus - Belt Feeder and Grizzly		1.0	ea	90,000.00	90,000	1.0	1			90,000.00	90,000							119,669.90	119,670
186		Sandvik - CH420 Cone Crusher Skid		1.0	ea	350,000.00	350,000	1.0	1			350,000.00	350,000							465,382.94	465,383
187		Elrus - 5 x 16 2D Screen Skid		1.0	ea	165,000.00	165,000	1.0	1			165,000.00	165,000							219,394.82	219,395
188		4 - 24"x50' Superior Conveyors		1.0	ea	115,000.00	115,000	1.0	1			115,000.00	115,000							152,911.54	152,912
189		1 - 20' Electrical/Genset Container		1.0	ea	225,000.00	225,000	1.0	1			225,000.00	225,000							299,174.75	299,175
190		Spare Parts Allowance		1.0	LS	100,000.00	100,000	1.0	1			100,000.00	100,000							132,966.55	132,967
191		Elrus - Trucking to Yellowknife		4.0	LDS	5,000.00	20,000									5,000.00	20,000			6,648.33	26,593
192		Crane Truck - Trucking to Yknife		1.0	LD	5,000.00	5,000									5,000.00	5,000			6,648.33	6,648
193		Crane Truck Purchase		1.0	LS	150,000.00	150,000	1.0	1			150,000.00	150,000							199,449.83	199,450
194																					
195																					
196		First Air - C130 Flights to Eureka		5.0	LDS	130,000.00	650,000									130,000.00	650,000			172,856.52	864,283
197		(4 LDS for Elrus + 1 LD for Picker Tr.)																			
198																					
199																					
200		**Subtotal**		**1.0**	**LS**		**1,870,000**		*7*				**1,195,000**				**675,000**			**2,486,474.58**	**2,486,475**
201																					
202	**12.0**	**Processing Equipment Setup**		**1.0**	**LS**																
203		Elrus/operator flight in		1.0	ea	20,000.00	20,000									20,000.00	20,000			26,593.31	26,593
204		Crane Truck to Haul to Deposit		5.0	moves	909.09	4,545	0.33	15	100.00	1,515	200.00	3,030							1,208.79	6,044
205		Elrus Personnel and Operator		5.0	moves	757.58	3,788	0.33	15	250.00	3,788									1,007.32	5,037
206		1 - * EC Pickup to support		5.0	moves	454.55	2,273	0.33	15			150.00	2,273							604.39	3,022
207		1 - * EC Loader to assist		5.0	moves	696.97	3,485	0.33	15			230.00	3,485							926.74	4,634
208																					
209		Crane Truck to support assembly		1.0	LS	30,000.00	30,000	0.01	100	100.00	10,000	200.00	20,000							39,889.97	39,890
210		Elrus / Operator to assemble		1.0	LS	25,000.00	25,000	0.01	100	250.00	25,000									33,241.64	33,242
211		1 - * EC Pickup to support		1.0	LS	15,000.00	15,000	0.01	100			150.00	15,000							19,944.98	19,945
212																					
213		Crew to Run 10 hour trial		1.0	LS	5,500.00	5,500	0.1	10	350.00	3,500	200.00	2,000							7,313.16	7,313
214																					
215		Elrus Service man return flight		1.0	ea	20,000.00	20,000									20,000.00	20,000			26,593.31	26,593
216		Subsistence for Crew (3)		36.0	mdays	480.00	17,280											480.00	17,280	638.24	22,977
217																					
218		**Subtotal**		**1.0**	**LS**		**146,871**		*371*		**43,803**		**45,788**				**40,000**		**17,280**	**195,289.18**	**195,289**
219																					
220	**13.0**	**Gravel Processing**		**40,450.0**	**m3**																
221		Crane Truck for support		40,450.0	m3	7.50	303,375	40.0	1,011	100.00	101,125	200.00	202,250							9.97	403,387
222		1 - * EC WFEL to load		40,450.0	m3	5.75	232,588	40.0	1,011			230.00	232,588							7.65	309,264
223		1 - * EC Dozer to push to loader		40,450.0	m3	6.75	273,038	40.0	1,011			270.00	273,038							8.98	363,049
224		1 - Gravel Process Operator		40,450.0	m3	2.50	101,125	40.0	1,011	100.00	101,125									3.32	134,462
225		1 - * EC Pickup to support 50%		40,450.0	m3	1.88	75,844	80.0	506			150.00	75,844							2.49	100,847
226																					
227		Crew Subsistence (2 men x 2 shifts)		200.0	mdays	480.00	96,000											480.00	96,000	638.24	127,648
228		Fuel Consumption @ 32.5l/hr		33,000.0	litres	6.00	198,000							6.00	198,000					7.98	263,274
229		Return flight for Crew (+ 1 for relief)		2.0	ea	20,000.00	40,000									20,000.00	40,000			26,593.31	53,187
230																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
231																					
232																					
233																					
234		(Mat'l Req'd = 20,450m3 + 20,000m3																			
235		surplus for other purposes)																			
236		**Subtotal**		**40,450.0**	**m3**	**32.63**	**1,319,969**	**0.1**	*4,551*	**5.00**	**202,250**	**19.38**	**783,719**	**4.89**	**198,000**	**0.99**	**40,000**	**2.37**	**96,000**	**43.39**	**1,755,117**
237																					
238	**14.0**																				
239																					
240																					
241																					
242																					
243																					
244																					
245																					
246																					
247																					
248																					
249																					
250																					
251																					
252																					
253																					
254		**Subtotal**																			
255																					
256	**15.0**																				
257																					
630																					
631																					
632		**Subtotal**																			
633																					
634																					
635																					
636		**Grand Total**					**6,762,010**		***8,325***		**645,545**		**4,074,609**		**404,819**		**1,510,317**		**126,720**		**8,991,212**
637																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3	**10.0**	**General Conditions I**																	
4	**11.0**	**Site**																	
5	11.1	Access roads, clearing, drainage																	
6	12.2	Locates																	
7	**12.0**	**Buildings**																	
8	12.1	Sheds, shops, offices, camp																	
9	12.2	Signs, fencing, barricades																	
10	**13.0**	**Temporary Services**																	
11	13.1	Water - install and operate																	
12	13.2	Power - install and operate		2,000.0	kwh	1.15	2,300											1.15	2,300
13	13.3	Heat - install and operate																	
14	13.4	Telephone and Telegraph		1.0	LS	1,000.00	1,000											1,000.00	1,000
15	**14.0**	**Camp**																	
16	14.1	Equipment, cooks, bullcooks		480.0	mdays	480.00	230,400											480.00	230,400
17	14.2	Supplies																	
18	**15.0**	**Equipment**																	
19	15.1	Unassigned rentals																	
20	15.2	Outside rentals																	
21	15.3	Plant set up																	
22	15.4	Gas and oil		98,000.0	litres	4.50	441,000											4.50	441,000
23	15.5	Repair and Maintenance																	
24	15.6	Expendable Supplies, First Aid		1.0	LS	1,000.00	1,000							1,000.00	1,000				
25	15.7	PPE																	
26	15.8	Small Tools, Hardware		1.0	LS	3,000.00	3,000							3,000.00	3,000				
27	**16.0**	**Misc.**																	
28	16.1	Concrete and Materials Tests																	
29	16.2	Rentals - Parking																	
30	16.3	Cleanup																	
31	16.4	Legal Surveys																	
32	16.5	Photos, plans, office supplies																	
33	16.6	Patent Fees, Royalties, Advertising																	
34	16.7	Special Taxes, Licenses																	
35	**17.0**	**Transport**																	
36	17.1	Car and Expense																	
37	17.2	Trucking, Cartage Freight		2.0	Herc	130,000.00	260,000											130,000.00	260,000
38	17.3	Materials Handling		8.0	ea	415.00	3,320											415.00	3,320
39	17.4	Move In and Out		1.0	air	30,000.00	30,000											30,000.00	30,000
40	**18.0**	**Supervision**																	
41	18.1	Superintendent																	
42	18.2	Engineer																	
43	18.3	Foreman																	
44	18.4	Surveyour																	
45	18.5	Accountant																	
46	18.6	Mechanics, Electricians																	
47	18.7	Drivers, Flagmen, Watchmen																	
48																			
49		**Subtotal**					**972,020**								**4,000**				**968,020**
50																			
51	**20.0**	**General Conditions II**																	
52	21.0	**WCB - UIC - HP**																	
53	21.1	Contract Security		8,990.0	thou	8.50	76,415											8.50	76,415
54	21.2	Subcontract Security																	
55	21.3	Building Permit																	
56	21.4	Fire Insurance																	
57	21.5	Other Insurance																	
58	22.0	**Subsistence**																	
59	22.1	L.O.A.																	
60	22.2	Travelling Time		160.0	mhrs	50.00	8,000	1.0	160	50.00	8,000								
61	23.0	**Contingency**																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
62	23.1	Labor																	
63	23.2	Overtime																	
64	23.3	Material																	
65	23.4	Subcontracts																	
66	24.0	**PC Sums**																	
67	24.1	Landscape																	
68	24.2	Other																	
69	25.0	**Head Office Inspection**																	
70	25.1	Overhead, Administration																	
71	26.0	**Salvage**																	
72																			
73																			
74		**Subtotal**					**84,415**		*160*		**8,000**								**76,415**
75																			
76		**TOTAL ALL INDIRECT COSTS**					1,056,435		160		8,000				4,000				1,044,435
77		**TOTAL ALL DIRECT COSTS**					6,762,010		8,325		645,545		4,074,609		404,819		1,510,317		126,720
78		**Subtotal**					**7,818,445**		*8,485*		**653,545**		**4,074,609**		**408,819**		**1,510,317**		**1,171,155**
79																			
80		**MARK UP**		**15%**		15%	1,172,767				98,032		611,191		61,323		226,548		175,673
81		**ADJUSTMENTS**																	
82		**Subtotal**					**1,172,767**				**98,032**		**611,191**		**61,323**		**226,548**		**175,673**
83																			
84		**Final Total**					**8,991,212**		***8,485***		**751,576**		**4,685,800**		**470,142**		**1,736,865**		**1,346,828**
85																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3																					
4	**1.0**	**Heavy Equipment Purchase**		**1.0**	**LS**																
5		Cat 330 Hoe		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							255,883.91	255,884
6		Cat CS 563 Packer		1.0	ea	85,000.00	85,000	1.0	1			85,000.00	85,000							117,568.28	117,568
7		Cat 730 Rock Trucks		3.0	ea	200,000.00	600,000	1.0	3			200,000.00	600,000							276,631.25	829,894
8		GMC 3500 Pickups		3.0	ea	25,000.00	75,000	1.0	3			25,000.00	75,000							34,578.91	103,737
9		Cat 963 TFEL		1.0	ea	145,000.00	145,000	1.0	1			145,000.00	145,000							200,557.66	200,558
10		Cat D7R Dozer		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							255,883.91	255,884
11		add - 1 x Cat CS 563 Packer		1.0	ea	85,000.00	85,000	1.0	1			85,000.00	85,000							117,568.28	117,568
12		add - 1 x GMC 3500 Pickup		1.0	ea	25,000.00	25,000	1.0	1			25,000.00	25,000							34,578.91	34,579
13		add - 3 x Cat 730 Rock Trucks		3.0	ea	200,000.00	600,000	1.0	3			200,000.00	600,000							276,631.25	829,894
14		add - 1 x 950H Wheeled FEL (WFEL)		1.0	ea	120,000.00	120,000	1.0	1			120,000.00	120,000							165,978.75	165,979
15																					
16																					
17		Spare Parts Allowance		1.0	LS	125,000.00	125,000							125,000.00	125,000					172,894.53	172,895
18																					
19		(Use multiplier of 1.5 x ARA rates)																			
20		**Subtotal**		**1.0**	**LS**		**2,230,000**		*16*				**2,105,000**		**125,000**					**3,084,438.47**	**3,084,438**
21																					
22	**2.0**	**Heavy Equipment Sealift**		**1.0**	**LS**																
23		(Assume MV Umiavut - NEAS)																			
24																					
25		1 - Cat 950H WFEL		32.7	RT	409.25	13,382									409.25	13,382			566.06	18,510
26		1 - Cat 330 Hoe		48.9	RT	409.25	20,012									409.25	20,012			566.06	27,680
27		2 - Cat CS 563 Packer (17.7 RT ea)		35.4	RT	409.25	14,487									409.25	14,487			566.06	20,038
28		6 - Cat 730 Rock Trucks (31.75 ea)		190.5	RT	409.25	77,962									409.25	77,962			566.06	107,834
29		4 - GMC 3500 Pickups (11.95 ea)		47.8	RT	409.25	19,562									409.25	19,562			566.06	27,058
30		1 - Cat 963 TFEL		22.7	RT	409.25	9,294									409.25	9,294			566.06	12,855
31		1 - D7R Dozer		27.3	RT	409.25	11,173									409.25	11,173			566.06	15,453
32		Diversion - Nanisivik to Eureka		1.0	LS	250,000.00	250,000									250,000.00	250,000			345,789.07	345,789
33		5 - Sea Containers		5.0	ea	6,500.00	32,500									6,500.00	32,500			8,990.52	44,953
34																					
35		Transport to Valleyfield, QC		11.0	LDS	5,000.00	55,000									5,000.00	55,000			6,915.78	76,074
36																					
37		(Revenue Ton = RT)																			
38		**Subtotal**		**1.0**	**LS**		**503,373**										**503,373**			**696,243.69**	**696,244**
39																					
40	**3.0**	**Pond Embankment Fill**		**36,755.0**	**m3**																
41		(Gravel Processing Req'd - Bulk)																			
42		1 - Hoe to Load		44,100.0	m3	3.36	148,235	89.25	494	100.00	49,412	200.00	98,824							4.65	205,033
43		6 (5.25) - Rock Trucks to Haul/Dump		44,100.0	m3	19.16	844,941	89.25	494	450.00	222,353	1,260.00	622,588							26.50	1,168,686
44		1 - D7R to spread		44,100.0	m3	3.64	160,588	89.25	494	85.00	42,000	240.00	118,588							5.04	222,119
45		2 - Packers to Compact		44,100.0	m3	4.48	197,647	89.25	494	150.00	74,118	250.00	123,529							6.20	273,377
46		4 - PU trucks to support + Foreman		44,100.0	m3	3.36	148,235	89.25	494	100.00	49,412	200.00	98,824							4.65	205,033
47		1 - 963 TFEL to assist		44,100.0	m3	2.97	130,941	89.25	494	85.00	42,000	180.00	88,941							4.11	181,112
48		1 - 950H WFEL to assist		44,100.0	m3	2.63	116,118	89.25	494	85.00	42,000	150.00	74,118							3.64	160,609
49																					
50																					
51																					
52		mob/demob hoe to gravel deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,484.71	2,485
53		mob/demob TFEL to deposit		1.0	ea	1,060.00	1,060	0.25	4	85.00	340	180.00	720							1,466.15	1,466
54		mob/demob WFEL to deposit		1.0	ea	470.00	470	0.5	2	85.00	170	150.00	300							650.08	650
55		(17.0m3/hr x 5.25 RT.'s = 89.25m3/hr)																			
56		**Subtotal**		**36,755.0**	**m3**	**47.61**	**1,750,032**	**0.1**	*3,471*	**14.21**	**522,403**	**33.40**	**1,227,629**							**65.86**	**2,420,568**
57																					
58	**4.0**	**Pond Excavation to Waste Pile**		**1,544.0**	**m3**																
59		(Waste Locally in Stockpile - Bulk)																			
60		1 - Hoe to excavate/rough in		1,852.0	m3	7.06	13,073	42.5	44	100.00	4,358	200.00	8,715							9.76	18,082
61		1 - D7R Dozer to move to spoil		1,852.0	m3	7.65	14,162	42.5	44	85.00	3,704	240.00	10,458							10.58	19,589
62		1 - 963 TFEL to load RT's		1,852.0	m3	3.12	5,774	85.0	22	85.00	1,852	180.00	3,922							4.31	7,986
63		5 - Rock Trucks to Stockpile		1,852.0	m3	16.76	31,048	85.0	22	375.00	8,171	1,050.00	22,878							23.19	42,945
64		4 - PU trucks to support + Foreman		1,852.0	m3	10.71	19,843	28.0	66	100.00	6,614	200.00	13,229							14.82	27,446
65																					
66		mob/demob hoe from deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,484.71	2,485
67		mob/demob 963 TFEL from deposit		1.0	ea	1,060.00	1,060	0.3	4	85.00	340	180.00	720							1,466.15	1,466
68																					
69																					
70																					
71																					
72																					
73																					
74		**Subtotal**		**1,544.0**	**m3**	**56.19**	**86,757**	**0.1**	*207*	**16.60**	**25,637**	**39.59**	**61,119**							**77.72**	**119,998**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
75																					
76	**5.0**	**Pond - Final Shaping/Trim**		**12,600.0**	**m2**																
77		1 - Hoe to assist / trim		12,600.0	m2	0.60	7,560	500.0	25	100.00	2,520	200.00	5,040							0.83	10,457
78		1 - D7R Dozer to assist / trim		12,600.0	m2	0.65	8,190	500.0	25	85.00	2,142	240.00	6,048							0.90	11,328
79		1 - Packer to Finish Slopes		12,600.0	m2	0.16	2,000	1,260.0	10	75.00	750	125.00	1,250							0.22	2,766
80		3 - PU trucks to support + Foreman		12,600.0	m2	0.69	8,750	360.0	35	100.00	3,500	150.00	5,250							0.96	12,103
91																					
92		**Subtotal**		**12,600.0**	**m2**	**2.10**	**26,500**	**0.0**	*95*	**0.71**	**8,912**	**1.40**	**17,588**							**2.91**	**36,654**
93																					
94	**6.0**	**100 mm Urecon Insulated Pipe**		**125.0**	**m**																
95		(To pump from Creek to Pond)																			
96																					
109																					
110		**Subtotal**		**125.0**	**m**			**-**													
111																					
112	**7.0**	**150 mm Urecon Insulated Pipe**		**100.0**	**m**																
113		(To pump from Pond to Treatment)																			
114																					
127																					
128		**Subtotal**		**100.0**	**m**			**-**													
129																					
130	**8.0**	**Pond Underdrain System**		**1.0**	**LS**																
131		Boss 2000 - Freight to Yellowknife		1.0	LS	4,500.00	4,500									4,500.00	4,500			6,224.20	6,224
132		Matl's - 150mm perf (215m + bulk)		246.0	m	10.23	2,517							10.23	2,517					14.15	3,481
133		250mm nonperf (20m + bulk)		30.0	m	23.51	705							23.51	705					32.52	976
134		1 cross, 1 increaser, 2 ells, 3 caps		1.0	LS	300.00	300							300.00	300					414.95	415
135		600 x 250 Fabricated Manhole		1.0	ea	1,150.00	1,150							1,150.00	1,150					1,590.63	1,591
136		Geotextile Wrap (2 rolls @ 418 m2)		836.0	m2	4.00	3,344							4.00	3,344					5.53	4,625
137		Coarse Gravel (gravel processing)		60.0	m3	32.26	1,936							32.26	1,936					44.62	2,677
138																					
139		1 - Hoe to excavate trench		235.0	m	35.29	8,294	8.500	28	100.00	2,765	200.00	5,529							48.82	11,472
140		1 - 963 TFEL to assist		235.0	m	31.18	7,326	8.500	28	85.00	2,350	180.00	4,976							43.12	10,134
141		2 - RT's to Stockpile / Haul Gravel		235.0	m	67.06	15,759	8.500	28	150.00	4,147	420.00	11,612							92.75	21,797
142		3 - PU trucks to support + Foreman		235.0	m	29.41	6,912	8.500	28	100.00	2,765	150.00	4,147							40.68	9,560
143		3 - operator / labourers		235.0	m	30.00	7,050	8.500	28	255.00	7,050									41.49	9,751
144		(1/3 of added Hercules C130 flight)		0.333	LS	130,000.00	43,290									130,000.00	43,290			179,810.33	59,877
145																					
146		**Subtotal**		**1.0**	**LS**		**103,083**		*138*		**19,076**		**26,265**		**9,951**		**47,790**			**142,579.42**	**142,579**
147																					
148	**9.0**	**DS Geocomposite (Floor Only)**		**2,925.0**	**m2**																
149		C130 - DS Comp + Liner Panels		0.6	LS	130,000.00	78,000									130,000.00	78,000			179,810.32	107,886
150		Supply Only - TN-220-2-6 DS Comp		3,368.0	m2	5.75	19,366							5.75	19,366					7.95	26,786
151		Crew flight In (10 hrs @ $195)		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			30,360.28	30,360
152		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			574.01	1,148
153		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,272.50	1,273
154		Crew to Install (@ $230 per hour)		3,368.0	m2	0.82	2,767	280.0	12	200.00	2,406	30.00	361							1.14	3,827
155		Weather Standby		1.0	ea	1,950.00	1,950	0.1	10	195.00	1,950									2,697.15	2,697
156																					
157		Crew Subsistence (2 Layfield)		8.0	mdays	480.00	3,840											480.00	3,840	663.92	5,311
158		* EC Vehicle Support		4.0	days	454.55	1,818	0.33	12			150.00	1,818							628.71	2,515
159		* EC Loader to Support		2.0	days	696.97	1,394	0.33	6			230.00	1,394							964.02	1,928
160		* EC Labour (2) to Support		2.0	days	3,000.00	6,000	0.1	20	300.00	6,000									4,149.47	8,299
161																					
162																					
163																					
164		**Subtotal**		**2,925.0**	**m2**	**47.46**	**138,835**	**0.0**	*74*	**4.21**	**12,306**	**1.54**	**4,493**	**6.62**	**19,366**	**33.79**	**98,830**	**1.31**	**3,840**	**65.65**	**192,030**
165																					
166	**10.0**	**40 mil PP Geomembrane Liner**		**6,789.0**	**m2**																
167		C130 - remaining Liner Panels		1.4	LS	130,000.00	182,000									130,000.00	182,000			179,810.31	251,734
168		Supply Only - 40 mil Geoflex		7,357.0	m2	8.20	60,327							8.20	60,327					11.34	83,442
169																					
170		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			574.01	1,148
171		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,272.50	1,273
172		Crew to Install (@ $230 per hour)		7,357.0	m2	1.73	12,723	133.0	55	200.00	11,063	30.00	1,659							2.39	17,597
173		Weather Standby		1.0	ea	2,910.45	2,910	0.067	15	195.00	2,910									4,025.60	4,026
174		Crew Flight Out		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			30,360.28	30,360
175																					
176		Crew Subsistence (2 Layfield)		14.0	mdays	480.00	6,720											480.00	6,720	663.92	9,295
177		* EC Vehicle Support		7.0	days	600.00	4,200	0.25	28			150.00	4,200							829.89	5,809
178		* EC Loader to Support		6.0	days	920.00	5,520	0.25	24			230.00	5,520							1,272.50	7,635
179		* EC Labour (2) to Support		6.0	days	3,000.00	18,000	0.1	60	300.00	18,000									4,149.47	24,897
180																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
181																					
182		**Subtotal**		**6,789.0**	**m2**	**46.56**	**316,100**	**0.0**	*196*	**5.00**	**33,923.61**	**1.81**	**12,299**	**8.89**	**60,327**	**29.88**	**202,830**	**0.99**	**6,720**	**64.40**	**437,216**
183																					
184	**11.0**	**Gravel Processing Equipment**		**1.0**	**LS**																
185		Elrus - Belt Feeder and Grizzly		1.0	ea	90,000.00	90,000	1.0	1			90,000.00	90,000							124,484.06	124,484
186		Sandvik - CH420 Cone Crusher Skid		1.0	ea	350,000.00	350,000	1.0	1			350,000.00	350,000							484,104.70	484,105
187		Elrus - 5 x 16 2D Screen Skid		1.0	ea	165,000.00	165,000	1.0	1			165,000.00	165,000							228,220.79	228,221
188		4 - 24"x50' Superior Conveyors		1.0	ea	115,000.00	115,000	1.0	1			115,000.00	115,000							159,062.97	159,063
189		1 - 20' Electrical/Genset Container		1.0	ea	225,000.00	225,000	1.0	1			225,000.00	225,000							311,210.16	311,210
190		Spare Parts Allowance		1.0	LS	100,000.00	100,000	1.0	1			100,000.00	100,000							138,315.63	138,316
191		Elrus - Trucking to Yellowknife		4.0	LDS	5,000.00	20,000									5,000.00	20,000			6,915.78	27,663
192		Crane Truck - Trucking to Yknife		1.0	LD	5,000.00	5,000									5,000.00	5,000			6,915.78	6,916
193		Crane Truck Purchase		1.0	LS	150,000.00	150,000	1.0	1			150,000.00	150,000							207,473.44	207,473
194																					
195																					
196		First Air - C130 Flights to Eureka		5.0	LDS	130,000.00	650,000									130,000.00	650,000			179,810.32	899,052
197		(4 LDS for Elrus + 1 LD for Picker Tr.)																			
198																					
199																					
200		**Subtotal**		**1.0**	**LS**		**1,870,000**		*7*				**1,195,000**				**675,000**			**2,586,502.24**	**2,586,502**
201																					
202	**12.0**	**Processing Equipment Setup**		**1.0**	**LS**																
203		Elrus/operator flight in		1.0	ea	20,000.00	20,000									20,000.00	20,000			27,663.13	27,663
204		Crane Truck to Haul to Deposit		5.0	moves	909.09	4,545	0.33	15	100.00	1,515	200.00	3,030							1,257.41	6,287
205		Elrus Personnel and Operator		5.0	moves	757.58	3,788	0.33	15	250.00	3,788									1,047.85	5,239
206		1 - * EC Pickup to support		5.0	moves	454.55	2,273	0.33	15			150.00	2,273							628.71	3,144
207		1 - * EC Loader to assist		5.0	moves	696.97	3,485	0.33	15			230.00	3,485							964.02	4,820
208																					
209		Crane Truck to support assembly		1.0	LS	30,000.00	30,000	0.01	100	100.00	10,000	200.00	20,000							41,494.69	41,495
210		Elrus / Operator to assemble		1.0	LS	25,000.00	25,000	0.01	100	250.00	25,000									34,578.91	34,579
211		1 - * EC Pickup to support		1.0	LS	15,000.00	15,000	0.01	100			150.00	15,000							20,747.34	20,747
212																					
213		Crew to Run 10 hour trial		1.0	LS	5,500.00	5,500	0.1	10	350.00	3,500	200.00	2,000							7,607.36	7,607
214																					
215		Elrus Service man return flight		1.0	ea	20,000.00	20,000									20,000.00	20,000			27,663.13	27,663
216		Subsistence for Crew (3)		36.0	mdays	480.00	17,280											480.00	17,280	663.92	23,901
217																					
218		**Subtotal**		**1.0**	**LS**		**146,871**		*371*		**43,803**		**45,788**				**40,000**		**17,280**	**203,145.43**	**203,145**
219																					
220	**13.0**	**Gravel Processing**		**64,100.0**	**m3**																
221		Crane Truck for support		64,100.0	m3	7.50	480,750	40.0	1,603	100.00	160,250	200.00	320,500							10.37	664,952
222		1 - * EC WFEL to load		64,100.0	m3	5.75	368,575	40.0	1,603			230.00	368,575							7.95	509,797
223		1 - * EC Dozer to push to loader		64,100.0	m3	6.75	432,675	40.0	1,603			270.00	432,675							9.34	598,457
224		1 - Gravel Process Operator		64,100.0	m3	2.50	160,250	40.0	1,603	100.00	160,250									3.46	221,651
225		1 - * EC Pickup to support 50%		64,100.0	m3	1.88	120,188	80.0	801			150.00	120,188							2.59	166,238
226																					
227		Crew Subsistence (2 men x 2 shifts)		320.0	mdays	480.00	153,600											480.00	153,600	663.92	212,453
228		Fuel Consumption @ 32.5l/hr		52,000.0	litres	6.00	312,000							6.00	312,000					8.30	431,545
229		Return flight for Crew (+ 1 for relief)		2.0	ea	20,000.00	40,000									20,000.00	40,000			27,663.13	55,326
230																					
231																					
232																					
233																					
234		(Mat'l Req'd = 44,100m3 + 20,000m3																			
235		surplus for other purposes)																			
236		**Subtotal**		**64,100.0**	**m3**	**32.26**	**2,068,038**	**0.1**	*7,211*	**5.00**	**320,500**	**19.38**	**1,241,938**	**4.87**	**312,000**	**0.62**	**40,000**	**2.40**	**153,600**	**44.62**	**2,860,419**
237																					
238	**14.0**																				
239																					
240																					
241																					
242																					
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252																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
253																					
254		**Subtotal**																			
255																					
256	**15.0**																				
257																					
630																					
631																					
632		**Subtotal**																			
633																					
634																					
635																					
636		**Grand Total**					**9,239,588**		***11,787***		**986,561**		**5,937,119**		**526,645**		**1,607,823**		**181,440**		**12,779,795**
637																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3	**10.0**	**General Conditions I**																	
4	**11.0**	**Site**																	
5	11.1	Access roads, clearing, drainage																	
6	12.2	Locates																	
7	**12.0**	**Buildings**																	
8	12.1	Sheds, shops, offices, camp																	
9	12.2	Signs, fencing, barricades																	
10	**13.0**	**Temporary Services**																	
11	13.1	Water - install and operate																	
12	13.2	Power - install and operate		2,500.0	kwh	1.15	2,875											1.15	2,875
13	13.3	Heat - install and operate																	
14	13.4	Telephone and Telegraph		1.0	LS	1,000.00	1,000											1,000.00	1,000
15	**14.0**	**Camp**																	
16	14.1	Equipment, cooks, bullcooks		910.0	mdays	480.00	436,800											480.00	436,800
17	14.2	Supplies																	
18	**15.0**	**Equipment**																	
19	15.1	Unassigned rentals																	
20	15.2	Outside rentals																	
21	15.3	Plant set up																	
22	15.4	Gas and oil		186,000.0	litres	4.50	837,000											4.50	837,000
23	15.5	Repair and Maintenance																	
24	15.6	Expendable Supplies, First Aid		1.0	LS	1,500.00	1,500							1,500.00	1,500				
25	15.7	PPE																	
26	15.8	Small Tools, Hardware		1.0	LS	4,500.00	4,500							4,500.00	4,500				
27	**16.0**	**Misc.**																	
28	16.1	Concrete and Materials Tests																	
29	16.2	Rentals - Parking																	
30	16.3	Cleanup																	
31	16.4	Legal Surveys																	
32	16.5	Photos, plans, office supplies																	
33	16.6	Patent Fees, Royalties, Advertising																	
34	16.7	Special Taxes, Licenses																	
35	**17.0**	**Transport**																	
36	17.1	Car and Expense																	
37	17.2	Trucking, Cartage Freight		3.0	Herc	130,000.00	390,000											130,000.00	390,000
38	17.3	Materials Handling		12.0	ea	415.00	4,980											415.00	4,980
39	17.4	Move In and Out		2.0	air	30,000.00	60,000											30,000.00	60,000
40	**18.0**	**Supervision**																	
41	18.1	Superintendent																	
42	18.2	Engineer																	
43	18.3	Foreman																	
44	18.4	Surveyour																	
45	18.5	Accountant																	
46	18.6	Mechanics, Electricians																	
47	18.7	Drivers, Flagmen, Watchmen																	
48																			
49		**Subtotal**					**1,738,655**								**6,000**				**1,732,655**
50																			
51	**20.0**	**General Conditions II**																	
52	21.0	**WCB - UIC - HP**																	
53	21.1	Contract Security		12,779.0	thou	8.50	108,622											8.50	108,622
54	21.2	Subcontract Security																	
55	21.3	Building Permit																	
56	21.4	Fire Insurance																	
57	21.5	Other Insurance																	
58	22.0	**Subsistence**																	
59	22.1	L.O.A.																	
60	22.2	Travelling Time		520.0	mhrs	50.00	26,000	1.0	520	50.00	26,000								
61	23.0	**Contingency**																	
62	23.1	Labor																	
63	23.2	Overtime																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
64	23.3	Material																	
65	23.4	Subcontracts																	
66	24.0	**PC Sums**																	
67	24.1	Landscape																	
68	24.2	Other																	
69	25.0	**Head Office Inspection**																	
70	25.1	Overhead, Administration																	
71	26.0	**Salvage**																	
72																			
73																			
74		**Subtotal**					**134,622**		*520*		**26,000**								**108,622**
75																			
76		**TOTAL ALL INDIRECT COSTS**					1,873,277		520		26,000				6,000				1,841,277
77		**TOTAL ALL DIRECT COSTS**					9,239,588		11,787		986,561		5,937,119		526,645		1,607,823		181,440
78		**Subtotal**					**11,112,865**		*12,307*		**1,012,561**		**5,937,119**		**532,645**		**1,607,823**		**2,022,717**
79																			
80		**MARK UP**		**15%**		15%	1,666,930				151,884		890,568		79,897		241,173		303,407
81		**ADJUSTMENTS**																	
82		**Subtotal**					**1,666,930**				**151,884**		**890,568**		**79,897**		**241,173**		**303,407**
83																			
84		**Final Total**					**12,779,795**		***12,307***		**1,164,445**		**6,827,687**		**612,542**		**1,848,997**		**2,326,124**
85																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3																					
4	**1.0**	**Heavy Equipment Purchase**		**1.0**	**LS**																
5		Cat 330 Hoe		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							259,082.38	259,082
6		Cat CS 563 Packer		2.0	ea	85,000.00	170,000	1.0	2			85,000.00	170,000							119,037.85	238,076
7		Cat 730 Rock Trucks		6.0	ea	200,000.00	1,200,000	1.0	6			200,000.00	1,200,000							280,089.06	1,680,534
8		GMC 3500 Pickups		4.0	ea	25,000.00	100,000	1.0	4			25,000.00	100,000							35,011.13	140,045
9		Cat 963 TFEL		1.0	ea	145,000.00	145,000	1.0	1			145,000.00	145,000							203,064.57	203,065
10		Cat D7R Dozer		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							259,082.38	259,082
11		Cat 950H WFEL		1.0	ea	120,000.00	120,000	1.0	1			120,000.00	120,000							168,053.43	168,053
12		add - Cat 330 Hoe		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							259,082.38	259,082
13																					
14																					
15																					
16																					
17		Spare Parts Allowance		1.0	LS	150,000.00	150,000							150,000.00	150,000					210,066.79	210,067
18																					
19		(Use multiplier of 1.5 x ARA rates)																			
20		**Subtotal**		**1.0**	**LS**		**2,440,000**		*17*				**2,290,000**		**150,000**					**3,417,086.50**	**3,417,087**
21																					
22	**2.0**	**Heavy Equipment Sealift**		**1.0**	**LS**																
23		(Assume MV Umiavut - NEAS)																			
24																					
25		1 - Cat 950H WFEL		32.7	RT	409.25	13,382									409.25	13,382			573.13	18,741
26		2 - Cat 330 Hoe (48.9 RT ea)		97.8	RT	409.25	40,025									409.25	40,025			573.13	56,052
27		2 - Cat CS 563 Packer (17.7 RT ea)		35.4	RT	409.25	14,487									409.25	14,487			573.13	20,289
28		6 - Cat 730 Rock Trucks (31.75 ea)		190.5	RT	409.25	77,962									409.25	77,962			573.13	109,182
29		4 - GMC 3500 Pickups (11.95 ea)		47.8	RT	409.25	19,562									409.25	19,562			573.13	27,396
30		1 - Cat 963 TFEL		22.7	RT	409.25	9,294									409.25	9,294			573.13	13,016
31		1 - D7R Dozer		27.3	RT	409.25	11,173									409.25	11,173			573.13	15,647
32		Diversion - Nanisivik to Eureka		1.0	LS	250,000.00	250,000									250,000.00	250,000			350,111.32	350,111
33		5 - Sea Containers		5.0	ea	6,500.00	32,500									6,500.00	32,500			9,102.89	45,514
34																					
35		Transport to Valleyfield, QC		12.0	LDS	5,000.00	60,000									5,000.00	60,000			7,002.23	84,027
36																					
37		(Revenue Ton = RT)																			
38		**Subtotal**		**1.0**	**LS**		**528,385**										**528,385**			**739,974.89**	**739,975**
39																					
40	**3.0**	**Pond Embankment Fill**		**28,500.0**	**m3**																
41		(Gravel Processing Req'd - Bulk)																			
42		2 - Hoes to Load / Assist (1.5 rate)		34,200.0	m3	5.04	172,437	89.25	383	150.00	57,479	300.00	114,958							7.06	241,489
43		6 (5.25) - Rock Trucks to Haul/Dump		34,200.0	m3	19.16	655,261	89.25	383	450.00	172,437	1,260.00	482,824							26.83	917,656
44		1 - D7R to spread		34,200.0	m3	3.64	124,538	89.25	383	85.00	32,571	240.00	91,966							5.10	174,408
45		2 - Packers to Compact		34,200.0	m3	4.48	153,277	89.25	383	150.00	57,479	250.00	95,798							6.28	214,656
46		4 - PU trucks to support + Foreman		34,200.0	m3	3.36	114,958	89.25	383	100.00	38,319	200.00	76,639							4.71	160,992
47		1 - 963 TFEL to assist		34,200.0	m3	2.97	101,546	89.25	383	85.00	32,571	180.00	68,975							4.16	142,210
48		1 - 950H WFEL to assist		34,200.0	m3	2.63	90,050	89.25	383	85.00	32,571	150.00	57,479							3.69	126,111
49																					
50																					
51																					
52		mob/demob hoe to gravel deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,515.77	2,516
53		mob/demob TFEL to deposit		1.0	ea	1,060.00	1,060	0.25	4	85.00	340	180.00	720							1,484.47	1,484
54		mob/demob WFEL to deposit		1.0	ea	470.00	470	0.5	2	85.00	170	150.00	300							658.21	658
55		(17.0m3/hr x 5.25 RT.'s = 89.25m3/hr)																			
56		**Subtotal**		**28,500.0**	**m3**	**49.66**	**1,415,394**	**0.1**	*2,694*	**14.90**	**424,537**	**34.77**	**990,856**							**69.55**	**1,982,181**
57																					
58	**4.0**	**Pond Excavation to Waste Pile**		**5,588.0**	**m3**																
59		(Waste Locally in Stockpile - Bulk)																			
60		2 - Hoes to excavate (1.5 rate)		6,705.0	m3	7.50	50,288	60.00	112	150.00	16,763	300.00	33,525							10.50	70,425
61		1 - D7R Dozer to move to spoil		6,705.0	m3	5.42	36,319	60.00	112	85.00	9,499	240.00	26,820							7.59	50,862
62		1 - 963 TFEL to load RT's		6,705.0	m3	2.21	14,807	120.0	56	85.00	4,749	180.00	10,058							3.09	20,736
63		5 - Rock Trucks to Stockpile		6,705.0	m3	11.88	79,622	120.0	56	375.00	20,953	1,050.00	58,669							16.63	111,506
64		4 - PU trucks to support + Foreman		6,705.0	m3	7.50	50,288	40.0	168	100.00	16,763	200.00	33,525							10.50	70,425
65																					
66		mob/demob hoe from deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,515.77	2,516
67		mob/demob 963 TFEL from deposit		1.0	ea	1,060.00	1,060	0.3	4	85.00	340	180.00	720							1,484.47	1,484
68																					
69																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
70																					
71																					
72																					
73																					
74		**Subtotal**		**5,588.0**	**m3**	**41.91**	**234,179**	**0.1**	*513*	**12.47**	**69,665**	**29.44**	**164,514**							**58.69**	**327,955**
75																					
76	**5.0**	**Pond - Final Shaping/Trim**		**12,600.0**	**m2**																
77		2 - Hoes to assist / trim (1.5 rate)		12,600.0	m2	0.90	11,340	500.0	25	150.00	3,780	300.00	7,560							1.26	15,881
78		1 - D7R Dozer to assist / trim		12,600.0	m2	0.65	8,190	500.0	25	85.00	2,142	240.00	6,048							0.91	11,470
79		1 - Packer to Finish Slopes		12,600.0	m2	0.16	2,000	1,260.0	10	75.00	750	125.00	1,250							0.22	2,801
80		3 - PU trucks to support + Foreman		12,600.0	m2	0.69	8,750	360.0	35	100.00	3,500	150.00	5,250							0.97	12,254
91																					
92		**Subtotal**		**12,600.0**	**m2**	**2.40**	**30,280**	**0.0**	*95*	**0.81**	**10,172**	**1.60**	**20,108**							**3.37**	**42,405**
93																					
94	**6.0**	**150 mm Urecon Insulated Pipe**		**80.0**	**m**																
95		(To pump from Creek to Pond)																			
96																					
109																					
110		**Subtotal**		**80.0**	**m**			**-**													
111																					
112	**7.0**	**150 mm Urecon Insulated Pipe**		**300.0**	**m**																
113		(To pump from Pond to Treatment)																			
114																					
127																					
128		**Subtotal**		**300.0**	**m**			**-**													
129																					
130	**8.0**	**Pond Underdrain System**		**1.0**	**LS**																
131		Boss 2000 - Freight to Yellowknife		1.0	LS	4,500.00	4,500									4,500.00	4,500			6,302.00	6,302
132		Matl's - 150mm perf (215m + bulk)		246.0	m	10.23	2,517							10.23	2,517					14.33	3,524
133		250mm nonperf (20m + bulk)		30.0	m	23.51	705							23.51	705					32.92	988
134		1 cross, 1 increaser, 2 ells, 3 caps		1.0	LS	300.00	300							300.00	300					420.13	420
135		600 x 250 Fabricated Manhole		1.0	ea	1,150.00	1,150							1,150.00	1,150					1,610.51	1,611
136		Geotextile Wrap (2 rolls @ 418 m2)		836.0	m2	4.00	3,344							4.00	3,344					5.60	4,683
137		Coarse Gravel (gravel processing)		60.0	m3	32.50	1,950							32.50	1,950					45.51	2,731
138																					
139		1 - Hoe to excavate trench		235.0	m	35.29	8,294	8.500	28	100.00	2,765	200.00	5,529							49.43	11,615
140		1 - 963 TFEL to assist		235.0	m	31.18	7,326	8.500	28	85.00	2,350	180.00	4,976							43.66	10,260
141		2 - RT's to Stockpile / Haul Gravel		235.0	m	67.06	15,759	8.500	28	150.00	4,147	420.00	11,612							93.91	22,069
142		3 - PU trucks to support + Foreman		235.0	m	29.41	6,912	8.500	28	100.00	2,765	150.00	4,147							41.19	9,680
143		3 - operator / labourers		235.0	m	30.00	7,050	8.500	28	255.00	7,050									42.01	9,873
144		(1/3 of added Hercules C130 flight)		0.333	LS	130,000.00	43,290									130,000.00	43,290			182,057.90	60,625
145																					
146		**Subtotal**		**1.0**	**LS**		**103,097**		*138*		**19,076**		**26,265**		**9,966**		**47,790**			**144,381.78**	**144,382**
147																					
148	**9.0**	**DS Geocomposite (Floor Only)**		**2,925.0**	**m2**																
149		C130 - DS Comp + Liner Panels		0.6	LS	130,000.00	78,000									130,000.00	78,000			182,057.88	109,235
150		Supply Only - TN-220-2-6 DS Comp		3,368.0	m2	5.75	19,366							5.75	19,366					8.05	27,121
151		Crew flight In (10 hrs @ $195)		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			30,739.77	30,740
152		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			581.19	1,162
153		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,288.41	1,288
154		Crew to Install (@ $230 per hour)		3,368.0	m2	0.82	2,767	280.0	12	200.00	2,406	30.00	361							1.15	3,874
155		Weather Standby		1.0	ea	1,950.00	1,950	0.1	10	195.00	1,950									2,730.87	2,731
156																					
157		Crew Subsistence (2 Layfield)		8.0	mdays	480.00	3,840											480.00	3,840	672.21	5,378
158		* EC Vehicle Support		4.0	days	454.55	1,818	0.33	12			150.00	1,818							636.57	2,546
159		* EC Loader to Support		2.0	days	696.97	1,394	0.33	6			230.00	1,394							976.07	1,952
160		* EC Labour (2) to Support		2.0	days	3,000.00	6,000	0.1	20	300.00	6,000									4,201.34	8,403
161																					
162																					
163																					
164		**Subtotal**		**2,925.0**	**m2**	**47.46**	**138,835**	**0.0**	*74*	**4.21**	**12,306**	**1.54**	**4,493**	**6.62**	**19,366**	**33.79**	**98,830**	**1.31**	**3,840**	**66.47**	**194,430**
165																					
166	**10.0**	**40 mil PP Geomembrane Liner**		**6,789.0**	**m2**																
167		C130 - remaining Liner Panels		1.4	LS	130,000.00	182,000									130,000.00	182,000			182,057.89	254,881
168		Supply Only - 40 mil Geoflex		7,357.0	m2	8.20	60,327							8.20	60,327					11.48	84,485
169																					
170		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			581.19	1,162

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
171		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,288.41	1,288
172		Crew to Install (@ $230 per hour)		7,357.0	m2	1.73	12,723	133.0	55	200.00	11,063	30.00	1,659							2.42	17,817
173		Weather Standby		1.0	ea	2,910.45	2,910	0.067	15	195.00	2,910									4,075.92	4,076
174		Crew Flight Out		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			30,739.77	30,740
175																					
176		Crew Subsistence (2 Layfield)		14.0	mdays	480.00	6,720											480.00	6,720	672.21	9,411
177		* EC Vehicle Support		7.0	days	600.00	4,200	0.25	28			150.00	4,200							840.27	5,882
178		* EC Loader to Support		6.0	days	920.00	5,520	0.25	24			230.00	5,520							1,288.41	7,730
179		* EC Labour (2) to Support		6.0	days	3,000.00	18,000	0.1	60	300.00	18,000									4,201.34	25,208
180																					
181																					
182		**Subtotal**		**6,789.0**	**m2**	**46.56**	**316,100**	**0.0**	*196*	**5.00**	**33,923.61**	**1.81**	**12,299**	**8.89**	**60,327**	**29.88**	**202,830**	**0.99**	**6,720**	**65.21**	**442,681**
183																					
184	**11.0**	**Gravel Processing Equipment**		**1.0**	**LS**																
185		Elrus - Belt Feeder and Grizzly		1.0	ea	90,000.00	90,000	1.0	1			90,000.00	90,000							126,040.08	126,040
186		Sandvik - CH420 Cone Crusher Skid		1.0	ea	350,000.00	350,000	1.0	1			350,000.00	350,000							490,155.85	490,156
187		Elrus - 5 x 16 2D Screen Skid		1.0	ea	165,000.00	165,000	1.0	1			165,000.00	165,000							231,073.47	231,073
188		4 - 24"x50' Superior Conveyors		1.0	ea	115,000.00	115,000	1.0	1			115,000.00	115,000							161,051.21	161,051
189		1 - 20' Electrical/Genset Container		1.0	ea	225,000.00	225,000	1.0	1			225,000.00	225,000							315,100.19	315,100
190		Spare Parts Allowance		1.0	LS	100,000.00	100,000	1.0	1			100,000.00	100,000							140,044.53	140,045
191		Elrus - Trucking to Yellowknife		4.0	LDS	5,000.00	20,000									5,000.00	20,000			7,002.23	28,009
192		Crane Truck - Trucking to Yknife		1.0	LD	5,000.00	5,000									5,000.00	5,000			7,002.23	7,002
193		Crane Truck Purchase		1.0	LS	150,000.00	150,000	1.0	1			150,000.00	150,000							210,066.79	210,067
194																					
195																					
196		First Air - C130 Flights to Eureka		5.0	LDS	130,000.00	650,000									130,000.00	650,000			182,057.89	910,289
197		(4 LDS for Elrus + 1 LD for Picker Tr.)																			
198																					
199																					
200		**Subtotal**		**1.0**	**LS**		**1,870,000**		*7*				**1,195,000**				**675,000**			**2,618,832.69**	**2,618,833**
201																					
202	**12.0**	**Processing Equipment Setup**		**1.0**	**LS**																
203		Elrus/operator flight in		1.0	ea	20,000.00	20,000									20,000.00	20,000			28,008.91	28,009
204		Crane Truck to Haul to Deposit		5.0	moves	909.09	4,545	0.33	15	100.00	1,515	200.00	3,030							1,273.13	6,366
205		Elrus Personnel and Operator		5.0	moves	757.58	3,788	0.33	15	250.00	3,788									1,060.94	5,305
206		1 - * EC Pickup to support		5.0	moves	454.55	2,273	0.33	15			150.00	2,273							636.57	3,183
207		1 - * EC Loader to assist		5.0	moves	696.97	3,485	0.33	15			230.00	3,485							976.07	4,880
208																					
209		Crane Truck to support assembly		1.0	LS	30,000.00	30,000	0.01	100	100.00	10,000	200.00	20,000							42,013.36	42,013
210		Elrus / Operator to assemble		1.0	LS	25,000.00	25,000	0.01	100	250.00	25,000									35,011.13	35,011
211		1 - * EC Pickup to support		1.0	LS	15,000.00	15,000	0.01	100			150.00	15,000							21,006.68	21,007
212																					
213		Crew to Run 10 hour trial		1.0	LS	5,500.00	5,500	0.1	10	350.00	3,500	200.00	2,000							7,702.45	7,702
214																					
215		Elrus Service man return flight		1.0	ea	20,000.00	20,000									20,000.00	20,000			28,008.91	28,009
216		Subsistence for Crew (3)		36.0	mdays	480.00	17,280											480.00	17,280	672.21	24,200
217																					
218		**Subtotal**		**1.0**	**LS**		**146,871**		*371*		**43,803**		**45,788**				**40,000**		**17,280**	**205,684.68**	**205,685**
219																					
220	**13.0**	**Gravel Processing**		**54,200.0**	**m3**																
221		Crane Truck for support		54,200.0	m3	7.50	406,500	40.0	1,355	100.00	135,500	200.00	271,000							10.50	569,281
222		1 - * EC WFEL to load		54,200.0	m3	5.75	311,650	40.0	1,355			230.00	311,650							8.05	436,449
223		1 - * EC Dozer to push to loader		54,200.0	m3	6.75	365,850	40.0	1,355			270.00	365,850							9.45	512,353
224		1 - Gravel Process Operator		54,200.0	m3	2.50	135,500	40.0	1,355	100.00	135,500									3.50	189,760
225		1 - * EC Pickup to support 50%		54,200.0	m3	1.88	101,625	80.0	678			150.00	101,625							2.63	142,320
226																					
227		Crew Subsistence (2 men x 2 shifts)		272.0	mdays	480.00	130,560											480.00	130,560	672.21	182,842
228		Fuel Consumption @ 32.5l/hr		45,000.0	litres	6.00	270,000							6.00	270,000					8.40	378,120
229		Return flight for Crew (+ 1 for relief)		2.0	ea	20,000.00	40,000									20,000.00	40,000			28,008.91	56,018
230																					
231																					
232																					
233																					
234		(Mat'l Req'd = 44,100m3 + 20,000m3																			
235		surplus for other purposes)																			
236		**Subtotal**		**54,200.0**	**m3**	**32.50**	**1,761,685**	**0.1**	*6,098*	**5.00**	**271,000**	**19.38**	**1,050,125**	**4.98**	**270,000**	**0.74**	**40,000**	**2.41**	**130,560**	**45.52**	**2,467,143**
237																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
238	**14.0**																				
239																					
240																					
241																					
242																					
243																					
244																					
245																					
246																					
247																					
248																					
249																					
250																					
251																					
252																					
253																					
254		**Subtotal**																			
255																					
256	**15.0**																				
257																					
630																					
631																					
632		**Subtotal**																			
633																					
634																					
635																					
636		**Grand Total**					**8,984,826**		***10,203***		**884,483**		**5,799,448**		**509,659**		**1,632,835**		**158,400**		**12,582,757**
637																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3	**10.0**	**General Conditions I**																	
4	**11.0**	**Site**																	
5	11.1	Access roads, clearing, drainage																	
6	12.2	Locates																	
7	**12.0**	**Buildings**																	
8	12.1	Sheds, shops, offices, camp																	
9	12.2	Signs, fencing, barricades																	
10	**13.0**	**Temporary Services**																	
11	13.1	Water - install and operate																	
12	13.2	Power - install and operate		2,500.0	kwh	1.15	2,875											1.15	2,875
13	13.3	Heat - install and operate																	
14	13.4	Telephone and Telegraph		1.0	LS	1,000.00	1,000											1,000.00	1,000
15	**14.0**	**Camp**																	
16	14.1	Equipment, cooks, bullcooks		980.0	mdays	480.00	470,400											480.00	470,400
17	14.2	Supplies																	
18	**15.0**	**Equipment**																	
19	15.1	Unassigned rentals																	
20	15.2	Outside rentals																	
21	15.3	Plant set up																	
22	15.4	Gas and oil		197,000.0	litres	4.50	886,500											4.50	886,500
23	15.5	Repair and Maintenance																	
24	15.6	Expendable Supplies, First Aid		1.0	LS	1,500.00	1,500							1,500.00	1,500				
25	15.7	PPE																	
26	15.8	Small Tools, Hardware		1.0	LS	4,500.00	4,500							4,500.00	4,500				
27	**16.0**	**Misc.**																	
28	16.1	Concrete and Materials Tests																	
29	16.2	Rentals - Parking																	
30	16.3	Cleanup																	
31	16.4	Legal Surveys																	
32	16.5	Photos, plans, office supplies																	
33	16.6	Patent Fees, Royalties, Advertising																	
34	16.7	Special Taxes, Licenses																	
35	**17.0**	**Transport**																	
36	17.1	Car and Expense																	
37	17.2	Trucking, Cartage Freight		3.0	Herc	130,000.00	390,000											130,000.00	390,000
38	17.3	Materials Handling		12.0	ea	415.00	4,980											415.00	4,980
39	17.4	Move In and Out		2.0	air	30,000.00	60,000											30,000.00	60,000
40	**18.0**	**Supervision**																	
41	18.1	Superintendent																	
42	18.2	Engineer																	
43	18.3	Foreman																	
44	18.4	Surveyour																	
45	18.5	Accountant																	
46	18.6	Mechanics, Electricians																	
47	18.7	Drivers, Flagmen, Watchmen																	
48																			
49		**Subtotal**					**1,821,755**								**6,000**				**1,815,755**
50																			
51	**20.0**	**General Conditions II**																	
52	21.0	**WCB - UIC - HP**																	
53	21.1	Contract Security		12,582.0	thou	8.50	106,947											8.50	106,947
54	21.2	Subcontract Security																	
55	21.3	Building Permit																	
56	21.4	Fire Insurance																	
57	21.5	Other Insurance																	
58	22.0	**Subsistence**																	
59	22.1	L.O.A.																	
60	22.2	Travelling Time		560.0	mhrs	50.00	28,000	1.0	560	50.00	28,000								
61	23.0	**Contingency**																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
62	23.1	Labor																	
63	23.2	Overtime																	
64	23.3	Material																	
65	23.4	Subcontracts																	
66	24.0	**PC Sums**																	
67	24.1	Landscape																	
68	24.2	Other																	
69	25.0	**Head Office Inspection**																	
70	25.1	Overhead, Administration																	
71	26.0	**Salvage**																	
72																			
73																			
74		**Subtotal**					**134,947**		*560*		**28,000**								**106,947**
75																			
76		**TOTAL ALL INDIRECT COSTS**					1,956,702		560		28,000				6,000				1,922,702
77		**TOTAL ALL DIRECT COSTS**					8,984,826		10,203		884,483		5,799,448		509,659		1,632,835		158,400
78		**Subtotal**					**10,941,528**		*10,763*		**912,483**		**5,799,448**		**515,659**		**1,632,835**		**2,081,102**
79																			
80		**MARK UP**		**15%**		15%	1,641,229				136,872		869,917		77,349		244,925		312,165
81		**ADJUSTMENTS**																	
82		**Subtotal**					**1,641,229**				**136,872**		**869,917**		**77,349**		**244,925**		**312,165**
83																			
84		**Final Total**					**12,582,757**		***10,763***		**1,049,356**		**6,669,365**		**593,008**		**1,877,761**		**2,393,267**
85																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3																					
4	**1.0**	**Heavy Equipment Purchase**		**1.0**	**LS**																
5		Cat 330 Hoe		2.0	ea	185,000.00	370,000	1.0	2			185,000.00	370,000							263,232.38	526,465
6		Cat CS 563 Packer		2.0	ea	85,000.00	170,000	1.0	2			85,000.00	170,000							120,944.61	241,889
7		Cat 730 Rock Trucks		6.0	ea	200,000.00	1,200,000	1.0	6			200,000.00	1,200,000							284,575.55	1,707,453
8		GMC 3500 Pickups		4.0	ea	25,000.00	100,000	1.0	4			25,000.00	100,000							35,571.94	142,288
9		Cat 963 TFEL		1.0	ea	145,000.00	145,000	1.0	1			145,000.00	145,000							206,317.27	206,317
10		Cat D7R Dozer		1.0	ea	185,000.00	185,000	1.0	1			185,000.00	185,000							263,232.38	263,232
11		Cat 950H WFEL		1.0	ea	120,000.00	120,000	1.0	1			120,000.00	120,000							170,745.33	170,745
12																					
13																					
14																					
15																					
16																					
17		Spare Parts Allowance		1.0	LS	150,000.00	150,000							150,000.00	150,000					213,431.66	213,432
18																					
19		(Use multiplier of 1.5 x ARA rates)																			
20		**Subtotal**		**1.0**	**LS**		**2,440,000**		*17*				**2,290,000**		**150,000**					**3,471,821.68**	**3,471,822**
21																					
22	**2.0**	**Heavy Equipment Sealift**		**1.0**	**LS**																
23		(Assume MV Umiavut - NEAS)																			
24																					
25		1 - Cat 950H WFEL		32.7	RT	409.25	13,382									409.25	13,382			582.31	19,042
26		2 - Cat 330 Hoe (48.9 RT ea)		97.8	RT	409.25	40,025									409.25	40,025			582.31	56,950
27		2 - Cat CS 563 Packer (17.7 RT ea)		35.4	RT	409.25	14,487									409.25	14,487			582.31	20,614
28		6 - Cat 730 Rock Trucks (31.75 ea)		190.5	RT	409.25	77,962									409.25	77,962			582.31	110,931
29		4 - GMC 3500 Pickups (11.95 ea)		47.8	RT	409.25	19,562									409.25	19,562			582.31	27,835
30		1 - Cat 963 TFEL		22.7	RT	409.25	9,294									409.25	9,294			582.31	13,224
31		1 - D7R Dozer		27.3	RT	409.25	11,173									409.25	11,173			582.31	15,897
32		Diversion - Nanisivik to Eureka		1.0	LS	250,000.00	250,000									250,000.00	250,000			355,719.44	355,719
33		5 - Sea Containers		5.0	ea	6,500.00	32,500									6,500.00	32,500			9,248.71	46,244
34																					
35		Transport to Valleyfield, QC		12.0	LDS	5,000.00	60,000									5,000.00	60,000			7,114.39	85,373
36																					
37		(Revenue Ton = RT)																			
38		**Subtotal**		**1.0**	**LS**		**528,385**										**528,385**			**751,827.89**	**751,828**
39																					
40	**3.0**	**Pond Embankment Fill**		**23,600.0**	**m3**																
41		(Gravel Processing Req'd - Bulk)																			
42		2 - Hoes to Load / Assist (1.5 rate)		28,320.0	m3	5.04	142,790	89.25	317	150.00	47,597	300.00	95,193							7.17	203,173
43		6 (5.25) - Rock Trucks to Haul/Dump		28,320.0	m3	19.16	542,602	89.25	317	450.00	142,790	1,260.00	399,812							27.26	772,056
44		1 - D7R to spread		28,320.0	m3	3.64	103,126	89.25	317	85.00	26,971	240.00	76,155							5.18	146,736
45		2 - Packers to Compact		28,320.0	m3	4.48	126,924	89.25	317	150.00	47,597	250.00	79,328							6.38	180,598
46		4 - PU trucks to support + Foreman		28,320.0	m3	3.36	95,193	89.25	317	100.00	31,731	200.00	63,462							4.78	135,448
47		1 - 963 TFEL to assist		28,320.0	m3	2.97	84,087	89.25	317	85.00	26,971	180.00	57,116							4.22	119,646
48		1 - 950H WFEL to assist		28,320.0	m3	2.63	74,568	89.25	317	85.00	26,971	150.00	47,597							3.75	106,101
49																					
50																					
51																					
52		mob/demob hoe to gravel deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,556.07	2,556
53		mob/demob TFEL to deposit		1.0	ea	1,060.00	1,060	0.25	4	85.00	340	180.00	720							1,508.25	1,508
54		mob/demob WFEL to deposit		1.0	ea	470.00	470	0.5	2	85.00	170	150.00	300							668.75	669
55		(17.0m3/hr x 5.25 RT.'s = 89.25m3/hr)																			
56		**Subtotal**		**23,600.0**	**m3**	**49.69**	**1,172,617**	**0.1**	*2,233*	**14.90**	**351,737**	**34.78**	**820,880**							**70.70**	**1,668,491**
57																					
58	**4.0**	**Pond Excavation to Waste Pile**		**9,400.0**	**m3**																
59		(Waste Locally in Stockpile - Bulk)																			
60		2 - Hoes to excavate (1.5 rate)		11,280.0	m3	7.50	84,600	60.00	188	150.00	28,200	300.00	56,400							10.67	120,375
61		1 - D7R Dozer to move to spoil		11,280.0	m3	5.42	61,100	60.00	188	85.00	15,980	240.00	45,120							7.71	86,938
62		1 - 963 TFEL to load RT's		11,280.0	m3	2.21	24,910	120.0	94	85.00	7,990	180.00	16,920							3.14	35,444
63		5 - Rock Trucks to Stockpile		11,280.0	m3	11.88	133,950	120.0	94	375.00	35,250	1,050.00	98,700							16.90	190,594
64		4 - PU trucks to support + Foreman		11,280.0	m3	7.50	84,600	40.0	282	100.00	28,200	200.00	56,400							10.67	120,375
65																					
66		mob/demob hoe from deposit		1.0	ea	1,796.41	1,796	0.167	6	100.00	599	200.00	1,198							2,556.07	2,556
67		mob/demob 963 TFEL from deposit		1.0	ea	1,060.00	1,060	0.3	4	85.00	340	180.00	720							1,508.25	1,508
68																					
69																					
70																					
71																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
72																					
73																					
74		**Subtotal**		**9,400.0**	**m3**	**41.70**	**392,016**	**0.1**	*856*	**12.40**	**116,559**	**29.30**	**275,458**							**59.34**	**557,791**
75																					
76	**5.0**	**Pond - Final Shaping/Trim**		**14,600.0**	**m2**																
77		2 - Hoes to assist / trim (1.5 rate)		14,600.0	m2	0.90	13,140	500.0	29	150.00	4,380	300.00	8,760							1.28	18,697
78		1 - D7R Dozer to assist / trim		14,600.0	m2	0.65	9,490	500.0	29	85.00	2,482	240.00	7,008							0.92	13,503
79		1 - Packer to Finish Slopes		14,600.0	m2	0.16	2,317	1,260.0	12	75.00	869	125.00	1,448							0.23	3,297
80		3 - PU trucks to support + Foreman		14,600.0	m2	0.69	10,139	360.0	41	100.00	4,056	150.00	6,083							0.99	14,426
91																					
92		**Subtotal**		**14,600.0**	**m2**	**2.40**	**35,086**	**0.0**	*111*	**0.81**	**11,787**	**1.60**	**23,300**							**3.42**	**49,924**
93																					
94	**6.0**	**100 mm Urecon Insulated Pipe**		**375.0**	**m**																
95		(To pump from Creek to Pond)																			
96																					
109																					
110		**Subtotal**		**375.0**	**m**			**-**													
111																					
112	**7.0**	**150 mm Urecon Insulated Pipe**		**225.0**	**m**																
113		(To pump from Pond to Treatment)																			
114																					
127																					
128		**Subtotal**		**225.0**	**m**			**-**													
129																					
130	**8.0**	**Pond Underdrain System**		**1.0**	**LS**																
131		Boss 2000 - Freight to Yellowknife		1.0	LS	4,500.00	4,500									4,500.00	4,500			6,402.95	6,403
132		Matl's - 150mm perf (250m + bulk)		288.0	m	10.23	2,946							10.23	2,946					14.56	4,192
133		250mm nonperf (20m + bulk)		30.0	m	23.51	705							23.51	705					33.45	1,004
134		1 cross, 1 increaser, 2 ells, 3 caps		1.0	LS	300.00	300							300.00	300					426.86	427
135		600 x 250 Fabricated Manhole		1.0	ea	1,150.00	1,150							1,150.00	1,150					1,636.31	1,636
136		Geotextile Wrap (2 rolls @ 418 m2)		836.0	m2	4.00	3,344							4.00	3,344					5.69	4,758
137		Coarse Gravel (gravel processing)		70.0	m3	32.59	2,281							32.59	2,281					46.37	3,246
138																					
139		1 - Hoe to excavate trench		270.0	m	35.29	9,529	8.500	32	100.00	3,176	200.00	6,353							50.22	13,559
140		1 - 963 TFEL to assist		270.0	m	31.18	8,418	8.500	32	85.00	2,700	180.00	5,718							44.36	11,977
141		2 - RT's to Stockpile / Haul Gravel		270.0	m	67.06	18,106	8.500	32	150.00	4,765	420.00	13,341							95.42	25,762
142		3 - PU trucks to support + Foreman		270.0	m	29.41	7,941	8.500	32	100.00	3,176	150.00	4,765							41.85	11,299
143		3 - operator / labourers		270.0	m	30.00	8,100	8.500	32	255.00	8,100									42.69	11,525
144		(1/3 of added Hercules C130 flight)		0.333	LS	130,000.00	43,290									130,000.00	43,290			184,974.11	61,596
145																					
146		**Subtotal**		**1.0**	**LS**		**110,611**		*159*		**21,918**		**30,176**		**10,727**		**47,790**			**157,385.87**	**157,386**
147																					
148	**9.0**	**DS Geocomposite (Floor Only)**		**4,000.0**	**m2**																
149		C130 - DS Comp + Liner Panels		0.75	LS	130,000.00	97,500									130,000.00	97,500			184,974.11	138,731
150		Supply Only - TN-220-2-6 DS Comp		4,380.0	m2	5.75	25,185							5.75	25,185					8.18	35,835
151		Crew flight In (10 hrs @ $195)		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			31,232.17	31,232
152		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			590.50	1,181
153		1 - * EC loader to offload		1.0	LS	920.00	920	0.25	4			230.00	920							1,309.05	1,309
154		Crew to Install (@ $230 per hour)		4,380.0	m2	0.73	3,198	315.0	14	200.00	2,781	30.00	417							1.04	4,551
155		Weather Standby		1.0	ea	1,950.00	1,950	0.1	10	195.00	1,950									2,774.61	2,775
156																					
157		Crew Subsistence (2 Layfield)		8.0	mdays	480.00	3,840											480.00	3,840	682.98	5,464
158		* EC Vehicle Support		4.0	days	526.32	2,105	0.285	14			150.00	2,105							748.88	2,996
159		* EC Loader to Support		2.0	days	807.02	1,614	0.285	7			230.00	1,614							1,148.29	2,297
160		* EC Labour (2) to Support		2.0	days	3,000.00	6,000	0.1	20	300.00	6,000									4,268.64	8,537
161																					
162																					
163																					
164		**Subtotal**		**4,000.0**	**m2**	**41.27**	**165,092**	**0.0**	*79*	**3.17**	**12,681**	**1.26**	**5,056**	**6.30**	**25,185**	**29.58**	**118,330**	**0.96**	**3,840**	**58.73**	**234,906**
165																					
166	**10.0**	**40 mil PP Geomembrane Liner**		**8,100.0**	**m2**																
167		C130 - remaining Liner Panels		1.25	LS	130,000.00	162,500									130,000.00	162,500			184,974.10	231,218
168		Supply Only - 40 mil Geoflex		10,047.0	m2	8.20	82,385							8.20	82,385					11.67	117,224
169																					
170		Air Movement @ Eureka		2.0	ea	415.00	830									415.00	830			590.50	1,181
171		1 - * EC loader to offload		1.0	LS	1,377.25	1,377	0.167	6			230.00	1,377							1,959.65	1,960
172		Crew to Install (@ $230 per hour)		10,047.0	m2	1.73	17,375	133.0	76	200.00	15,108	30.00	2,266							2.46	24,722
173		Weather Standby		1.0	ea	3,900.00	3,900	0.1	20	195.00	3,900									5,549.22	5,549
174		Crew Flight Out		1.0	ea	21,950.00	21,950	0.1	10	195.00	1,950					2,000.00	20,000			31,232.17	31,232
175																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
176		Crew Subsistence (2 Layfield)		20.0	mdays	480.00	9,600											480.00	9,600	682.98	13,660
177		* EC Vehicle Support		10.0	days	600.00	6,000	0.25	40			150.00	6,000							853.73	8,537
178		* EC Loader to Support		8.0	days	920.00	7,360	0.25	32			230.00	7,360							1,309.05	10,472
179		* EC Labour (2) to Support		8.0	days	3,000.00	24,000	0.1	80	300.00	24,000									4,268.63	34,149
180																					
181																					
182		**Subtotal**		**8,100.0**	**m2**	**41.64**	**337,277**	**0.0**	*264*	**5.55**	**44,958.27**	**2.10**	**17,003**	**10.17**	**82,385**	**22.63**	**183,330**	**1.19**	**9,600**	**59.25**	**479,904**
183																					
184	**11.0**	**Gravel Processing Equipment**		**1.0**	**LS**																
185		Elrus - Belt Feeder and Grizzly		1.0	ea	90,000.00	90,000	1.0	1			90,000.00	90,000							128,059.00	128,059
186		Sandvik - CH420 Cone Crusher Skid		1.0	ea	350,000.00	350,000	1.0	1			350,000.00	350,000							498,007.21	498,007
187		Elrus - 5 x 16 2D Screen Skid		1.0	ea	165,000.00	165,000	1.0	1			165,000.00	165,000							234,774.83	234,775
188		4 - 24"x50' Superior Conveyors		1.0	ea	115,000.00	115,000	1.0	1			115,000.00	115,000							163,630.94	163,631
189		1 - 20' Electrical/Genset Container		1.0	ea	225,000.00	225,000	1.0	1			225,000.00	225,000							320,147.49	320,147
190		Spare Parts Allowance		1.0	LS	100,000.00	100,000	1.0	1			100,000.00	100,000							142,287.77	142,288
191		Elrus - Trucking to Yellowknife		4.0	LDS	5,000.00	20,000									5,000.00	20,000			7,114.39	28,458
192		Crane Truck - Trucking to Yknife		1.0	LD	5,000.00	5,000									5,000.00	5,000			7,114.39	7,114
193		Crane Truck Purchase		1.0	LS	150,000.00	150,000	1.0	1			150,000.00	150,000							213,431.66	213,432
194																					
195																					
196		First Air - C130 Flights to Eureka		5.0	LDS	130,000.00	650,000									130,000.00	650,000			184,974.11	924,871
197		(4 LDS for Elrus + 1 LD for Picker Tr.)																			
198																					
199																					
200		**Subtotal**		**1.0**	**LS**		**1,870,000**		*7*				**1,195,000**				**675,000**			**2,660,781.37**	**2,660,781**
201																					
202	**12.0**	**Processing Equipment Setup**		**1.0**	**LS**																
203		Elrus/operator flight in		1.0	ea	20,000.00	20,000									20,000.00	20,000			28,457.55	28,458
204		Crane Truck to Haul to Deposit		5.0	moves	909.09	4,545	0.33	15	100.00	1,515	200.00	3,030							1,293.53	6,468
205		Elrus Personnel and Operator		5.0	moves	757.58	3,788	0.33	15	250.00	3,788									1,077.94	5,390
206		1 - * EC Pickup to support		5.0	moves	454.55	2,273	0.33	15			150.00	2,273							646.76	3,234
207		1 - * EC Loader to assist		5.0	moves	696.97	3,485	0.33	15			230.00	3,485							991.70	4,959
208																					
209		Crane Truck to support assembly		1.0	LS	30,000.00	30,000	0.01	100	100.00	10,000	200.00	20,000							42,686.33	42,686
210		Elrus / Operator to assemble		1.0	LS	25,000.00	25,000	0.01	100	250.00	25,000									35,571.94	35,572
211		1 - * EC Pickup to support		1.0	LS	15,000.00	15,000	0.01	100			150.00	15,000							21,343.17	21,343
212																					
213		Crew to Run 10 hour trial		1.0	LS	5,500.00	5,500	0.1	10	350.00	3,500	200.00	2,000							7,825.83	7,826
214																					
215		Elrus Service man return flight		1.0	ea	20,000.00	20,000									20,000.00	20,000			28,457.55	28,458
216		Subsistence for Crew (3)		36.0	mdays	480.00	17,280											480.00	17,280	682.98	24,587
217																					
218		**Subtotal**		**1.0**	**LS**		**146,871**		*371*		**43,803**		**45,788**				**40,000**		**17,280**	**208,979.34**	**208,979**
219																					
220	**13.0**	**Gravel Processing**		**48,320.0**	**m3**																
221		Crane Truck for support		48,320.0	m3	7.50	362,400	40.0	1,208	100.00	120,800	200.00	241,600							10.67	515,651
222		1 - * EC WFEL to load		48,320.0	m3	5.75	277,840	40.0	1,208			230.00	277,840							8.18	395,332
223		1 - * EC Dozer to push to loader		48,320.0	m3	6.75	326,160	40.0	1,208			270.00	326,160							9.60	464,086
224		1 - Gravel Process Operator		48,320.0	m3	2.50	120,800	40.0	1,208	100.00	120,800									3.56	171,884
225		1 - * EC Pickup to support 50%		48,320.0	m3	1.88	90,600	80.0	604			150.00	90,600							2.67	128,913
226																					
227		Crew Subsistence (2 men x 2 shifts)		244.0	mdays	480.00	117,120											480.00	117,120	682.98	166,647
228		Fuel Consumption @ 32.5l/hr		40,000.0	litres	6.00	240,000							6.00	240,000					8.54	341,491
229		Return flight for Crew (+ 1 for relief)		2.0	ea	20,000.00	40,000									20,000.00	40,000			28,457.56	56,915
230																					
231																					
232																					
233																					
234		(Mat'l Req'd = 44,100m3 + 20,000m3																			
235		surplus for other purposes)																			
236		**Subtotal**		**48,320.0**	**m3**	**32.59**	**1,574,920**	**0.1**	*5,436*	**5.00**	**241,600**	**19.38**	**936,200**	**4.97**	**240,000**	**0.83**	**40,000**	**2.42**	**117,120**	**46.38**	**2,240,919**
237																					
238	**14.0**																				
239																					
240																					
241																					
242																					
243																					
244																					
245																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BID ITEM	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS		BID	
2	**DIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
246																					
247																					
248																					
249																					
250																					
251																					
252																					
253																					
254		**Subtotal**																			
255																					
256	**15.0**																				
257																					
630																					
631																					
632		**Subtotal**																			
633																					
634																					
635																					
636		**Grand Total**					**8,772,877**		***9,532***		**845,043**		**5,638,861**		**508,297**		**1,632,835**		**147,840**		**12,482,731**
637																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
3	**10.0**	**General Conditions I**																	
4	**11.0**	**Site**																	
5	11.1	Access roads, clearing, drainage																	
6	12.2	Locates																	
7	**12.0**	**Buildings**																	
8	12.1	Sheds, shops, offices, camp																	
9	12.2	Signs, fencing, barricades																	
10	**13.0**	**Temporary Services**																	
11	13.1	Water - install and operate																	
12	13.2	Power - install and operate		2,500.0	kwh	1.15	2,875											1.15	2,875
13	13.3	Heat - install and operate																	
14	13.4	Telephone and Telegraph		1.0	LS	1,000.00	1,000											1,000.00	1,000
15	**14.0**	**Camp**																	
16	14.1	Equipment, cooks, bullcooks		1,064.0	mdays	480.00	510,720											480.00	510,720
17	14.2	Supplies																	
18	**15.0**	**Equipment**																	
19	15.1	Unassigned rentals																	
20	15.2	Outside rentals																	
21	15.3	Plant set up																	
22	15.4	Gas and oil		216,000.0	litres	4.50	972,000											4.50	972,000
23	15.5	Repair and Maintenance																	
24	15.6	Expendable Supplies, First Aid		1.0	LS	1,500.00	1,500							1,500.00	1,500				
25	15.7	PPE																	
26	15.8	Small Tools, Hardware		1.0	LS	4,500.00	4,500							4,500.00	4,500				
27	**16.0**	**Misc.**																	
28	16.1	Concrete and Materials Tests																	
29	16.2	Rentals - Parking																	
30	16.3	Cleanup																	
31	16.4	Legal Surveys																	
32	16.5	Photos, plans, office supplies																	
33	16.6	Patent Fees, Royalties, Advertising																	
34	16.7	Special Taxes, Licenses																	
35	**17.0**	**Transport**																	
36	17.1	Car and Expense																	
37	17.2	Trucking, Cartage Freight		3.0	Herc	130,000.00	390,000											130,000.00	390,000
38	17.3	Materials Handling		12.0	ea	415.00	4,980											415.00	4,980
39	17.4	Move In and Out		2.0	air	30,000.00	60,000											30,000.00	60,000
40	**18.0**	**Supervision**																	
41	18.1	Superintendent																	
42	18.2	Engineer																	
43	18.3	Foreman																	
44	18.4	Surveyour																	
45	18.5	Accountant																	
46	18.6	Mechanics, Electricians																	
47	18.7	Drivers, Flagmen, Watchmen																	
48																			
49		**Subtotal**					**1,947,575**								**6,000**				**1,941,575**
50																			
51	**20.0**	**General Conditions II**																	
52	21.0	**WCB - UIC - HP**																	
53	21.1	Contract Security		12,482.0	thou	8.50	106,097											8.50	106,097
54	21.2	Subcontract Security																	
55	21.3	Building Permit																	
56	21.4	Fire Insurance																	
57	21.5	Other Insurance																	
58	22.0	**Subsistence**																	
59	22.1	L.O.A.																	
60	22.2	Travelling Time		560.0	mhrs	50.00	28,000	1.0	560	50.00	28,000								
61	23.0	**Contingency**																	
62	23.1	Labor																	
63	23.2	Overtime																	
64	23.3	Material																	
65	23.4	Subcontracts																	
66	24.0	**PC Sums**																	
67	24.1	Landscape																	
68	24.2	Other																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	BID ITEM NO.	DESCRIPTION OF WORK	NUMBER	QUANTITY	UNIT	TOTAL COST		PROD/HR	HRS REQ'D.	LABOR		EQUIP. RENTALS		MATERIALS OR LANDFILL		TRUCKING		SUBCONTRACTS	
2	**INDIRECTS**		EA			UNIT	AMOUNT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
69	25.0	**Head Office Inspection**																	
70	25.1	Overhead, Administration																	
71	26.0	**Salvage**																	
72																			
73																			
74		**Subtotal**					**134,097**		*560*		**28,000**								**106,097**
75																			
76		**TOTAL ALL INDIRECT COSTS**					2,081,672		560		28,000				6,000				2,047,672
77		**TOTAL ALL DIRECT COSTS**					8,772,877		9,532		845,043		5,638,861		508,297		1,632,835		147,840
78		**Subtotal**					**10,854,549**		*10,092*		**873,043**		**5,638,861**		**514,297**		**1,632,835**		**2,195,512**
79																			
80		**MARK UP**		**15%**		15%	1,628,182				130,956		845,829		77,145		244,925		329,327
81		**ADJUSTMENTS**																	
82		**Subtotal**					**1,628,182**				**130,956**		**845,829**		**77,145**		**244,925**		**329,327**
83																			
84		**Final Total**					**12,482,731**		***10,092***		**1,003,999**		**6,484,691**		**591,442**		**1,877,761**		**2,524,839**
85																			

Appendix 1.6 Above Ground Water Storage Tank Information

Western Tank and Lining Ltd.

Bolted Steel Tanks & Geomembrane Liners

08 October 2010

Project: Eureka Weather Stn

File: BC10-0057

Attention: Gilbert Gangnon, P.Eng

Re: Budget Price For Bolted Steel Reservoir for Eureka Weather Stn

Please find our budget for the supply and installation of the requested bolted tank system. Our quotation is based on the information supplied by the owner's representative.

Our tank System includes

1. Supply and install of 72' x 26' galvanized steel water tank
2. Supply and install of complete insulation system to R26 including floor
3. Supply of a mixer system to keep the water form bothe freezing and going stagnant
4. Supply of 2 x 15kW heaters to ensure the water does not freeze. One heater is back up
5. Erection of bolted steel tank
6. Installation of interior piping and ladders
7. Installation of mixer and heaters

Items by others

1. Supply of suitable base for construction of tank
2. Instrumentation
3. Wiring for above
4. Wiring for mixer and heaters

We have included the following systems:

QUOTATION:

Item	Description	Volume	Extension
Item 1	First 72 x 26 galvanized steel reservoir with ring beam and steel floor	3018m^3	$3,104,000.^{00}
Item 2	Remaining 72 x 26 galvanized steel reservoir with ring beam and steel floor	3018m^3	$2,643,000.^{00}

SCOPE OF WORK:

Western Tank and Lining would provide all necessary field installation equipment, personnel and materials to supply and install the referenced bolted tank system.

Scope of work for WTL:

1) Provide all required sealed drawings
2) Provide all pre construction documentation covering insurance & WCB standing.
3) Supply labour to install wall penetration piping to 1 meter beyond the tank shell.
4) Construct the base with steel retaining ring, fill supplied by others and placed by WTL.
5) Erect the tank and install all internal piping as required.
6) Install siding and steel cladding
7) Install mixing system with wiring by others
8) Install heaters and control panel with wiring by others
9) Clean, and disinfect to AWWA spray chlorination requirements and leak test.
10) Provide sealed as built drawings as required.

Scope of work of owner:

1) Provide a level and tested sub grade for the tank's foundation to be constructed on.
2) Install and supply any required instrumentation
3) Connect the tank piping to the project's appropriate inlet, outlet and drain/overflow supply and discharge pipes.
4) Provide water for leak testing as soon as the tank is completed, with sufficient flow to fill tank in a reasonable time. If water is not available a remob fee may be applicable.
5) Provide all necessary permits for construction based on the WTL engineered and sealed shop drawings.

DETAILS AND SPECIFICATIONS OF TANK

The standard details and design Considerations are as follows:

- Tank Details:
  - Foundation Type — Steel retainer ring with compacted fill
  - Tank coating — Galvanized Steel
  - Floor — Galvanized Steel
- Design Considerations:
  - Seismic Zone — 0
  - Roof Snow Load — 29psf
  - Wind Load — 1/10: 0.47kPA – 1/50: 0.67kPA
  - Soil strength — 4,300psf
  - AWWA Specification — D103-09

Additional Features:

Item		included	not include
30 by 46 2 pc. Construction door		x	
30 inch round hinged collar manway door		x	
Polycapped bolts for walls and roof			x
Outside ladder w/ safety cage and anti climb door		x	
Inside ladder from the roof hatch to floor			x
Locking roof hatch		x	
Roof vent		x	
Internal plumbing Sized to suit		x	
Drain			
Inlet			
Outlet			
Overflow			

SCHEDULE

It is estimated the duration of the project from notice to proceed to substantial completion will be 158 days the time line will be as follows:

1) Upon receiving notice to proceed Western Tank and Lining will obtain the as for construction engineered drawings from our consulting engineer and shop drawings to submit to the owner for approval.
    a. 2 to 4 weeks for shop drawing preparation
2) After receiving approval from the owner we will issue a PO to the tank manufacturer.
    a. The tank manufacturing process is currently 6 to 8 weeks
3) During the time that the tank is being manufactured the base can be prepared and installed.
4) When the tank arrives on site WTL will erect the tank and install the internal piping and other tank details.
    a. Expected duration of 60 working days to completion
5) After tank construction is completed it will be chlorinated and leak tested
6) Final as built information and O&M manual submitted to owner

TERMS:

- Prices are shown in Canadian Dollars with HST extra
- Prices for US supplied product use today's exchange rate and are subject to change
- Prices are firm for thirty days from the date of this quotation. A purchase order must be received within the thirty day period and the customer must agree to take delivery of the products within the period under Schedule Item 2 or the prices for these products will escalate as prices for non-WTL manufactured materials are subject to price changes based on supplier increases
- Payment term's net 30 days with progress billing based on materials ordered and areas completed during the month, interest of 1.5% per month to be added to overdue accounts
- Price quoted based on non-union, non-prevailing wage rates
- Offer based on one mobilization to site additional mobilizations and or standby time would be charged at our standard force account rates or as specified.
- Field survey of tank location is the responsibility of others
- Offer based on installation being completed during summer months, installation after this maybe subject to additional costs, such as winter installation costs, etc
- Construction delays due to unforeseen weather conditions will be subject to standby charges at our standard force account rates.
- Payment upon substantial completion of our work with standard holdback
- This quotation if accepted must be included, in whole, in any agreement or contract that may result from that acceptance. This offer is limited to the supply of materials and work specifically noted above.

PAYMENT SCHEDULE:

- Up to 7% on shop drawing submittal
- Up to 10% on shop drawing approval
- Up to 50% on material delivery from factory
- Up to 90% on completion of erection
- 100% upon issuance of Certificate of Substantial Performance

Thank you for providing our firm with the opportunity to submit this price quotation. We look forward to working on this project with your firm.

Regards,

Western Tank & Lining Ltd.



Todd Smith, CD, AScT,

Appendix 2 Wastewater Treatment Options Review Study

WorleyParsons
resources & energy

EcoNomics

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Eureka Civil Consulting Services

Wastewater Treatment Options Review Study

C71130000 – Document No: C71130000-WW-REP-0001

15 December 2010

WorleyParsons Canada Ltd.
Infrastructure & Environment Division
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Calgary, AB T3B 0M6 CANADA
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PROJECT C71130000 - EUREKA CIVIL CONSULTING SERVICES

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EXECUTIVE SUMMARY

Public Works and Government Services Canada (PWGSC) has identified a need to upgrade the water reservoir, wastewater lagoon, and airport at Environment Canada High Arctic Weather Station (the Station) in Eureka, Nunavut, Canada. WorleyParsons has been retained by PWGSC to carry out a conceptual engineering study to assess potential upgrades to the water reservoir, wastewater treatment lagoon and related facilities at the Station.

The wastewater treatment portion of the Civil Consulting Services project is to provide an analysis of existing information and recommendations for the next phase of the design. The objective of this document is to provide a review of a Golder Associates' report (Golder 2009) on wastewater treatment options for the Station; and to provide a preliminary design basis for the pipeline, pumps and other major components of the proposed wastewater treatment system.

The Golder Associates' report (Golder 2009) evaluates several wastewater treatment options and ranks them based on treatment performance, ease of operation, upset risk/impact, mechanical failure risk/impact, energy consumption, solids handing requirements and capital cost. The resulting short-listed treatment technologies recommended are two kinds of attached growth systems (media-based trickling filters or submerged fixed film bioreactors) or a new facultative pond lagoon.

Since, secondary quality effluent is not required at this site and sludge/solids handling is expected to be difficult at this location, mechanical type systems including attached growth systems are not recommended for this facility. Lagoons have several advantages over the other two recommended systems. In northern climates, lagoons offer a reliable and easy-to-operate process. The recommendation to proceed with lagoon treatment is based on the assumption that past performance of the existing lagoon meets the current and future Nunavut Water Board (NWB) licence effluent requirements, and also meets the Station's operational and performance requirements. Preliminary design information and recommendations are presented for the recommended wastewater treatment option.

The next phase of the design includes confirmation of the design data including flows and loads to the wastewater system, followed by system component selection and sizing, and finally detailed design of the wastewater treatment system.

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1. INTRODUCTION

Public Works and Government Services Canada (PWGSC) has identified the need to upgrade the water reservoir, wastewater lagoon and airport at Environment Canada's High Arctic Weather Station (the Station) in Eureka, Nunavut. WorleyParsons was retained by PWGSC to carry out a conceptual engineering study to assess potential upgrades to the water reservoir, wastewater treatment lagoon and related facilities at the Station as part of the Civil Consulting Study (Contract R.015446.001).

1.1 Site Location

Eureka, Nunavut is a small weather monitoring facility located on Slidre Fjord, midway up Ellesmere Island in the Canadian High Arctic. The facility is located in an extreme climate with long, very cold winters and short cool summers. The site has been continuously occupied since 1947 and is the second most northerly permanently inhabited site on the globe. In addition to the weather station, the site also currently supports ongoing atmospheric research and Canadian Forces activities. Most of the activity and research work is carried out in the short arctic summer – June, July and August. The primary facilities at the site include the main weather station complex, a water reservoir, a wastewater treatment lagoon and an airstrip. Drinking water is obtained from Station Creek that carries melt water from ice and snow in the Arctic spring (May and June). Wastewater at the site is currently pumped into a single celled lagoon that is discharged twice a year into Slidre Fjord (Environment Canada 2010).

1.2 Scope of Work

The wastewater treatment portion of the Civil Consulting Services project is to provide an analysis of existing information and recommendations for the next phase of the design. The proposed scope of work was outlined in WorleyParsons' proposal CPR 10-039 dated July 21, 2010 and includes:

a) reviewing the Golder Associates' report (Golder 2009) on wastewater treatment options for the Station that was prepared in March 2009; and

b) conducting an analysis to determine the size and capacity of the pipeline, pumps and other major components of the proposed wastewater treatment system.

1.3 Related Documents

The PWGSC Civil Consulting Services project is a conceptual engineering study to assess potential upgrades to the facility including the water reservoir and wastewater treatment lagoon. In addition to this study, WorleyParsons has prepared the following related documents as part of the Civil Consulting Services project:

- **Water Supply and Distribution Study** by WorleyParsons as part of the Civil Consulting Services project in October 2010. The purpose of this study is to evaluate all aspects of the water supply for the facility including the existing water source, storage, treatment, and distribution. The study also presents an evaluation of the various options available for meeting the potential future water

demand of the facility for the next 15 years. Information related to water sources, storage, treatment, and distribution is presented. This document establishes the design flow criteria for the water and wastewater system.

- **Geotechnical Report** prepared by WorleyParsons as part of the Civil Consulting Services project in October 2010. This study included a preliminary geotechnical investigation to support the overall infrastructure study. This investigation comprised a site reconnaissance, a subsurface investigation of the proposed wastewater treatment lagoon sites. This document addresses the constructability and site specific requirements of the proposed wastewater treatment lagoon.

In addition, Golder Associates had been retained by PWGSC to identify suitable alternatives to upgrade the wastewater treatment infrastructure at the Station in Eureka, Nunavut. The treatment options provided by Golder Associates are presented in a document entitled “Environment Canada’s High Arctic Weather Station Eureka, Nunavut – Investigation of Wastewater Treatment Options” dated March 2009 (Golder 2009). A key objective of this document is to provide an evaluation of the design options presented by Golder Associates and to provide recommendations for future consideration.

2. OPTIONS REVIEW

The purpose of this section is to evaluate the information provided by Golder Associates regarding wastewater treatment options and to provide additional recommendations as necessary for PWGSC to consider for the next phase of the design. The treatment options provided by Golder Associates are presented in a document entitled “Environment Canada’s High Arctic Weather Station Eureka, Nunavut - Investigation of Wastewater Treatment Options” dated March 2009 (Golder 2009).

The objective of this portion of investigation is to review the information prepared by Golder Associates and confirm that the capacity of wastewater treatment and its components is sufficient for 15 year design period. The options review starts with a summary of the Golder Associates report followed by a design review discussion and recommendations for future consideration.

2.1 Options Report Summary

The following section provides a summary of the information contained in the report prepared by Golder Associates dated March 2009 evaluating the treatment options available for the Station. The report evaluates several technology options that were ranked based on treatment performance, ease of operation, upset risk/impact, mechanical failure risk/impact, energy consumption, solids handing requirements and capital cost. The resulting short-listed treatment technologies considered are as follows:

- media-based trickling filters (e.g. Waterloo Biofilter®, etc.);
- submerged fixed film bioreactor (e.g. Fixed Activated Sludge Treatment (FAST®) by Bio-Microbics Inc., etc.); and
- new facultative lagoon and pumping station:
  - Option 1 Location – South of Main Road – site may not be feasible based on the location of power lines and nearby buildings; and
  - Option 2 Location – North of Main Road – site is located further away from Slidre Fjord and site buildings and would require more piping.

The short-listed facility options were preliminarily sized based on feedback Golder Associates received from Environment Canada and was based on a design flow that used 2008 data with a 20 percent increase. This information is summarized in the Table A.

Table A Golder Associates Option Report Preliminary Design Data

Design Parameters	Design Data
2008 Average Per Capita Wastewater Generation	325 L/person/day
2008 Maximum Per Capita Wastewater Generation	565 L/person/day
Average Day Design Flow Rate	12.4 m^3/d
Maximum Day Design Flow Rate	24.8 m^3/d
Peak Hourly Design Flow Rate	2.06 m^3/h

The year with the highest flow data was 2008 and this data was used to develop the preliminary design criteria for the treatment options evaluated. In 2008, an average observed wastewater generation rate of 325 L/capita/day was observed. A design flow of 12.4 m^3/d was selected using the average day flow rate of the maximum month observed in 2008. Maximum day flow rates assumed a peaking factor of two over the average flow rate and the peak hourly flow rate assumed a peaking factor of four over the average day flow. Raw wastewater quality information from the site was not provided and the preliminary designs included in the options report assumed a typical high strength wastewater to be conservative.

Golder Associates did not include lagoon design data as part of the report (Golder 2009). For assessment purposes, a two cell facultative lagoon with a side water depth of 3 m and a hydraulic capacity of 1 year was assumed. The report also presented three effluent disposal options including year round discharge with submerged or elevated outfalls, or seasonal discharge with effluent storage in the existing lagoon. Preliminary conceptual level lagoon site plans and implementation schedules were developed for the short listed technologies.

Golder Associates provided conceptual-level capital and Operating & Maintenance (O&M) costs for the options evaluated in the report. These estimates were based on preliminary design data and assumed designs and are intended to be used for comparing initial conceptual alternatives for the purpose of screening them to a reasonable few for further evaluation. Given the conceptual level of the designs used for the analysis, it is recommended that these cost estimates not be used for financial planning or rate-impact analysis. During the future design phase, site factors, contractor mark-ups and contingencies can be refined as additional design details become available and are captured in a more detailed cost estimate.

2.2 Technology Selection

The shortlisted technologies in Golder Associates report were selected based on their suitability for use in a remote cold climate area with a limited access to utilities, resources and operations staff and for their ability to meet the Nunavut Water Board (NWB) licence effluent requirements. The recommended options included two kinds of attached growth systems and wastewater lagoons. Each of these options is discussed further in the following section.

2.2.1 Attached Growth Systems

Both fixed film bioreactors and trickling filters systems recommended by Golder Associates are attached growth biological systems. Both fixed film bioreactors and trickling filters are available on the market as packaged systems from a variety of vendors. In attached growth processes, the microorganisms responsible for the removal of organic material in wastewater are attached onto various kinds of inert packing material such as rocks, rope, plastic media, sponges etc. In the case of the trickling filter, wastewater is distributed over the top of the tank containing the non-submerged packing media containing attached microorganisms using recirculation pumps. The oxygen required by the microorganisms for organics removal is provided through air circulation either by natural draft between the packing material void spaces or by blowers. Similarly, the fixed film bioreactor uses a submerged packing media for use in an activated sludge type process where oxygen is supplied to the microorganisms using process air blowers.

Excess biomass sloughs from the attached growth media periodically and solids/liquid separation is required followed by sludge dewatering, stabilization and disposal. Both the fixed film activated sludge system and the media based trickling filter are designed to retain sludge for an extended period of time minimizing the amount of sludge generated. However, sludge/solids generation rates are expected to be higher with these technologies when compared to the existing lagoon system. The sludge handing process recommended by Golder Associates was a passive dewatering and stabilization system using drying beds. Drying beds are only suitable when a large land area is available, where odours are not going to be an issue and where evaporation typically exceeds precipitation. Once sludge has been stabilized and dewatered, an appropriate solids disposal option is then required. However, sludge stabilization and solids disposal is expected to be quite challenging at this remote location where handling options are likely to be very limited and difficult.

A summary of the key advantages and disadvantages of the attached growth systems are presented in Table B.

Table B Advantages and Disadvantages of Attached Growth Systems

Advantages	Disadvantages
Small facility footprint	Increased process monitoring, operation and maintenance requirements.
Modular and easily expandable to meet future growth.	Media replacement may be required after a certain length of time.
Capable of producing secondary quality effluent.	Package plants are usually proprietary systems which may result on the increased reliance on one specific vendor for system support or maintenance requirements.
Short construction period.	Higher sludge production rates and higher solids handling requirements. More solids are produced that require stabilization and ultimate disposal.
Low initial capital cost.	Increased system complexity. System relies on mechanical equipment including process air blowers or recirculation pumps to perform and to achieve effluent quality requirements.
	Increased noise and possibly odour emissions.
	Increased energy consumption requirements for process equipment, building HVAC etc. Stable power supply is required to maintain system performance.
	More susceptible to process upsets.
	Year round effluent discharge required to Slidre Fjord or storage is required to allow for intermittent discharges.
	Comparatively few installations in remote/cold-climate locations.

Attached growth systems are usually only beneficial for facilities that require secondary or better effluent quality or where there are space restrictions. These systems are not recommended for facilities that may have difficulty managing the added process complexity including increased monitoring, operation and maintenance and solids handling requirements. Wastewater storage is usually limited within the process and year round effluent discharge to Slidre Fjord would be required. This is likely to be challenging during the winter months, and therefore effluent storage (if possible in the existing lagoon) would be recommended with these options. In addition, ongoing process monitoring and effluent quality monitoring would be required with a continuous discharge and this can be difficult in remote locations due to shipping delays and the time limitations between when samples are taken and when they need to be analysed. Onsite monitoring may be considered for the site using portable test kits and/or inline instrumentation and

monitoring. Each of these options comes with different cost implications and various advantages or disadvantages which can be considered during the next phase of the design. However, continuous sampling and monitoring would increase the system operational requirements over what is currently done with the existing lagoon system.

Increased energy requirements and an increased dependency on the power supply of the facility would also be required. However, given the remote location, the increased power consumption would translate to an increase in the amount of fuel imported for power generation, resulting in an increased carbon footprint for the facility.

These systems carry an increased risk of process upsets and/or mechanical failures where reduced quality effluent may potentially be discharged to Slidre Fjord. These systems also have a limited track record in very remote cold climate locations and are also more susceptible to process upsets and reliability issues. Since package systems are often proprietary in nature, this could potentially increase the facility's dependence on a specific equipment supplier to maintain performance, troubleshooting and/or technical support.

Attached growth systems have the key advantage of being capable of producing secondary quality effluent with lower operation/maintenance and solids handling requirements than most other mechanical suspended growth systems. These systems also have a small footprint and are modular in design allowing for easier construction and future upgrades. However, the site specific constraints of the Station make these systems less favourable than they would otherwise be due to the increased operation and maintenance requirements that are difficult to address given the remote location of the site.

2.2.2 Lagoon Systems

Lagoons are a well-established technology with numerous full scale applications in remote and/or cold climate locations. Lagoons are often characterized as natural systems where wastewater treatment is achieved through passive atmospheric re-aeration, algal respiration and/or quiescent settling to achieve conditions that support aerobic and facultative organisms responsible for organics and solids removal from the wastewater.

Lagoons with multiple cells, adequate detention times, loading rates, inlets/outlets with seasonal discharges can often achieve good effluent in temperate climates. When ice cover forms for extended periods of time, lagoons perform as cold anaerobic ponds and remove particulate organic matter by quiescent settling for any liquid fraction that may exist under the ice. In addition, because of long detention times, lagoons may be capable of achieving good removal of other constituents such as nitrogen and pathogens under certain conditions. However, in northern climates, lagoons cannot be expected to achieve the degree of treatment of those in more moderate climates. During the winter, wastewater is discharged onto the lagoon surface periodically from the holding tank located inside the heated weather station. Since the volume that is discharged is relatively small, the discharged wastewater is expected to freeze in layers over the winter. Following spring breakup, the frozen lagoon is expected to thaw completely within a few weeks. However, the degree of biological treatment achieved during the relatively short summer is expected to be quite limited as average water temperatures can be expected to be

relatively low in northern climates and this is reflected in the discharge requirements specified by the Nunavut Water Board and the CCME. A summary of the key advantages and disadvantages of the wastewater lagoon treatment option is presented in Table C.

Table C Advantages and Disadvantages of Wastewater Lagoon Systems

Advantages	Disadvantages
Familiar process and operation can be expected to be similar to the existing system.	Large footprint.
Low O&M requirements and costs.	Additional treatment may be required to meet secondary treatment effluent quality.
Easy to operate and does not require additional process equipment, instruments/monitoring, building HVAC, stable power supply etc.	Algae growth may be problematic in summer months and may increase effluent Total Suspended Solids (TSS).
Lowest sludge production rate of all the systems.	Odours may be a problem in the spring and fall or during periods of algal blooms or unfavorable weather conditions.
Capable of producing an effluent quality that meets current license requirements.	Long construction period and high initial capital cost.
Many installations in remote/cold-climate locations – well known technology.	Cannot be easily expanded to accommodate future growth.
Low power/energy requirements.	
Large buffering capacity makes system less susceptible to process upsets.	
Seasonal effluent discharge is recommended.	

The Lagoon option has the key advantage of being easy to operate and would also be the most familiar process for the staff operating the Station's wastewater system. Lagoon maintenance is not intensive, solids handling is minimal and power requirements are low because only transfer pumps are typically required. The reliance on a stable power supply is not critical to the performance of the system and would have a limited impact on the effluent quality of the system. Although some analytical work is essential to confirm compliance with discharge license, an extensive sampling and monitoring program is usually not necessary.

2.2.3 Recommendations

Since secondary quality effluent is not required at this site and sludge/solids handling is expected to be problematic at this location, mechanical type systems including attached growth systems are not recommended for this facility.

Lagoons have several advantages over the attached growth systems discussed in this document. In northern climates, lagoons offer a reliable and easy-to-operate process. The recommendation to proceed with lagoon treatment is based on the assumption that past performance of the existing lagoon meets the current and future NWB licence effluent requirements, and also meets the Station's operational and performance requirements for the site.

To improve lagoon effluent quality, influent pre-treatment, additional cells/retention time, recirculation, aeration and a variety of post-treatment options can be considered as required. A fairly simple upgrade option would be to add aeration and/or mixing to the holding tank to enhance organics removal prior to discharge to the lagoon. This addition may be beneficial in reducing Biochemical Oxygen Demand (BOD_5) concentrations in the effluent without adding a significant amount of complexity to the system. This potentially simple upgrade could improve the performance of the wastewater treatment system especially during periods when conditions in the lagoon are not favourable for biological activity. Implementation of an aerated equalization would likely require a replacement of the existing holding tank with one of sufficient size to achieve meaningful BOD reductions. The tank would also need to accommodate aeration and/or mixing and be designed in such a way to minimize debris accumulation. The principle benefits of the system would be to achieve enhanced biological treatment. However, the increased storage capacity of the holding tank could have the added benefit of decreasing the transfer pump sizes required to pump wastewater to lagoon as the holding tank would have increased capacity to buffer peak flows. During average flows the holding tank could decrease the frequency that wastewater is required to be pumped to the lagoon which may have benefits during the winter months. However, enhanced flow equalization, may require additional infrastructure to accommodate the larger tank and associated pumps/blowers and associated equipment. The system would need to be designed in such a way as to minimize solids accumulation within the tank and that odour/noise emissions are controlled. However, further investigation is required during the next phase of the design to confirm the feasibility of adding an aerated storage tank prior to lagoon treatment and to assess the relative cost/benefits that can be expected.

3. BASIS OF DESIGN

The following section provides preliminary design information for a wastewater lagoon system for the Station.

3.1 Existing Facility

The existing wastewater facility consists of a holding tank, a pump house and a facultative wastewater lagoon that discharges effluent to Slidre Fjord during the summer. The existing lagoon system currently receives wastewater solely from the Station into a single cell engineered retention pond. Wastewater is collected in a storage holding tank inside the weather station building and periodically discharged to the wastewater lagoon along a 6 inch heat traced pipeline that travels along on the surface of the ground. The existing lagoon has an approximate volumetric capacity of 2,230 m^3 and an average side water depth of about 2 m. Wastewater from the lagoon is typically discharged twice a year into Slidre Fjord – first in the beginning of July after the spring thaw and then again at the end of August prior to freezing to allow for winter storage. Discharging of wastewater from the lagoon to Slidre Fjord takes approximately 48 hours to complete. Lagoon effluent sampling is currently done when the water level is at the two-thirds (16 hour) and one-third mark (32 hour) and the samples are analyzed for BOD_5, TSS, ammonia, fecal coliforms, pH, metals, oil and grease and total phenols (Environment Canada 2010).

3.1.1 Effluent Quality Requirements

The wastewater effluent discharges for the Station are regulated by the NWB. Table D below shows the reported current NWB licence maximum allowable average effluent concentrations.

Table D Effluent Criteria (Maximum Average)

Parameter	Current NWB Licence (Golder Associates 2009)	Secondary Treatment Effluent Quality[1] (CCME 2009)
Total Suspended Solids (TSS)	<120 mg/L	<25 mg/L [2]
Biochemical Oxygen Demand (BOD_5)	<100 mg/L	<25 mg/L

[1] As defined by the CCME's "Canada-wide Strategy for the Management of Municipal Wastewater Effluent" dated February 17, 2009. However, these National Performance Standards currently do not apply to facilities located in Canada's Far North where extreme climatic conditions impede treatment.

[2] Total suspended solids may exceed the National Performance Standard of 25 mg/L if exceedance is caused by algae.

Golder Associates noted in their report (Golder 2009) that Environment Canada and PWGSC had expressed interest in selecting a technology capable of achieving secondary treatment effluent quality which is also presented for comparison purposes in the above summary table. Given the extreme climatic conditions at the Station it is unlikely that secondary quality effluent can be achieved with a wastewater lagoon. Options to improve lagoon effluent quality include various pre-treatment, pond enhancements and post-treatment options that can be considered during the next phase of the design as required. One option to upgrade the holding tank to allow for supplemental organics removal is described in Section 2.2.3 of this document.

3.2 Preliminary Lagoon Design

Water is supplied to the Station where it is used within the building and then discharged to the wastewater facility for treatment and discharge. The system is essentially a closed loop with no other inputs or outputs to the system anticipated. Therefore, the potable water produced for the facility will more or less equal the wastewater generation rates that would require treatment.

3.2.1 Water Demand Assessment Data

An evaluation of the anticipated potable water demand assessment for the facility has been summarized in a companion document prepared by WorleyParsons (WorleyParsons 2010A). This study reviewed 2005 to 2010 facility data and estimated the average and maximum occupancies and water consumption rates. The ultimate capacity of the facility is 60 people and the wastewater system was sized to have sufficient capacity to meet this demand. The design criteria used in this study is summarized in Table E.

Table E Wastewater System Preliminary Design Flow Criteria

Historical & Design Data	**Details**		
Average Per Capita Water Consumption Rate	335 L/person/day		
	Minimum	**Average**	**Maximum**
Weather Station Occupancy	8 people	18.5 people	60 people
Design Flow Rates	2.7 m^3/d	6.2 m^3/d	20 m^3/d

Short and long-term variations in flow will have a significant impact on the pipeline, holding tank capacity and/or lagoon size. The design criterion for the wastewater treatment facility is to have sufficient capacity for the next 15 years and was therefore sized to accommodate the maximum occupancy possible at the current facility. The design wastewater flow rate was determined using maximum facility occupancy and the average per capita water consumption rate as observed in 2005 to 2010. WorleyParsons understands that no additional expansion of the Station is planned within the next 15 years that would result in an increase of the maximum occupancy of the facility to more than 60 people. Therefore, the proposed

wastewater facility should have sufficient capacity within the context of the current facility's maximum occupant population.

3.2.2 Raw Wastewater Design Data

Based on the previously presented design flows, the raw water concentration loadings to the wastewater facility were estimated using typical unit loading factors. This information is presented in Table F.

Table F Raw Wastewater Preliminary Design Data (Metcalf and Eddy 2003)

Unit Loading Factors	Average	Maximum
Biochemical Oxygen Demand (BOD_5)	80 g/person/d	100 g/person/d
Total Suspended Solids (TSS)	90 g/person/d	110 g/person/d
Ammonia	7.6 g/person/d	8.4 g/person/d
Total Phosphorus	3.2 g/person/d	3.5 g/person/d
Oil and Grease	30 g/person/d	34 g/person/d
Design Load Concentrations		
Biochemical Oxygen Demand (BOD_5)	240 mg/L	300 mg/L
Total Suspended Solids (TSS)	330 mg/L	400 mg/L
Ammonia	23 mg/L	26 mg/L
Total Phosphorus	10 mg/L	11 mg/L
Oil and Grease	90 mg/L	102 mg/L

The above raw wastewater concentrations were derived from typical unit loading factors and fall within the range of what is considered to be a typical medium to high strength wastewater.

3.2.3 Wastewater Holding Tank

The holding tank is used to store wastewater generated by the Station and is then periodically pumped out to the existing lagoon for treatment. As part of the next phase of the design, an assessment of the existing infrastructure is required to determine if modifications are required as part of the system upgrade. The volume of the existing holding tank was obtained during the site visit. Based on this information, the hydraulic capacity of the existing tank has been estimated in Table G.

Table G Existing Wastewater Holding Tank

Holding Tank	Details
Existing Tank Volume	4 m^3
Approximate Hydraulic Capacity:	
Average Wastewater Flow Rate	15 hours with facility occupancy: 18.5 people
Minimum Wastewater Flow Rate	35 hours with facility occupancy: 8 people
Design Flow Wastewater Flow Rate	4 hours with facility occupancy: 60 people

Depending on the desired operating and treatment objectives, the existing holding tank provides varying amounts of storage capacity at the different design flow rates considered. As discussed previously, modifications to the holding tank may be required to accommodate operational and/or treatment requirements. This assessment will be developed in the next phase of the design.

3.2.4 Pipeline to the Lagoon

A new pipeline is required to transfer wastewater from the holding tank located inside the Station building to the new wastewater treatment lagoon. The Golder Associates options report (Golder 2009) provided two location options for the proposed lagoon system. The evaluation of the constructability for the two proposed wastewater lagoon sites from the geotechnical perspective has been summarized in a companion document by WorleyParsons (WorleyParsons 2010B). Based on the geotechnical assessment of the site, both of these locations are feasible options for the future lagoon. However, each would have different considerations that would need to be taken into account during final site selection. From a wastewater transfer pipeline perspective, location Option 1 has the advantage of shorter pipeline distance and a lower ground elevation making gravity flow a more of possibility for this location. Location Option 2 has the disadvantage of a longer pipeline length and it is also at a higher ground surface elevation. The following table summarizes preliminary design data and assumptions for the transfer pipeline and pumps.

Table H Preliminary Transfer Pipeline and Pump Design Data

	Option 1: South of Main Road	Option 2: North of Main Road
Holding Tank Ground Elevation (approx.)	8.5 m	8.5 m
Lagoon Surface Elevation (approx.)	5.0 m	7.5 m
Pipeline Length (approx.)	150 m	225 m
Pipeline Material/Size	6 inch (HDPE)	6 inch (HDPE)
Static Head (approx.)	-3.5 m (downhill)	-1 m (downhill)
Design Flow	40 m^3/h	40 m^3/h
Pipeline Velocity	> 1 m/s	> 1 m/s
Pump Total Dynamic Head (TDH)	n/a	3 m
Power	n/a	1 HP

The above very preliminary analysis suggests that location Option 1 could have sufficient head to allow for gravity flow through the transfer pipeline, however further analysis is required in the next phase of the design to confirm. As noted in the companion constructability document prepared by WorleyParsons (WorleyParsons 2010B), Option 1 is located on a slope and has the disadvantage of requiring more site grading than Option 2. Alternatively, Option 2 is also located slightly downhill from the Station but may not have sufficient head to permit gravity flow to the new lagoon location depending on the selected design flow rates and pipeline size. In addition, a line size of sufficient size to accommodate wastewater transfer flows may not have sufficient velocity to prevent solids deposition within the line with gravity flow alone (typically greater than 1 m/s). In this case, a pumped force main would be recommended. A higher transfer line velocity would also be beneficial during the winter seasons when freezing could cause potential problems as it would limit the amount of time required to transfer wastewater to the lagoon.

The transfer pump and pipeline design is dependant on the lagoon location and the design flow rate required by the system. Modifications and upgrades to the holding tank would also impact the design and operation of the transfer pumps. A larger holding tank would decrease the frequency that wastewater transfers from the holding tank to the lagoon would be required. Buffering of peak wastewater flows by providing additional storage would allow for additional pumping flexibility to be built into the system. This should be evaluated during the next phase of the design.

3.2.5 Lagoon Design Data

Based on the wastewater flows and loads presented earlier in this report, a preliminary lagoon design was generated and this information is presented in Table I.

Table I Preliminary Lagoon Design Data

Lagoon Preliminary Design Data	Details
Average Winter Water Temperature	< 0°C
BOD_5 loading rate (WEF et al. 2009)	11 kg/ha-d
Design Flow Rate	20 m^3/d
Number of Lagoon Cells	2
Lagoon Side Slope	4:1
Preliminary Lagoon Water Surface Area	5,500 m^2
Average Side Water Depth	3 m
Sludge Accumulation Allowance	1 m
Functional Side Water Depth	2 m
Functional Pond Volume (approximate)	7,750 m^3
Hydraulic Retention Time at Design Flow Rate	1.05 years
Hydraulic Retention Time at Average Flow Rate	3.5 years

This preliminary sizing provides allowances for functional lagoon volume reductions as a result of sludge accumulation at the bottom of the lagoon and provides sufficient volume to allow for once a year effluent discharge at the end of the summer season prior to freezing. The above design data is based on preliminary wastewater flows, loads and assumptions that would need to be confirmed during the next phase of the design. However, based on this information a lagoon sized to accommodate the full facility design flow would have this approximate footprint.

As noted previously, the design flow for the facility was determined from the maximum occupancy of 60 people that can be accommodated at the Station. However, historical data has shown that average annual occupancy for the facility typically ranges between 15 and 20 people. Therefore, the above lagoon will have significantly more storage capacity than is currently required when less than full facility occupancy occurs. The hydraulic retention time of the proposed lagoon at the current average design flow rate of 6.2 m^3/d (18.5 people) would be approximately 3.5 years. The increased lagoon capacity has the added advantage allowing for increased treatment as wastewater can be stored for more than one summer season – when the majority of biological activity required for wastewater treatment is expected to

occur – which should result in a better wastewater effluent quality. However, the increased lagoon size equates to an increased footprint area and increased construction costs. Therefore, confirmation of the facility's design parameters and peaking factors is recommended prior to the next phase of the design to ensure that the facility design is consistent with the future plans for the Station.

3.2.6 Effluent Discharge

Similar to the proposed lagoon transfer pumping system, further investigation is needed into effluent discharge options for the proposed wastewater treatment lagoon option. The assessment should include location specific considerations, regulatory requirements, and/or other operational considerations. Without specific facility details, there is insufficient information available to provide a complete assessment and design basis at this time.

3.2.7 Constructability

The evaluation of the constructability in the two proposed wastewater lagoon sites from the geotechnical perspective has been summarized in a companion document prepared by WorleyParsons (WorleyParsons 2010B). This study concluded that either of the two lagoon site options may be feasible each with various considerations to be addressed during the next phase of the design.

3.2.8 Decommissioning of the Existing Facility

Facility decommissioning needs to be staged to coincide with construction completion of the existing facility and weather conditions favourable for the commissioning of the new wastewater treatment facility. An assessment of existing facilities should be conducted with the goal of salvaging as much of the existing infrastructure as is feasible. Decommissioning of the existing lagoon would as a minimum includes the following recommendations:

- it is recommended that the commissioning of the new wastewater lagoon be done in the spring to allow for any additional start-up work that may be required to be done during the summer months if possible;
- the quality of wastewater in the existing lagoon should be sampled to see if it is of sufficient quality for discharge into Slidre Fjord. If quality requirements are not met, then the existing lagoon effluent should be pumped into the new lagoon for storage and additional treatment prior to discharge;
- once the existing lagoon has been drained, the remaining site can either be allowed to naturally dewater or if necessary, the sludge can be removed, dewatered and disposed of in a way that is appropriate for the site location;
- the existing lagoon can then be backfilled or used for wastewater effluent storage as required; and
- the associated infrastructure would also need to be decommissioned, if it is no longer required and these materials disposed of in a way that is appropriate for the site location.

4. NEXT STEPS

This document identifies several design details and information gaps that need to be addressed during the next phase of the design. Once a technology selection for the site and various design details are confirmed, further refinement can take place. This would include selection and sizing of key components of the system including the new wastewater transfer pipeline and pumps, wastewater treatment system and effluent discharge. In addition, an assessment of existing infrastructure would be required such as the use of the existing wastewater storage holding tank and potential upgrades to the system and/or use of the existing lagoon for effluent storage if an attached growth or mechanical system is used.

It is recommended that major components of the design be modeled to determine sizing and predict performance. These would include the lagoon transfer and discharge pipelines and pumps, as well as the performance of the selected wastewater treatment option. Modelling of the pipelines is required to select the final pump and line sizes. Modelling of the wastewater treatment system provides an estimate of the expected effluent quality when various design parameters are selected and what the impacts of certain variables such as temperature, hydraulic retention times, loading rates, etc. would be on the system performance.

5. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

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Appendix 3 Fuel Drum Storage Area Study

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PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EUREKA CIVIL CONSULTING SERVICES
FUEL DRUM STORAGE AREA

Eureka Civil Consulting Services

Fuel Drum Storage Area

C71130000 – Document No: C71130000-CI-REP-0002

13 January 2011

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resources & energy

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EUREKA CIVIL CONSULTING SERVICES
FUEL DRUM STORAGE AREA

PROJECT C71130000 - EUREKA CIVIL CONSULTING SERVICES

FILE LOC.: CALGARY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	F. Freckleton	L. Martin	R. MacDonald	04-Oct-10		
B	Issued for client review	F. Freckleton	L. Martin	R. MacDonald	21-Oct-10		
0	Issued for Final	F. Freckleton	L. Martin	R. MacDonald	13-Jan-10		

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Any questions concerning the information or its interpretation should be directed to Frankie Freckleton or Richard MacDonald.

EXECUTIVE SUMMARY

This report presents a design basis for a new fuel drum storage area in support of the Civil Consulting Study for Eureka, Nunavut, Canada. This report includes a review of existing information, a summary of the field work and the design basis.

The geometric design basis of the fuel drum storage maximizes the fuel drum storage capacity while minimizing the area footprint. The proposed layout inside the fuel drum storage area is “U-shaped”. This allows the front-end loader a maximum amount of manoeuvrability while maintaining the smallest footprint. This layout can be modified going forward, for operational reasons, if necessary. However, the proposed footprint of the fuel drum storage area is based on this arrangement.

A secondary containment structure is to be constructed on a pad of granular fill with a minimum thickness of 1.0 m (WorleyParsons 2010). The crushed gravel fill should be placed near the end of the summer season when the annual depth of thaw has been achieved. Constructing a stable crushed gravel fill during the poorest annual subgrade conditions should ensure stable crushed gravel fill in all seasons. To protect the linear low density polyethylene liner, two layers of sand will be used. One sand layer will be placed under the liner and the other sand layer will be placed on top of the liner. Two layers of woven geotextile will be used as separation barriers to prevent the sand mixing with the gravel. The first woven geotextile will be placed on top of the gravel fill, with the sand placed on top of the geotextile. The second woven geotextile will be placed on top of the upper sand layer with the gravel surface placed on top. For a trafficable surface, crushed gravel will be placed on the fuel drum storage footprint. The fuel drum storage footprint includes the area the drums are stored in and the area required for the front-end loader to manoeuvre.

Two locations were identified as potential sites for the fuel drum storage area (Drawing 19). One site, Location Option 1, was identified in the Terms of Reference (PWGSC 2010) and the second site, Location Option 2, was identified by WorleyParsons geotechnical engineers. The location of the fuel drum storage area is proposed to the north of the existing bulk fuel storage site at the airfield (Location Option 1). Location Option 1 was deemed less desirable by the WorleyParsons’ field team due to its proximity to the Rose Rock Creek slope and an alternative location (Option 2) has been suggested. Location Option 2 is situated slightly south and east of Option 1 moving it away from the potentially unstable slope of Rose Rock Creek. The soil conditions in the area of Option 1 consist of relatively undisturbed tundra (silty clay till) with permafrost located approximately 0.5 meters (m) below grade. The soil conditions in Option 2 are presumed to be similar to Option 1.

In terms of the proposed construction schedule, the compacted crushed gravel fill would ideally be placed and left in place over a full winter season (WorleyParsons 2010). The following summer, the crushed gravel fill can be re-graded as needed and the subsequent secondary containment structure can be placed. However, if necessary, the entire structure can be placed in one construction season.

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DRAWINGS 25-26 NOT INCLUDED IN THIS REPORT (INCLUDED IN THE GEOTECHNICAL REPORT)

DRAWING 27 NOT INCLUDED IN THIS REPORT (INCLUDED IN WATER SUPPLY AND DISTRIBUTION STUDY)

1. INTRODUCTION

1.1 General

WorleyParsons was retained by Public Works and Government Services Canada (PWGSC) to determine the area and recommended layout for a fuel drum storage site at Eureka, Nunavut. This activity supports the Civil Consulting Study, Contract R.015446.001. This study considers various options for upgrading the Eureka airstrip, the sewage lagoon, the water reservoir as well as the addition of a fuel drum storage area, which is the subject of this report.

1.2 Scope of Work

The proposed scope of work for the fuel drum storage site was outlined in WorleyParsons' Proposal No: CPR 10-039, dated July 21, 2010, and includes the following:

a) a review of any existing background information;

b) coordination with, and support for the geotechnical and topographic investigations for the proposed footprint area;

c) a review of geotechnical and topographical survey results, as they pertain to the fuel drum storage area; and

d) preparation of a design basis which outlines the key design aspects of the proposed fuel drum storage area, including preliminary engineering drawings and consideration of the technical challenges of construction in the Arctic.

2. GENERAL INFORMATION

2.1 Site Description

Eureka is located on the north shoreline of Slidre Fjord on the western coast of Ellesmere Island in the Qikiqtaalkuk Region of Nunavut (Figure 3.1). The area is in the high arctic polar desert and has an annual average temperature of -19.7°C and an annual average precipitation of 75.5 mm (Environment Canada 2010). Eureka's extreme climate with long, very cold winters and short cool summers allows the formation of continuous permafrost throughout the region.

The site forms part of Environment Canada's High Arctic Weather Station (HAWS) network and includes a Canadian Forces Station. Facilities at the site include the main weather station complex, a water reservoir, sewage lagoon, airstrip and Fort Eureka. The Fort, weather station and airstrip area are located in a low-lying plain between Skull Point, to the west, and Black Top Ridge, to the east.

Currently, there is no dedicated fuel drum storage area near the airstrip. The pallets of fuel drums are stored in multiple locations. They are grouped by company and fuel type and stored on the north side of the refuelling apron at the airstrip. Environment Canada also has a smaller cache of fuel drums near the main station. Some pallets are stored on crude, sand filled secondary containment pads. The pallets are moved using a front-end loader equipped with forks. Aircraft are typically refuelled by hand using electric pumps, directly from the drums. Used drums are stockpiled at the drum crushing station where they are crushed and buried.

2.2 Background Information and Literature Review

A fuel drum storage area is currently proposed north of the airstrip (Drawing 19). The key requirements outlined in the Terms of Reference (PWGSC 2010) are as follows:

- size to contain 2,000 drums, 4 per pallet and stacked two pallets high;
- include contingency areas for a sump, manoeuvring of equipment, etc.;
- storage area must be accessible by a loader with forks from the north apron;
- granular fill must not destroy liner with storage or equipment loads; and
- granular fill must allow water and spilled fuel to drain easily to liner.

From the key requirements, an area and recommended layout were to be proposed, including the geometry (length, width, berms and collection sump). After review of topographic maps and existing site information, preliminary areas were chosen. A geotechnical investigation and topographic survey of the preliminary locations for the proposed fuel drum storage was provided.

WorleyParsons understands that the fuel drum storage area should comply with Canadian Environmental Protection Act guidelines. Design of the storage area should also consider the severe weather at the site and the current methods for storing fuel drums on site.

Section 6 from the Stantec Eureka Fuel Storage Product Transfer Areas Analysis Report (Stantec 2009) outlines their recommendations for secondary containment for fuel drum storage. Stantec suggested the best option for contained storage of large drum caches is to install a synthetic liner within a graded bermed perimeter. The report also states the recommended options for secondary containment would depend on the quantity of drums and the need for separate areas of storage.

2.3 Geotechnical and Topographic Investigations

2.3.1 General

A geotechnical and topographic investigation of the fuel drum storage area was completed between August 15–17, 2010. A geotechnical engineer assessed the soil conditions and the general topography of the area located north of the existing bulk fuel drum storage and building (Drawing 18). This area was to be investigated as the location of the fuel drum storage area, as detailed in the PWGSC Terms of Reference.

2.3.2 Results for the Proposed Fuel Drum Storage Area

A Test Pit (TP10-07) was excavated in the centre of the proposed fuel drum storage area (WorleyParsons 2010). The area consists of relatively undisturbed tundra, comprised of very soft, moist, dark brownish grey silty clay till with some organics and rootlets at the surface and containing trace gravel, cobbles and boulders (WorleyParsons 2010). Permafrost was encountered in the test pit at a depth of 0.6 m below grade (WorleyParsons 2010).

The proposed site is adjacent to the slope down to Rose Rock Creek. This slope appears to be unstable and undergoing mass soil wasting or solifluction, with shallow soil slumps noticeable at the time of the site reconnaissance (WorleyParsons 2010). It is probable this slope may continue to destabilize (WorleyParsons 2010).

3. DESIGN BASIS OF FUEL DRUM STORAGE AREA

3.1 General

In accordance with the Canadian Council of Ministers of the Environment (CCME) document, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations, the fuel drum storage area's secondary containment structure incorporates berms, a geosynthetic liner and a sump to collect fluids. Due to the extreme climate and poor soil conditions, the secondary containment structure for the fuel drum storage area has been designed to limit the effects of permafrost on the structure while maintaining accessibility to the fuel drums.

3.2 Location of Fuel Drum Storage Area

Two locations were identified as potential sites for the fuel drum storage area (Drawing 19). One site, Location Option 1, was identified in the PWGSC Terms of Reference and the second site, Location Option 2, was identified on-site by a WorleyParsons geotechnical engineer.

3.2.1 Location Option 1

The fuel drum storage area in Option 1 is located north of the bulk fuel tanks as per Drawing 20.

Soil conditions in this area consist of relatively undisturbed tundra (TP10-07): very soft, moist, dark brownish grey silty clay till with some organics and rootlets at the surface and trace gravel, cobbles and boulders (WorleyParsons 2010). Ground ice was noticeable in the test pit at a depth of 0.6 m below grade (WorleyParsons 2010).

For Location Option 1 the ground conditions are suitable for construction of the outlined fuel drum storage area (WorleyParsons 2010). However, the site is adjacent to and slightly overhangs the slope down into Rose Rock Creek, which appears to be unstable. The slope appears to be undergoing mass soil wasting or solifluction, with shallow soil slumps noticeable at the time of the site reconnaissance (WorleyParsons 2010). It is a possibility that climate change may further destabilize this slope.

Therefore, we recommend that the fuel drum storage area be altered from the original proposed location (Option 1) to the area east of the bulk fuel storage on the east end of the north apron (Option 2).

3.2.2 Location Option 2

The fuel drum storage area Option 2 is located north of the airfield and east of the bulk fuel tanks as per Drawing 22.

Soil conditions in the second location for the proposed fuel drum storage area are presumed to be similar to those encountered in the first proposed location (Option 1) and are suitable for construction of the outlined fuel drum storage area (WorleyParsons 2010). This location (Option 2) is setback from the unstable slope while maintaining access to the airfield and apron.

3.3 Geometric Design

The intent of the geometric design of the fuel drum storage was to maximize the fuel drum storage capacity while minimizing the area footprint. The fuel drum layout inside the storage area is "U-shaped". This allows the front-end loader the maximum amount of manoeuvrability whilst maintaining the smallest footprint. This layout can be modified going forward, for operational reasons, if necessary. However, the required footprint of the fuel drum storage area may require alteration as a result. The proposed fuel drum storage area footprint is 75 m wide by 70 m long by 1.75 m high. The effective fuel drum storage area is 45 m wide by 30 m long (Drawing 20 and Drawing 22).

The crushed gravel surface should be graded to drain to a sump. The sump will allow water and product trapped in the secondary containment structure to be removed. An 8 m wide by 8 m long by 1 m deep sump should be sufficient. The slopes of the sump should be 3 horizontal to 1 vertical.

3.4 Secondary Containment Structure

The secondary containment structure will be constructed on a pad of granular fill with a minimum thickness of 1.0 m (WorleyParsons 2010) (Drawing 21 and Drawing 23). To protect the linear low density polyethylene liner two layers of sand will be used. One sand layer will be placed under the liner and the other sand layer will be placed on top of the liner. Two layers of woven geotextile will be used as separation barriers to prevent the sand mixing with the gravel. The first woven geotextile will be placed on top of the gravel fill, with the sand placed on top of the geotextile. The second woven geotextile will be placed on top of the upper sand layer with gravel placed on top. For a trafficable surface, crushed gravel will be placed on the fuel drum storage footprint. The fuel drum storage footprint includes the area where the drums are stored and the area required for the front-end loader to manoeuvre.

The following is the proposed detailed structure of the secondary containment for the fuel drum storage area, starting from the existing ground surfaces.

Table A Secondary Containment Structure

Item	Description
Crushed Gravel Fill	The crushed gravel fill should be composed of well graded, crushed gravel and a minimum of 1.0 m thick. This should move the active layer into the gravel pad and prevent the underlying tundra from thawing in the summer as the active layer will remain in the gravel. By placing a minimum of 1.0 m of crushed gravel fill, surface water should be diverted away from the containment area.
Woven Geotextile	A woven geotextile should be used as a separation layer between the crushed gravel fill and the sand. The geotextile will prevent the mixing of the sand and crushed gravel fill. It will also provide rigidity to the structure.
Sand	A protective layer of sand should be used, beneath the liner, to prevent the liner from tearing on the underlying crushed gravel fill. The sand thickness is recommended to be a minimum 150 mm thick to a maximum 250 mm thick.
Linear Low Density Polyethylene (LLDPE) Liner	The LLDPE liner should be a minimum of 40 mils (1 mm) thick and constructed of panels that will minimize field fabrication time while maximizing the shipping capacity. An LLDPE liner was selected due to its versatility in extreme cold climates as it is very flexible and elongates under stress.
DS Drainage Geocomposite (Optional)	If the granular materials and geotextiles are insufficient at conveying water to the sump, a drainage geocomposite should be utilized as a potential drainage aid.
Sand	A protective layer of sand should be used on top of the liner to prevent the liner from tearing on the overlying crushed gravel surface. The sand thickness is recommended to be a minimum 150 mm thick to a maximum 250 mm thick.
Woven Geotextile	A woven geotextile should be used as a separation layer between the crushed gravel fill and the sand. The woven geotextile will prevent mixing of the sand and crushed gravel fill. The woven geotextile will also provide rigidity to the structure.
Crushed Gravel Surface	The crushed gravel surface should be a minimum 400 mm thick to a maximum 500 mm thick. The crushed gravel surface will provide the trafficable area for the front end loaders and the stacked pallets. This traffic surface will need to be maintained through out the life of the fuel drum storage area.

Table B Secondary Containment Structure – Volumes (Option 2)

Material	Volume (m^3)	Area (m^2)
Crushed Gravel Fill	7,800	--
Sand	1,200	--
LLDPE Liner	--	2,700
Woven Geotextile	--	4,900
Crushed Gravel Surface	850	--

3.5 Construction Recommendations

The crushed gravel fill should be placed near the end of the summer season when the annual depth of thaw has been achieved. The underlying soil conditions will be representative of the poorest annual subgrade conditions (WorleyParsons 2010). Constructing the gravel fill during the poorest annual subgrade conditions should ensure stable crushed gravel fill in all seasons. The thickness of the fill will be dictated by drainage slopes and field conditions. However, a minimum fill depth of 1.0 m is sufficient for the crushed gravel fill (WorleyParsons 2010). The first lift of this fill should be placed in a 500 mm thick lift and compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (WorleyParsons 2010). To protect the native soil, the crushed gravel fill should be end dumped onto the undisturbed tundra off the edge of the existing apron. Vehicle traffic should remain off the natural tundra surface. This should prevent damage to the underlying soil. However, if rutting or punching failures occur the original lift thickness may have to be increased. Successive lifts of crushed gravel fill should be 300 mm thick and compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (WorleyParsons 2010).

Once the initial 1.0 m lift of crushed gravel fill has been placed and compacted, it should be proof-rolled. If any signs of instability are noted, the thickness of crushed gravel fill should be increased and the proof-rolling repeated. This process should continue until no signs of instability are noted in the gravel pad (WorleyParsons 2010).

Ideally, the compacted fill should be left in place over a full winter season (WorleyParsons 2010) and the following summer the crushed gravel fill can be re-graded as needed and the subsequent secondary containment structure described in Section 3.2 can be placed. However, if necessary the entire structure can be placed in one construction season.

Table C Potential Construction Timeline

Construction Item	Timeline
Crushing and screening of granular material	Construction Season 1
Place crushed gravel fill (minimum 1.0 m thick)	Construction Season 1
Construct berms with crushed gravel fill	Construction Season 1
Construct secondary containment structure	Construction Season 2
Crushed gravel surface maintenance	On-going

The containment berms should be constructed with a 3:1 slope on either side with the exception of the south facing slope. To accommodate equipment traffic the south slope should be graded at 6:1. During construction a 500 mm wide by 500 mm deep trench on top of the berm should be excavated to allow the liner to be anchored to the structure (Drawing 24). The height of the containment berm should be a minimum of 500 mm, to contain any fluids within the bermed area.

The protective sand layers can be placed in one lift. When placing the protective sand layer on top of the LLDPE liner, care should be taken to prevent damage to the liner. The liner may need to be assembled on site. This is dependant on shipping constraints. Prior to the liner installation a sump should be excavated in the north-west corner of the secondary containment structure. The slopes of the sump may not retain sand. This may leave the LLDPE liner exposed. However, a minimum of 150 mm of sand should be placed in the bottom of the sump.

For a trafficable surface, the crushed gravel surface should be placed by “end dumping” onto the woven geotextile (on top of the sand). This should help prevent damage to the liner. Lifts of crushed gravel surface should be a maximum of 300 mm thick.

3.6 Potential Granular Material Borrow Sources

The potential borrow sources listed below were investigated and discussed in the geotechnical study (WorleyParsons, 2010). They are representative of the potential granular sources that could be used to construct the fuel drum storage area.

- Blacktop Creek – potential for good quality crushed aggregate and sand, approx. 3 kilometres (km) to site;
- Station Creek – potential for good quality crushed aggregate and sand, approx. 7 km to site; and
- Remus Creek – potential for good quality crushed aggregate and sand, approx. 15 km to site.

These sources should be tested prior to construction to ensure they meet the construction specifications for the fuel drum storage area. However, a crushing and screening plant would be required at all locations.

4. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

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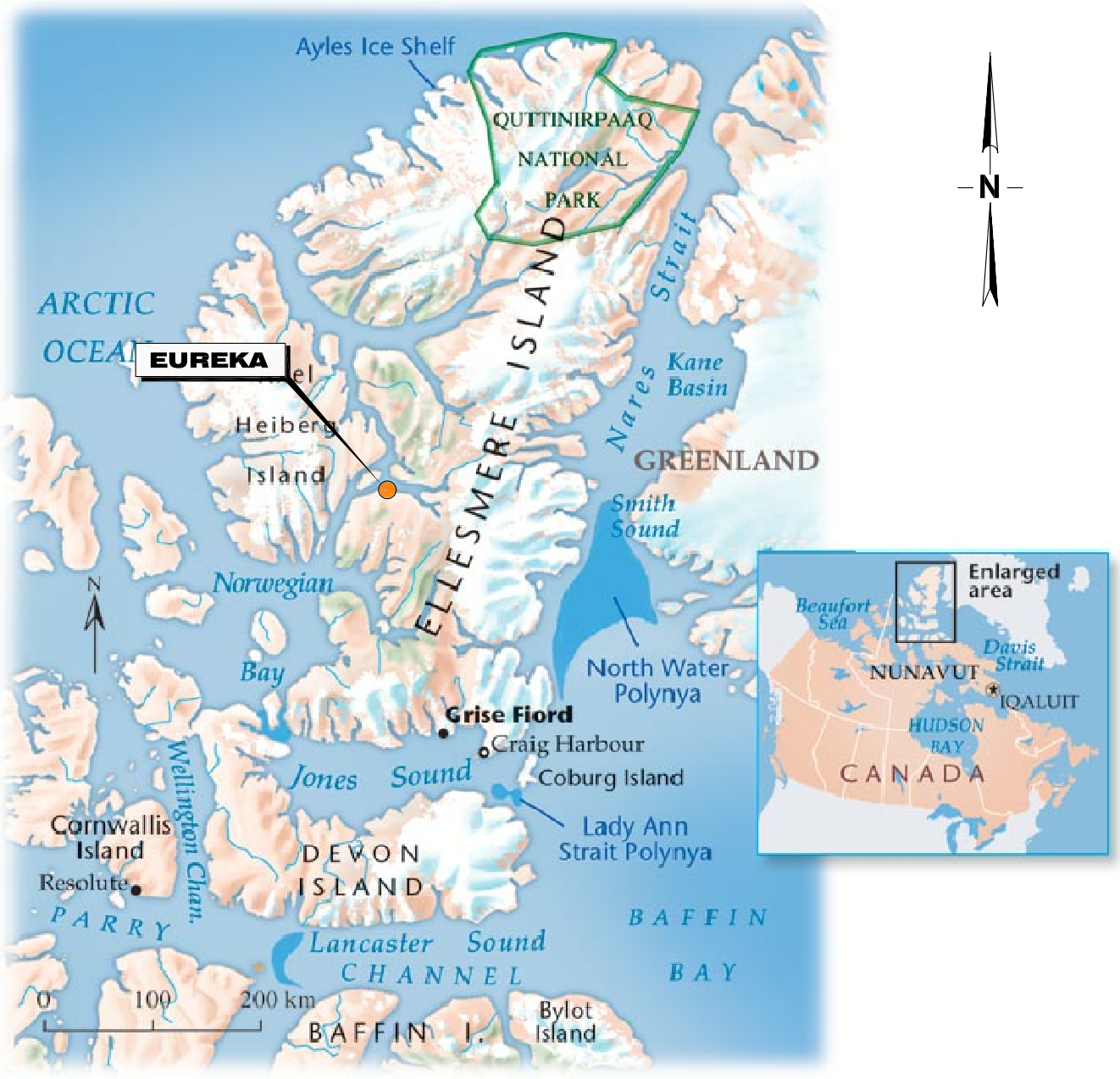
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Figures

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EUREKA, NUNAVUT

Drawing title/Titre du dessin

SITE LOCATION MAP

Approved by/Approuve par: J.Q.	PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.	Scale/Echelle: AS SHOWN	
Designed by/Concept par: L.M.	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Date/Date: 2010-12-14	
Drawn by/Dessine par: L.P.	Project No./No. du projet: R.015446.001	Sheet/Feuille: **Figure 3.1**	Revision/ Revision

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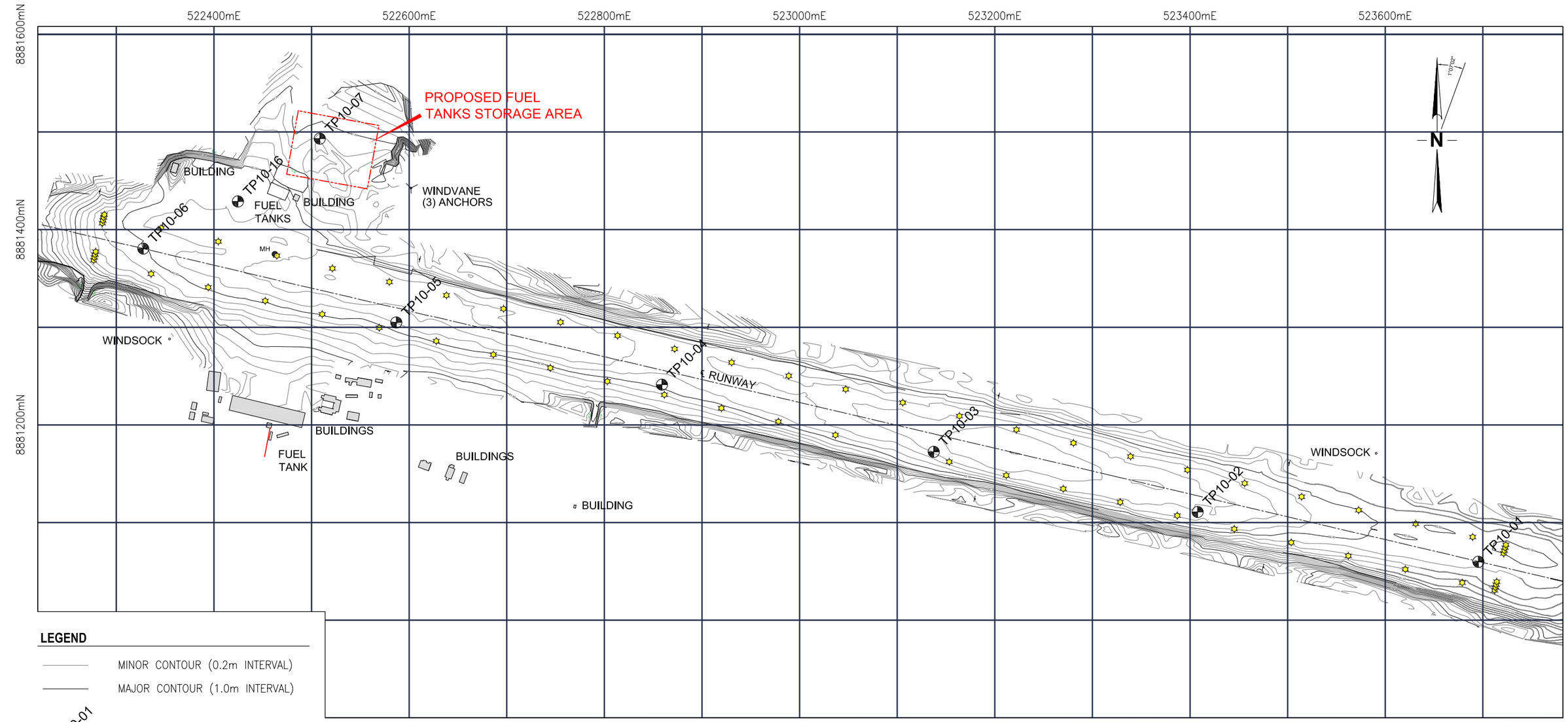
Drawings

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES / SERVICES IMMOBILIERS

Western Region / Région de l'ouest



LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- TP10-01 — TEST PIT LOCATION
- MH — MANHOLE
- RUNWAY LIGHT

0 50 100 150 200m

SCALE 1 : 4,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

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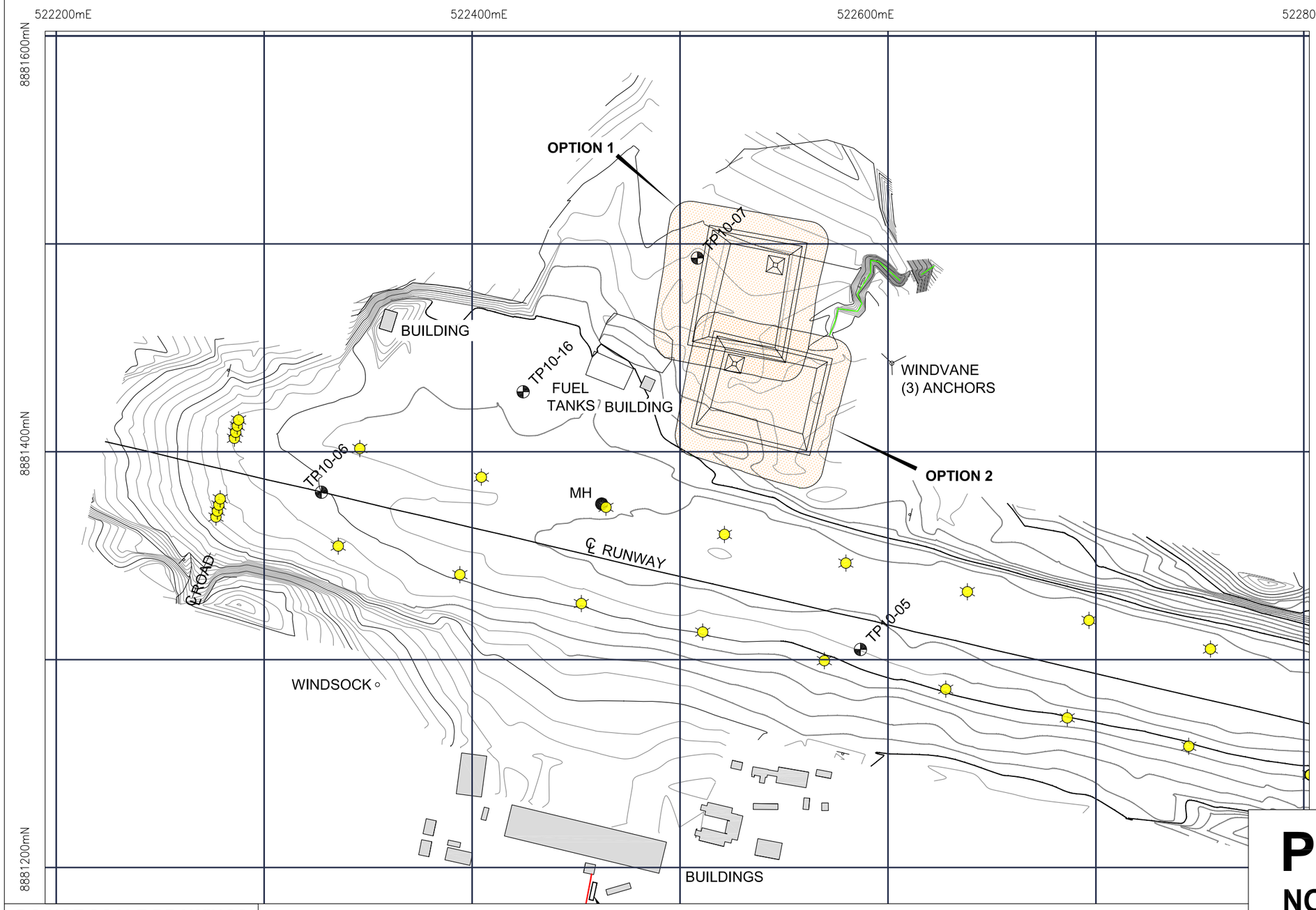
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REAL PROPERTY SERVICES / SERVICES IMMOBILIERS
Western Region / Région de l'ouest



N

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- TP10-01 TEST PIT LOCATION
- MH MANHOLE
- RUNWAY LIGHT

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Challenger Geomatics,
Drawing File: 35062 SS.dwg

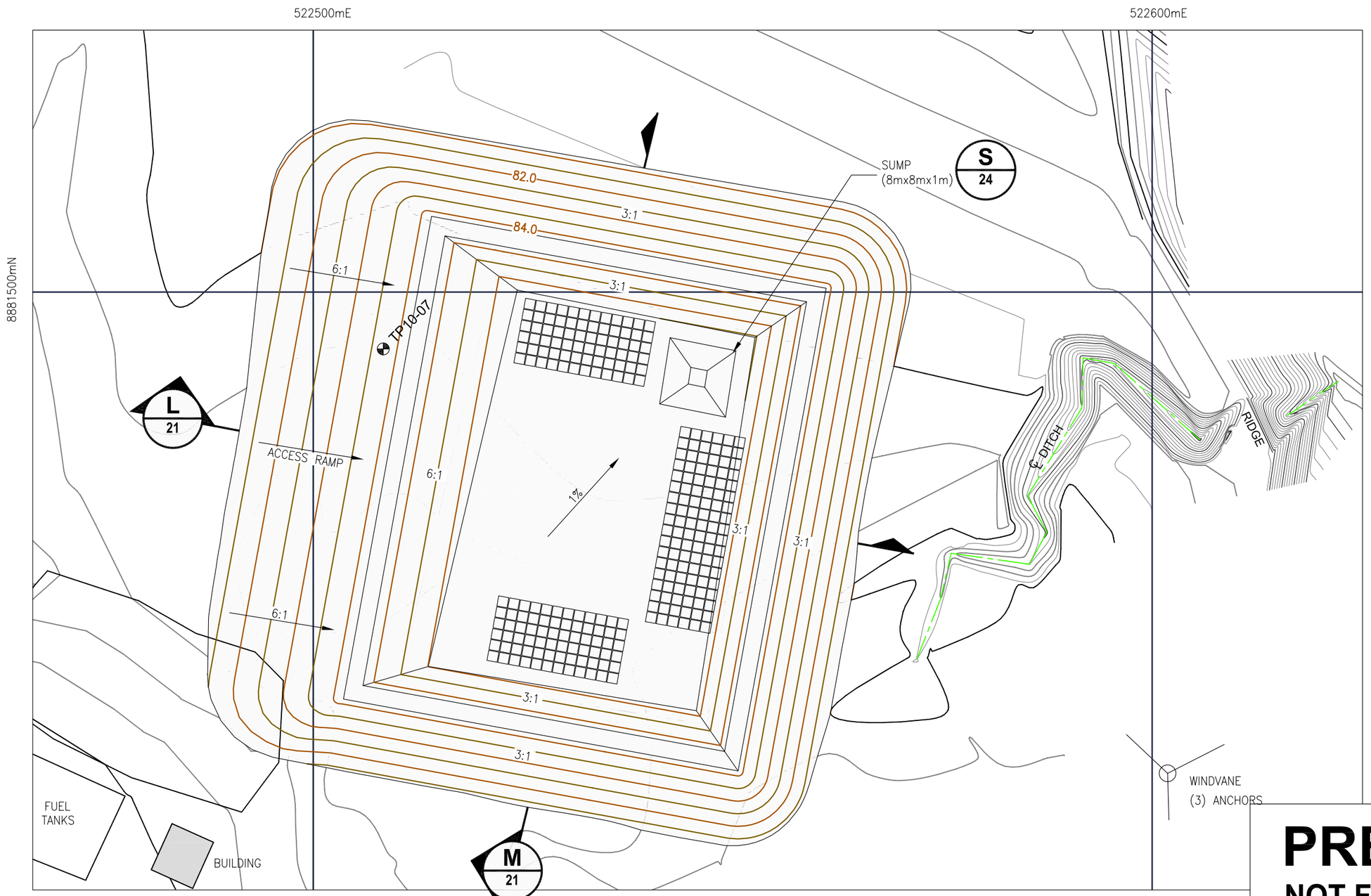
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C71130000-runway



N

CRUSHED GRAVEL FILL = 9,200m³

WOVEN GEOTEXTILE	4,900m²
LLDPE LINER	2,700m²
CRUSHED GRAVEL SURFACE	850m³
SAND	1,200m³

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- TP10-01 TEST PIT LOCATION
- DOUBLE STACKED PALLETS (8 DRUMS TOTAL)

0 5 10 15 20 25m

SCALE 1 : 500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

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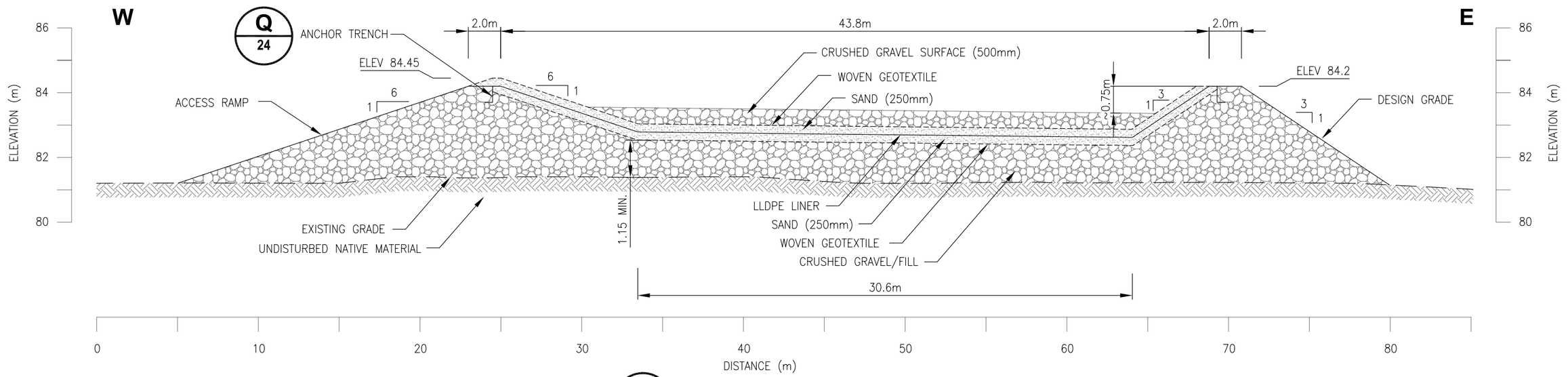
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EUREKA, NUNAVUT CANADA
CIVIL CONSULTING SERVICES

Drawing title/Titre du dessin
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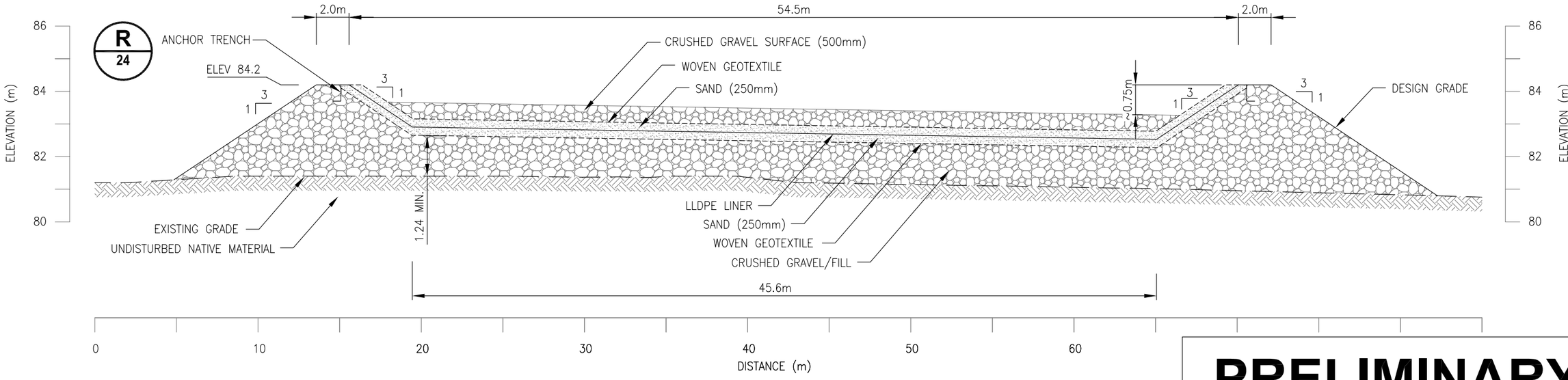
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L 20 OPTION 1 W-E SECTION
H 1:250 V 1:125



M 20 OPTION 1 S-N SECTION
H 1:250 V 1:125

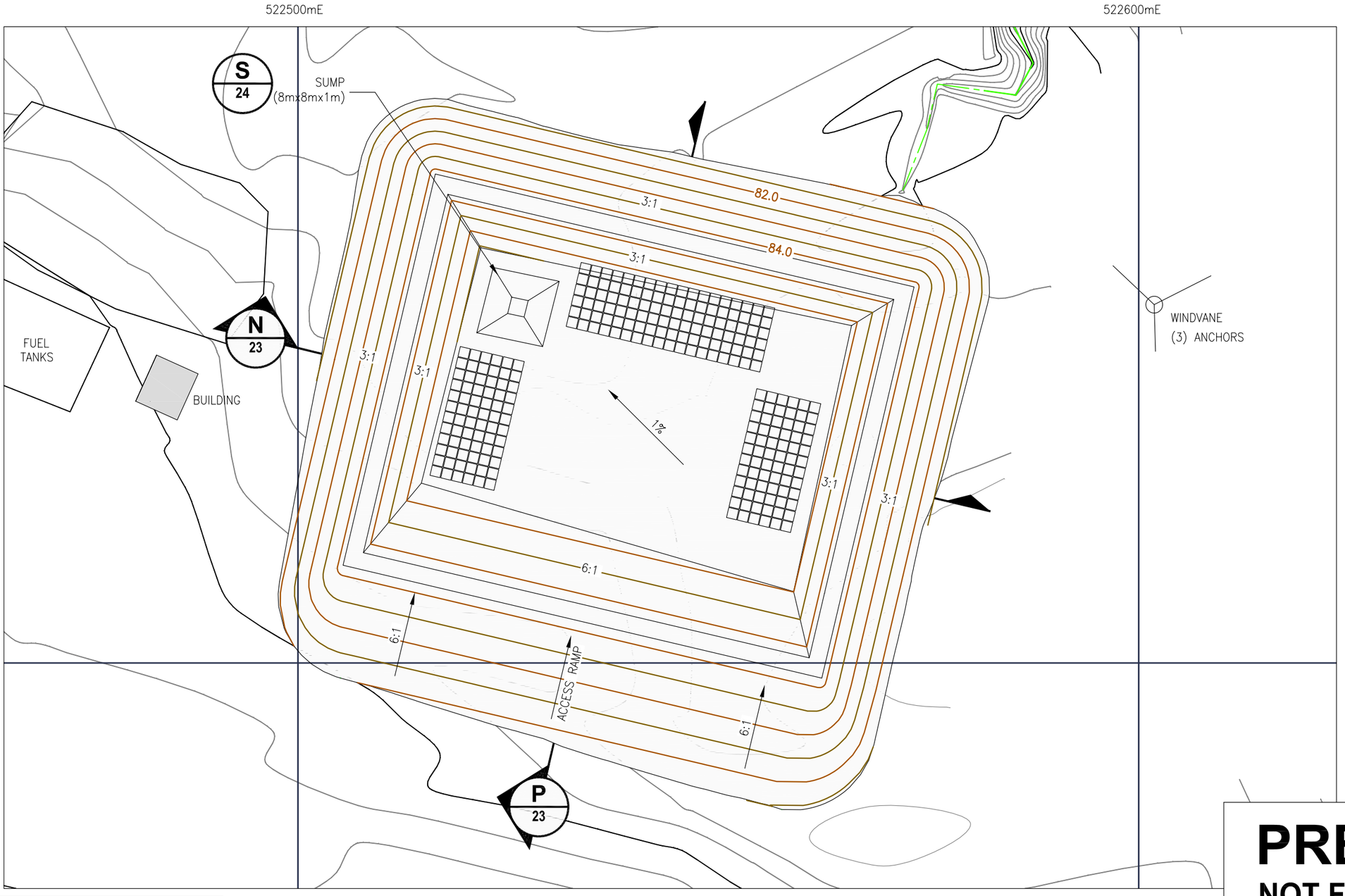
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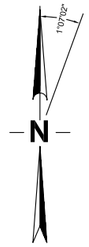
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A0 – PWGSC – ANSI B–L2 – 11X17

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CRUSHED GRAVEL FILL = 7,800m³	
WOVEN GEOTEXTILE	4,900m²
LLDPE LINER	2,700m²
CRUSHED GRAVEL SURFACE	850m³
SAND	1,200m³

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- DOUBLE STACKED PALLETS (8 DRUMS TOTAL)

0 5 10 15 20 25m

SCALE 1 : 500

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Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

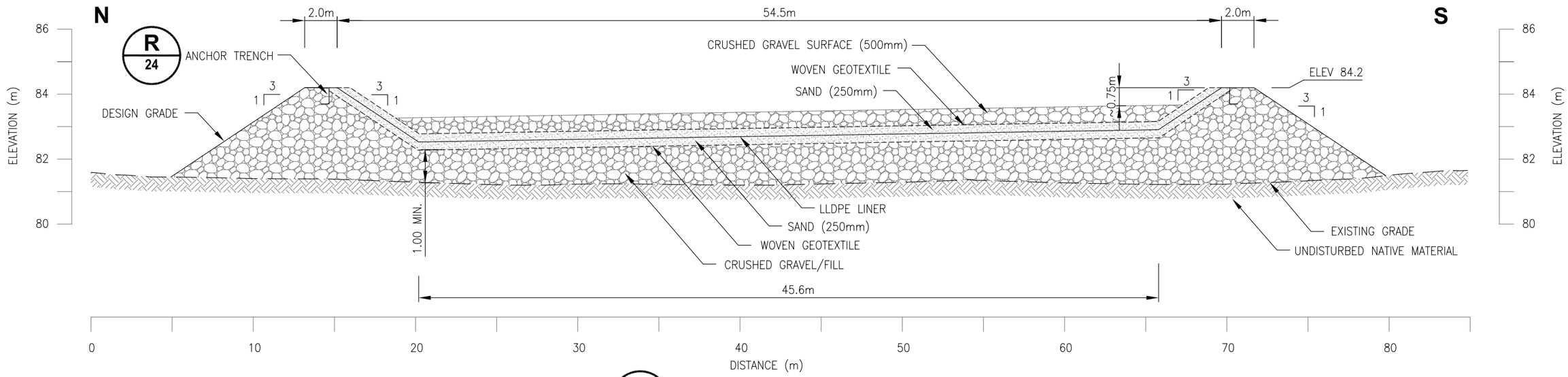
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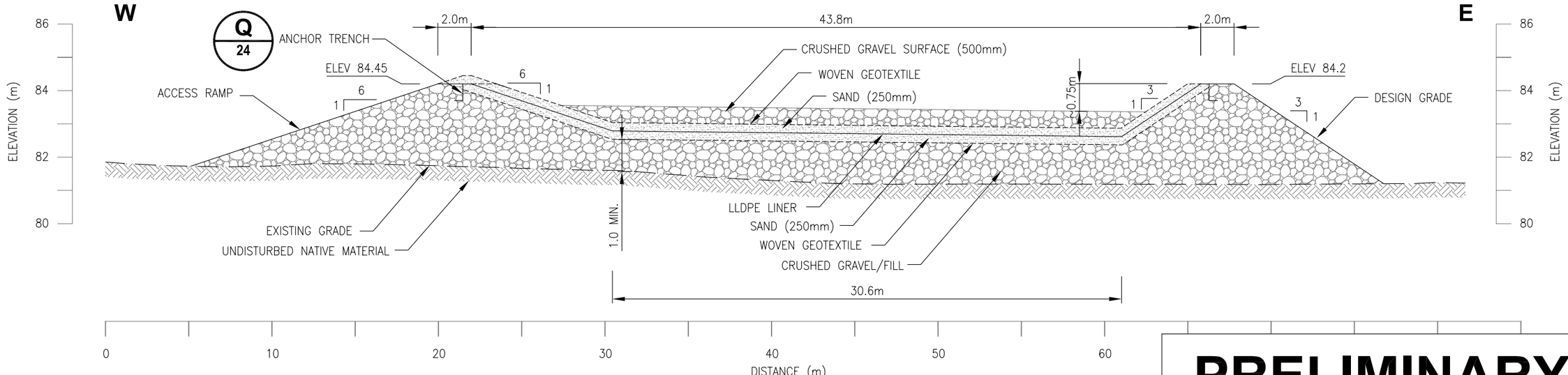
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N 22 OPTION 2 S-N SECTION
H 1:250 V 1:125



P 22 OPTION 2 W-E SECTION
H 1:250 V 1:125

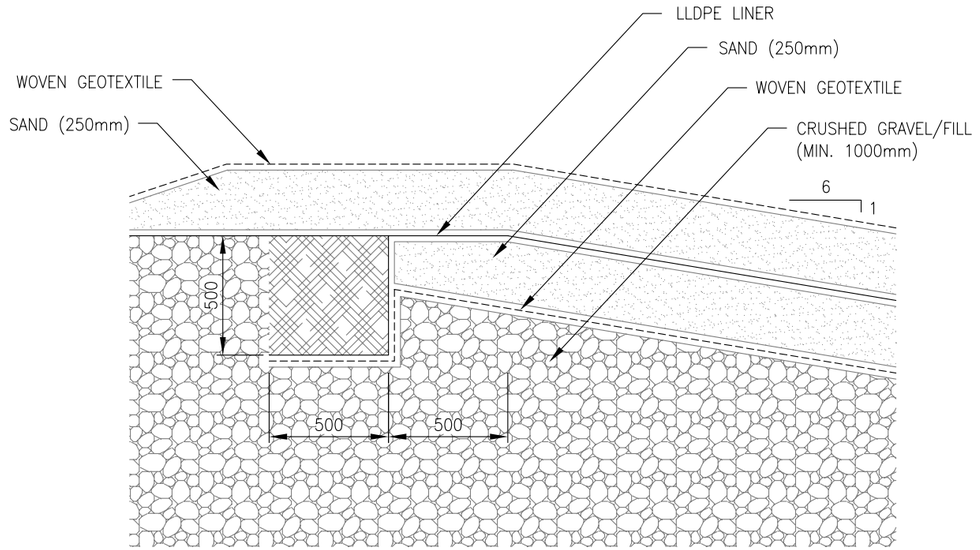
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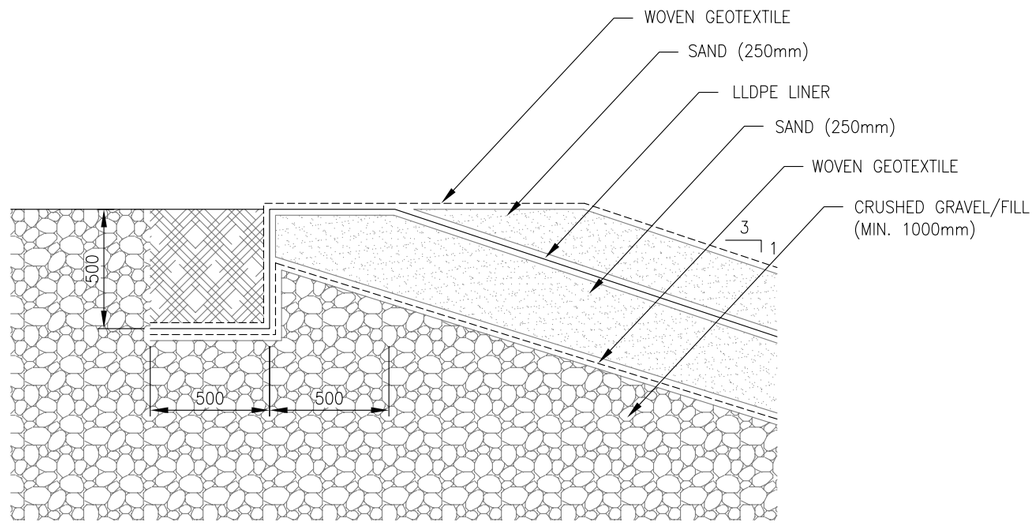
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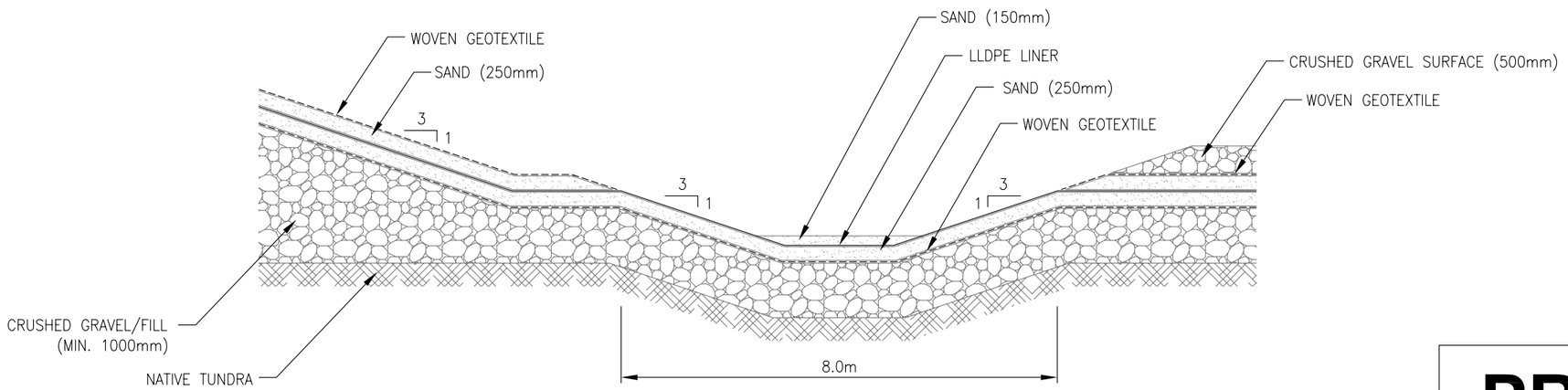
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Q 21/23 ANCHOR TRENCH DETAIL
1:25



R 21/23 ANCHOR TRENCH DETAIL
1:25



S 20/22 SUMP DETAIL
1:100

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			Designed by/Concept par **F.F.**	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Sheet/Feuille **24** **OF 27**	Revision/ Revision
			Drawn by/Dessine par **L.P./D.R.H.**	Date/Date **2010-12-09**		

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Appendix 4 Geotechnical Investigation Report

WorleyParsons
resources & energy

EcoNomics

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Eureka Civil Consulting Services

Geotechnical Report

C71130000 – Document No: C71130000-CI-REP-0001

10 January 2011

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PROJECT C71130000 - EUREKA CIVIL CONSULTING SERVICES

FILE LOC.: CALGARY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	L. Martin	B. Smith	J. Quiroga	04-Oct-10		
B	Issued for client review	L. Martin	B. Smith	J. Quiroga	21-Oct-10		
0	Issued as final	L. Martin	B. Smith	J. Quiroga	10-Jan-11		

EcoNomics™

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Any questions concerning the information or its interpretation should be directed to Lee Martin or Bruce Smith.

EXECUTIVE SUMMARY

This report presents a geotechnical evaluation conducted in support of the Civil Consulting Study for Eureka, Nunavut, Canada. This evaluation includes an assessment of the existing runway, the proposed new fuel drum storage area, the proposed new sewage lagoon sites and existing water reservoir as well as a granular material borrow source investigation. This report is based on the results of a terrain and topographic mapping study, from an air photo review and field programs involving site reconnaissance and a test pit program.

The existing runway at Eureka consists of a thin layer (approx 150 mm) of granular material directly overlying native silty clay till. The entire site is underlain by permafrost which presumably extends to great depth. The seasonal thaw at the time of the site visit ranged from 1.0 to 1.4 metres below existing grade; in winter the entire soil profile will be frozen. The runway is poorly drained in some areas and placement of additional gravel fill is proposed to promote adequate drainage and improve the structural strength.

A new fuel drum storage area is proposed to the north of the Canadian Forces bulk fuel storage site at the airfield. This site was deemed unsuitable by the WorleyParsons field team due to its proximity to the Rose Rock Creek slope and an alternative location has been suggested. Soil conditions in the area consist of relatively undisturbed tundra (silty clay till) with permafrost located approximately 0.5 m below grade. The fuel drum storage area should be constructed on a thick gravel pad placed directly on the tundra. The pad should be placed in summer at the time of maximum thaw depth, to replicate worst-case conditions, and constructed to sufficient thickness to adequately support a loader even when the underlying till is in a partially thawed state.

Two new sewage lagoon locations have been proposed by others. Soil conditions in these locations consists of various depths of granular fill overlying silty clay colluvium with permafrost at a depth of approximately 1.0 m below grade. Based on the site topography, the southern location (Option 1) is deemed more suitable for construction of the lagoon.

The existing water reservoir is understood to be undersized for the potential station population. As well, during the site reconnaissance, signs of instability were noted in the existing reservoir berms. Several options were examined for upgrading or expanding the existing reservoir and for construction of a new reservoir. Any new reservoir should have a geosynthetic liner with an underdrain system to prevent uncontrolled seepage during the thaw season and influxes of contaminated and/or brackish groundwater. Any new reservoir should also have appropriately graded side slopes; slopes of 3H:1V for berms formed out of good quality granular fill and slopes of 4H:1V for berms formed out of the native fine grained soils.

Sources of suitable sand and gravel to serve as feedstock for a screening and crushing operation to procure good quality granular material were identified along the Station Creek, Blacktop Creek and Remus Creek watercourses. Of the three, Blacktop Creek was identified as the most practical location for a screening and crushing plant.

It should be noted that this report presents the results only of a site reconnaissance and shallow test pitting investigation conducted using the available equipment on site. Prior to the detailed design of the sewage lagoon or water reservoir, a detailed geotechnical investigation should be conducted using suitable drilling equipment.

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Drawings

DRAWING 1 – 2 NOT INCLUDED IN THIS REPORT (INCLUDED IN THE R.015466.001 REPORT)

DRAWING 3 – 17 NOT INCLUDED IN THIS REPORT (INCLUDED IN WATER SUPPLY AND DISTRIBUTION STUDY)

DRAWING 18 RUNWAY, APRON AND TAXIWAY

DRAWING 19–24 NOT INCLUDED IN THIS REPORT (INCLUDED IN FUEL DRUM STORAGE STUDY)

DRAWING 25 SITE PLAN

DRAWING 26 OPTION 1-5 SITE PLAN

DRAWING 27 NOT INCLUDED IN THIS REPORT (INCLUDED IN WATER SUPPLY AND DISTRIBUTION STUDY)

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1. INTRODUCTION

1.1 General

WorleyParsons was retained by Public Works and Government Services Canada (PWGSC) to carry out a conceptual engineering study to assess potential upgrades to the water reservoir, sewage lagoon, airstrip and fuel storage facilities at Eureka, Nunavut.

The study included a preliminary geotechnical investigation to support the overall infrastructure study; this investigation comprised a site reconnaissance, a subsurface investigation at the existing airstrip and at the proposed sewage lagoon sites and a search for sources of granular construction materials.

1.2 Scope of Work

The proposed scope of work was outlined in WorleyParsons' Proposal No. CPR 10-039, dated July 21, 2010, and generally included:

a) a review of the available geotechnical and geological information for the Eureka area;

b) a geotechnical investigation, including site reconnaissance, test pitting and sampling of potential granular material borrow sources;

c) laboratory testing of selected soil samples recovered from the site; and

d) preparation of a geotechnical report, which summarizes the results of the study and provides suitable comments and recommendations.

1.3 Background Information

Eureka, Nunavut is a small outpost located on Slidre Fjord, midway up Ellesmere Island in the Canadian High Arctic (Figure 4.1). The site has been continuously occupied since 1946 and is the second most northerly permanently inhabited site on the globe. Mainly in use as part of Environment Canada's High Arctic Weather Station (HAWS) network, the site also currently supports ongoing atmospheric research as well as Canadian Forces activities. The primary facilities at the site include the main weather station complex, a water reservoir, sewage lagoon and an airstrip.

2. SITE DESCRIPTION

Eureka is located on the north shoreline of Slidre Fjord on the western coast of Ellesmere Island in the Qikiqtaalkuk Region of Nunavut. The area is in the high arctic and has an extreme climate with long, very cold winters and short cool summers. The average annual air temperature is -19.7 °C and the average annual precipitation is 75.5 mm (Environment Canada 2010). This temperature regime forms continuous permafrost across the region, with a thin active layer.

The station and airstrip are located in a low-lying plain between higher ridges to the west (Skull Point) and east (Black Top Ridge), and is roughly bound to the west by Station Creek, flowing north-south immediately east of the station and to the north by Rose Rock Creek, a west flowing tributary of Station Creek (Figure 4.2).

Photos 1 through 15, attached, were taken during the site reconnaissance and illustrate the prevalent conditions in and around Eureka.

2.1 Geological Setting

A surficial geological terrain mapping study was conducted by WorleyParsons using available satellite and air photo imagery for the station, as well as published geologic and surficial geologic maps of the region. The results of this mapping study are shown on Figures 4.3, 4.4, 4.5 and 4.6.

The study area was subject to recent glaciation, and the terrain is dominated by glacial, periglacial and mass wasting features. The terrain in the vicinity of the station consists of a glacial plain, incised by creek valleys. The predominant soil conditions in the area consist of silty clay glacial till overlying sedimentary bedrock. Creek channels, which are typically cut down into the glacial sediments and bedrock, comprise fluvial silts, sands and gravels and form deltas where they flow into the fjord. Exposed slopes immediately adjacent to the creek valleys and the shoreline typically consist of colluvial soil deposits left by mass wasting, thermokarst and soilfluction processes.

2.2 Permafrost

The site is located in the continuous permafrost region with 10-20% ground ice content (Natural Resources Canada 1995). Other than taliks that might be encountered underlying lakes and streams, permafrost is present throughout the entire region.

Three deep boreholes were drilled in or around the Eureka Area as part of a Canada wide permafrost survey (Taylor et al. 1982). These three (3) boreholes found that the base of the permafrost ranged from 300 to 500 meters below the ground surface (mbgs). Occasional thick ice layers (massive ice) were encountered in the boreholes; these may be relict ice bodies from glaciation.

3. GEOTECHNICAL SITE INVESTIGATION

3.1 Field Investigation

The geotechnical field investigation was conducted from August 15-17, 2010, consisting of 16 Test Pits (TP) that were excavated using a backhoe-loader. All test pits were excavated to practical bucket refusal on permafrost.

All test pit locations were selected in the field by WorleyParsons field personnel in locations which would not impede ongoing station work or airfield access. Following excavation, all test pit locations were established by high precision RTK GPS during the ongoing survey work.

Test Pits were excavated using a small rubber-tired Ford backhoe (Photo 1) and were supervised by WorleyParsons geotechnical field engineering staff, who logged in detail the soil and groundwater conditions encountered. Samples were obtained directly from the walls of the test pits or from the spoil pile. Detailed test pit logs are presented in Appendix 1.

In addition to the test pit program, five (5) bulk samples were recovered from several potential borrow sources using either the Ford backhoe (for vehicle accessible areas) or by hand.

3.2 Laboratory Testing

All soil samples recovered from test pits and borrow sources during the investigation were returned to the WorleyParsons Calgary office for review. Subsequently, samples were delivered for testing to EBA Engineering Ltd. laboratory in Calgary, AB.

The laboratory test program comprised the determination of:

- Natural Moisture Contents;
- Atterberg Limits;
- Grain Size Distributions;
- Standard Proctor Density;
- California Bearing Ratio;
- % Flat and Elongated Particles;
- Aggregate Soundness; and
- Petrographic Analysis.

The laboratory test results are discussed throughout the text of this report and can be found in Appendix 2.

3.3 Overall Subsurface Soil Conditions

Detailed descriptions of the subsurface conditions encountered in each test pit are presented on the Test Pit logs contained in Appendix 1. The soil descriptions provided in this report are based on accepted standard methods of classification and identification routinely used in current geotechnical state-of-practice. The stratigraphic boundaries shown on the test pit logs are inferred from non-continuous sampling and observations of excavation progress. These boundaries represent transitions between soil types rather than exact planes of geological change. Subsurface conditions may vary both with depth and laterally between individual borehole locations.

Based on the conditions encountered during the investigation, the subsurface soil stratigraphy at the site generally consists of granular fill materials overlying native silty clay till or colluvium. The till was encountered on the upland plateau by the airfield, while the native soils in and around the station appear to consist of colluvium.

Ground ice was encountered in all testpits and the thickness of surface thaw observed ranged from 0.6 mbgs to 1.9 mbgs, with an average depth of approximately 1.2 mbgs.

4. DISCUSSION AND RECOMMENDATIONS

4.1 Potential Granular Material Borrow Sources

It is our understanding that PWGSC would like to secure approximately 80,000 m^3 of good quality granular material, both for use in upgrading the runway, as well as for ongoing maintenance around Eureka.

The potential borrow sources investigated and discussed in this study were identified at the time of the site investigation by WorleyParsons' staff and in conversations with station personnel. They are considered representative of the potential sources that could be utilized for ongoing maintenance and construction purposes at the site. More detailed field investigations of the selected borrow sources should be undertaken prior to beginning quarry operations to ensure that the properties of the materials are suitable for specific project applications.

4.1.1 Existing Sandstone Pit

Currently, the station operates a gravel pit on an exposed sandstone outcrop located to the northwest of the main station (Figure 4.2). The rock in this area is a weakly cemented sandstone containing fossilized shells, light pinkish brown in colour. The sandstone is poorly cemented, friable and very weak (Photo 8).

The broken sandstone material is pushed up into low stockpiles using a bulldozer and then loaded into a tandem dump truck for use in and around the station; the bulldozer fragments the very weak sandstone into a useable size. The sandstone is removed by excavating in thin layers as the thaw front advances in July and August.

A bulk sample (Bulk 3) was retrieved from a low stockpile present in the quarry. As well, several large stockpiles of the broken sandstone were present at the barge landing site at the time of the investigation, and another bulk sample was also taken from these stockpiles (Bulk 2). Table A presents the laboratory determined properties:

Table A Broken Sandstone – Laboratory Properties

Sample	Gradation
Bulk 2 (Barge Landing)	2% Clay 4% Silt 33% Sand 61% Gravel
Bulk 3 (Existing Pit)	1% Clay 10% Silt 33% Sand 56% Gravel

Given that this material source is composed entirely of weak sandstone, this sandstone is not recommended for use as granular aggregate. Weathering of this material will result in ongoing and rapid breakdown of the larger particles to a fine sand.

4.1.2 Station Creek

Station Creek flows into Slidre Fjord to the west of the weather station. Surficial geologic features associated with Station Creek include the fluvial channel, a fluvial terrace and a delta at the mouth of the creek (Figure 4.3). Soil conditions in all of these terrain units consist of interbedded layers of silts, sands and fine gravel. Samples of these materials were not taken during the site reconnaissance.

It is apparent that these resources have been utilized for a gravel source in the past (Photo 9). A road is discernable, running up the creek channel to the fluvial terrace (s, g, F_t) identified on Figure 4.4, and several stockpiles are still present on the terrace (Photo 10). The material present in these stockpiles appears to be a silty sand and gravel, very similar to the material found in Blacktop and Remus Creeks, discussed below.

If deemed appropriate and necessary, either the Station Creek delta (s, g, F_d) or the terrace area (s, g, F_t) would likely be a favourable spot to develop a gravel pit. However, the supply of unprocessed material may be limited in the Station Creek delta. As well, based on visual observations of the stockpiles present in this area, the proportion of oversized cobbles and boulders, which are considered most suitable for crushing, is less than 5%.

4.1.3 Blacktop Creek

The mouth of Blacktop Creek is located approximately three km to the southeast of the airstrip (Figure 4.2). The surficial geologic features of Blacktop Creek include the fluvial channel, a fluvial plain (s, g, F_p) and a fluvial delta (c, g, F_d) (Figure 4.3). The soil conditions in these terrain units consist of interbedded layers of silts, sands and gravels.

The fluvial delta (c, g, F_d) associated with Blacktop Creek has been used as a gravel source in the past, and numerous shallow pits and low stockpiles were visible. A good quality, maintained road runs from the end of the runway down to Blacktop Creek. Based on conversations with the station staff, it is our understanding that the Canadian military has developed this gravel source. At the time of the investigation, there was a large stockpile of gravelly sand stockpiled on site (Photo 11). This stockpile was sampled using the backhoe (Bulk Sample 4); Table B presents the laboratory determined properties.

Table B Blacktop Creek Pit Run – Laboratory Properties

Gradation	Petrographic Number	Flat and Elongated Particles	Aggregate Soundness (ASTM C88)
1% Clay	80.7% Good	26.7 %	1.3% loss
5% Silt	11.7% Fair	(Poor)	(Good)
61% Sand	4.8% Poor		
33% Gravel	2.8% Deleterious		
	Overall Ranking = 172 (Poor)		

The pit run material in Blacktop Creek is not suitable for some applications, due to the high sand and fines content. However, by processing the material through a screening and crushing plant, good quality crushed aggregate could be produced. If required, Blacktop Creek can serve as a suitable source of water for washing operations. Based on visual observations taken of the existing stockpiles, as well as creek bank exposures, the pit run material appears to contain less than 5% cobbles and boulders.

The fluvial delta and plain at Blacktop Creek is approximately 1,000 m long by 500 m wide, and judging by the visible exposures (Photo 12), the granular materials are likely several metres thick. Based on these figures it has been estimated that at least 1 million cubic metres (m^3) of pit run material is present. Therefore, even considering losses during processing, several hundred thousand cubic metres of processed gravel may be available from this source.

4.1.4 Remus Creek

Remus Creek is located approximately 15 km east from the main station, on the coast of Slidre Fjord. The site is accessed by an existing trail, which continues on from Blacktop Creek, although there are no culverts or bridges along the route. At the time of the site investigation, Remus Creek was easily accessed along the road by an all-terrain vehicle. As with Station Creek and Blacktop Creek, the surficial terrain units of Remus Creek include a fluvial channel, a large fluvial delta and fluvial plain and several fluvial terraces. The soils associated with these terrain units consist of interbedded silts, sands and gravels.

A gravel sample was retrieved from an exposed face of a fluvial terrace (Photo 13) in Remus Creek by hand test pitting (Bulk 6); Table C presents the representative laboratory determined properties.

Table C Remus Creek Pit Run – Laboratory Properties

Gradation	Petrographic Number	Flat and Elongated Particles	Aggregate Soundness (ASTM C88)
0% Clay	71.6% Good	14.9%	1.4% loss
3% Silt	13.1% Fair	(Acceptable)	(Good)
38% Sand	12.1% Poor		
59% Gravel	3.2% Deleterious		
	Overall Ranking = 215 (Unsuitable)		

As with Blacktop Creek, the pit run material in the vicinity of Remus Creek would need to be processed for some applications. However, the Remus Creek delta is very large, on the order of 5 km^2. Therefore, assuming the depth of material is similar to Blacktop and Station Creeks, there is likely on the order of 10 million cubic metres of pit run material. Based on visual observations of bank exposures in Remus Creek, it is estimated that the pit run material from this area contains between 5 and 10% cobbles and boulders. This would provide a better feedstock of material for crushing operations, than Blacktop Creek.

4.1.5 Rock Outcrops

Multiple rock outcrops are visible along the road to Skull Point, as well as heading east to Remus Creek. These outcrops consist of siltstones and sandstones. Several outcrops were examined during the site reconnaissance, including the Awingak-Savik-Borden Island Formations approximately five (5) km west of the station (Photo 14) and along an exposed fault in the Heiberg Formation approximately two (2) km east of Blacktop Creek (Photo 15).

At both sites, the exposed rock was a poorly cemented sandstone which was fractured and friable. It is possible that these materials may be more suitable as a source of quarry rock than the sandstone outcrop currently being mined approximately two km west of the station. However, to properly characterize these formations it would be necessary to conduct geological mapping and obtain and test representative samples. Drilling would be a desirable supplement to confirm conditions at depth and to provide cores for test samples.

4.2 Airfield

4.2.1 General Information

The existing runway is located at the top of a plateau northeast of the main station (Figures 4.2 and 4.5). The plateau is relatively flat and is reasonably well drained, being bound on the east and west by dry gullies, to the north by the Rose Rock Creek valley, a tributary of Station Creek, and to the south by the

slope down to the Fjord. Based on the conditions encountered in the test pits, it appears likely that the runway was constructed by filling in any localized low spots and grading the native colluvial silty clay to a level surface. A thin lift (50 to 200 mm) of imported granular material was then placed over the graded subgrade.

It is our understanding that the airport is currently serviced mainly by small to medium sized turboprop airplanes, such as the Twin Otter or Dornier 228. Heavier aircraft, such as the C-130 Hercules or Boeing 737-200, also make occasional use of the facility. Use of the facility by these heavier aircraft (heavier than 65,000 lbs) is typically not permitted during the thaw season (July and August) when the near surface soils are unfrozen (NavCanada 2010).

The runway and fueling apron appear reasonably well drained, although several localized poorly drained areas were visible during the site reconnaissance (Photo 2). While the area to the south of the runway is well drained, several low lying areas and tundra ponds are evident along the north side (Photo 3).

We understand that aircraft operations are negatively affected during the thaw season, particularly following rainy weather, due to the presence of the soft, wet areas. Therefore, PWGSC is currently proposing placing additional granular material over the existing runway surface to improve surface drainage.

4.2.2 Soil Conditions

Test Pits TP10-01 through TP10-06 were excavated along the south side of the existing runway (Drawing 18). These test pits revealed 50 to 200 mm of granular material directly overlying the native silty clay till, although TP10-02 encountered 0.7 m of clayey fill and granular fill overlying the native silty clay till. It is possible that this represents a low area that was filled in during runway construction.

The granular material encountered in the test pits generally consisted of a fine clayey gravel and sand. The source of the majority of the material appears to be the sandstone outcrop quarry located approximately 2 km northwest of the station. It is our understanding that the runway surface is currently being re-surfaced with this material. However, it is likely that the runway was originally constructed out of gravelly sand from the Black Top Creek delta, as similar granular material was encountered in TP10-02.

Silty clay till was encountered underlying the granular surfacing material or fill in all test pits. The till was generally firm to stiff, damp to moist and dark grey in colour with traces of sand and gravel. Ground ice was encountered in the underlying silty clay till in all of the test pits along the runway, with the depth of seasonal thaw ranging from 1.0 to 1.4 m below existing grade.

A seventh test pit was excavated by hand in the apron area to confirm the gravel apron structure (TP10-16). Similar soil conditions to those of the runway area were encountered in the apron area, with approximately 200 mm of granular material overlying the native silty clay till.

4.2.3 Resurfacing Recommendations

The runway should be resurfaced in two layers; a free draining granular base course layer and a granular wearing course, in accordance with the material properties recommended in the Canadian Standards and Recommended Practices for Airport Engineering ASG-06 (PWGSC 1996), as summarized in Table D. The wearing surface should be at least 150 mm thick, while the thickness of the base course will be dictated by the grading requirements.

Table D Granular Material Requirements

Property	Free-Draining Base Course	Wearing Surface
Gradation (% Passing)		
75 mm	100	
25 mm		100
19 mm		75 – 100
9.5 mm		50 – 75
4.75 mm		30 – 50
0.425 mm	0 – 30	10 – 30
0.075 mm	0 – 8	5 – 10
Plasticity Index (max.)	6	6
Required Density	98% Standard Proctor Maximum Dry Density	100% Standard Proctor Maximum Dry Density

If a sufficient thickness of base course gravel were placed over the existing runway the resulting increase in bearing capacity could allow for all-weather operations by C-130 aircraft. WorleyParsons would be pleased to determine the required thickness of base course required to meet this objective, if requested.

4.3 Fuel Drum Storage Area

4.3.1 General Information

A new fuel drum storage area is currently proposed for the north apron area at the airport (Figure 4.5 and Drawing 18). Sized to contain 2,000 drums, it is understood that the storage area will incorporate containment berms, a geosynthetic liner and a sump. The storage area should comply with Canadian Environmental Protection Act guidelines and should consider the severe weather at the site, as well as the methodology for using fuel drums on site.

Currently, pallets of fuel drums are stored in several locations around the airfield and at the main station. A front-end loader equipped with forks is used to pick up the pallets and move them around as needed. Typically, aircraft are refuelled using electric pumps directly from the drums. Following use, the drums are stockpiled at the drum crushing station where they are crushed and buried.

It should be noted that in observations of refuelling practices at the site, the chances of hydrocarbon contamination at the site appear greatest while planes are being refuelled from drums on the apron and at the drum burial site.

4.3.2 Soil Conditions

Test Pit TP10-07 was excavated in the centre of the proposed fuel drum storage area (Drawing 18). The area is relatively undisturbed tundra, comprised of very soft, moist, dark brownish grey silty clay till with some organics and rootlets at the surface and containing trace gravel, cobbles and boulders. Permafrost was encountered in the test pit at a depth of 0.6 m below grade.

4.3.3 Construction Recommendations

Although the ground conditions in the proposed storage area are suitable for construction of the drum storage area, the site is adjacent to the slope down to Rose Rock Creek. This slope appears to be unstable and undergoing mass soil wasting or soilfluction, with shallow soil slumps noticeable at the time of the site reconnaissance. It is probable that any ongoing climate warming may further destabilize this slope. We therefore recommend that the drum storage area be moved to the area east of the bulk fuel storage, on the east end of the north apron (Figure 4.5)

The storage area should be constructed on top of a pad of granular fill. The pad should be placed near the end of the thaw season when the annual depth of thaw is at a maximum. The gravel should be end dumped onto the undisturbed tundra off the edge of the existing apron. Heavy equipment should not operate directly on the tundra surface.

By placing the gravel pad at the end of the summer, the underlying soil conditions will be representative of the softest subgrade conditions expected annually. While a fill depth of about 1.0m should be adequate, the actual thickness of the pad will be dictated by field observations. Once the initial 1.0m lift has been placed and compacted, it should be proof-rolled using a loaded dump truck or other heavy equipment. If any signs of instability are noted, the thickness of gravel should be increased and the proof-rolling repeated. This process should continue until no signs of instability are noted in the gravel pad.

Ideally, the gravel should be placed and compacted in lifts no more than 300 mm thick. However, we recommend that the first lift of gravel be at least 500 mm thick to limit disturbance to the underlying soil. Care should be taken during compaction operations to avoid punching or rutting failures in the gravel surface.

Ideally, the compacted gravel pad should be left in place over a full winter season to stabilize. The following summer season, the pad can be re-graded as needed and the liner and liner cover material installed.

4.4 Sewage Lagoon

4.4.1 General Information

A single-cell sewage lagoon is currently located immediately adjacent to the fjord on the east side of the main station (Figure 4.6). Sewage is collected in storage tanks inside the weather station building and, once these tanks are filled, released to the sewage lagoon. Sewage collected in the lagoon over the winter freezes and then thaws during the first few weeks of the thaw season. In late August, the sewage is pumped into the Fjord in preparation for the following winter.

The existing lagoon is not considered adequate for the site. A study completed by Golder Associates (Golder 2009) investigated potential treatment options. One of the options was the construction of a new, two-cell lagoon and two potential sites were identified, located to the north and south of the main road between the station and the airstrip (Figure 4.6).

Eight (8) test pits were excavated along the proposed force main alignments and sewage lagoon locations east of the station (Drawing 25). Test Pits TP10-08 through TP10-11 were excavated in the southern alignment and lagoon location (Option 1), while TP10-12 through TP10-15 were excavated in the northern alignment and lagoon location (Option 2).

4.4.2 Option 1 Location – South of Main Road

Soil conditions in these test pits consisted of sand and gravel fill overlying native silty clay colluvium. The fill ranged in depth from 1.0 to 1.2 m below existing grade, and consisted of sand and gravel pitrun material. Underlying the sand and gravel fill, silty clay colluvium was encountered in all of the test pits. This colluvium was typically stiff, damp to moist and of low plasticity. Permafrost was encountered in all of the test pits at depths ranging from 1.0 to 1.2 m below existing grade. In several cases, the bottom of the active layer appeared to coincide with the top of the colluvium.

In TP10-10, excavated in the shoulder of the main station road to the airstrip, close to the main station building along the proposed force main alignment, solid ice was encountered at the base of the sand and gravel fill zone. The drainage in this area is poor and based on conversations with the station staff, ponding water is often encountered. It is likely that surface water infiltrating through the permeable sandy gravel is trapped on the surface of the relatively impermeable silty clay colluvium beneath and has frozen into a massive ice deposit.

From a geotechnical point of view, the new sewage lagoon could be constructed at this location. It may be possible to construct the lagoon by excavating below the existing ground surface and using the excavated material to construct the berms. The excavation could be undertaken (in the Spring) by blasting and then using the blasted material to form the reservoir berms. The berms and slopes of the reservoir would be graded as the material thaws during the subsequent thaw season. For conceptual design, it should be assumed that side slopes of 4H:1V will be required. If the subsurface materials are relatively impervious, it may not be necessary to line the reservoir with a membrane liner.

The feasibility of the foregoing method of construction will depend on the water (ice) content and the proportion of silt and clay in the material that underlies the site. If the ice content is high, then the material would be very soft and unstable when it thaws. Therefore, in order to assess the feasibility of this method of construction, it would be necessary to reappraise the soil conditions using a drill to advance a number of test holes.

Alternatively, the lagoon berms could be constructed with imported pit run gravel, placed over the existing ground surface. If the berms of the lagoon are constructed of gravel fill, then it will probably be necessary to install a membrane liner and subdrainage system, to prevent uncontrolled seepage losses during the thaw season.

It should be noted that the main power line from Eureka up to the airstrip currently runs through the proposed Option 1 footprint. The power line currently lies on the ground surface (Photo 4) and insufficient slack may exist in the line to reroute it around the lagoon envelope. It may therefore be necessary to disconnect the power line and splice in a new length of cable.

4.4.3 Option 2 Location – North of Main Road

Soil conditions in this area generally consisted of native clayey or sandy silt colluvium directly from the surface, although Test Pit TP10-12, excavated immediately to the east of the main weather station building encountered approximately 0.9 m of sandy gravel fill overlying the native colluvium. The native colluvium was generally firm to stiff, damp to moist and low plastic. Permafrost was typically encountered at a depth of approximately 1.0 m below grade in all of these test pits.

Development at this location is considered feasible from a geotechnical point of view. As at Site 1, it may be possible to construct the lagoon by excavating below the existing ground surface by blasting (in the Spring) and using the blasted material to construct the berms. The feasibility of using this method of construction on Lagoon Site 2 also depends on the properties of the underlying soils and therefore it would be necessary to explore the subsurface soils via test holes drilled to depths of three (3) to five (5) m.

The lagoon berms could be constructed with imported gravel, placed over the existing ground surface. In this case, it will probably be necessary to install a membrane liner and subdrainage system, to prevent uncontrolled losses from the lagoon during the thaw season.

One of the significant disadvantages of the Option 2 location is that it cuts off a natural drainage gully at the east end of the proposed site. This could cause significant ponding on the north (upslope) side of the reservoir. One option would be to shift the lagoon further west, so that will not affect the drainage. Alternatively, the drainage gully could be routed around the water reservoir; however, this could involve significant excavation and measures would be required to prevent silt from being carried into the fjord.

4.5 Water Reservoir

4.5.1 General Information

The water reservoir for the station is currently located in the Station Creek valley, immediately adjacent to Station Creek at an elevation approximately eight (8) m below the main station buildings, which are located on the colluvial slope above the Fjord (Figure 4.6 and Drawing 25). Water is pumped into the reservoir directly from the Creek using a small electric sump pump; periodically, water is then pumped from the reservoir into heated storage and treatment tanks for distribution within the station.

The reservoir appears to have been constructed by pushing up the fluvial silts, sands and gravels in the creek channel to form the berms. A fill channel was constructed on the north side of the reservoir (Figure 4.6), so that during the thaw season, water would flow by gravity from the creek into the water reservoir, through two culverts located on the north side of the reservoir. Several years ago, this practice was discontinued due to environmental concerns, and the entrance from the Creek into the fill channel was blocked off. However, the inlet culverts have not been blocked, so that there is still a hydraulic connection between the reservoir and the fill channel.

Seepage through the berms of the lagoon and the fill channel was noted at the time of the site reconnaissance (Photo 7). This is not unexpected, given that the berms are formed out of alluvial silts and sands. Signs of slumping and instability were also noticable in the reservoir berms at the time of the inspection and the lack of freeboard on the reservoir was also apparent (Photo 5). The berms at the north end of the fill channel are being actively eroded by the Creek (Photo 6).

It is our understanding that the water reservoir is currently undersized and an expansion is proposed (WorleyParsons 2010). Several options are being considered:

a) refurbishing the existing reservoir (Option 1);

b) raising the existing reservoir berms or deepening the existing reservoir (Option 2);

c) constructing a new reservoir north of the existing one (Option 3);

d) constructing a new, appropriately sized reservoir in a different location (Options 4 & 5); and

e) constructing above grade storage tanks (Option 6).

The design and construction issues for each option are discussed in more detail below.

4.5.2 Design Features

One constraint on reservoir design at Eureka is the amount of ice that forms on the reservoir every year. Ice formation on a body of water is a function of the winter temperatures, snow cover and water flow beneath the ice cover. Examining the Eureka climate record, the most severe winter in the past 30 years at the station was 1986/1987. Considering this winter season as the design-freezing index gives a value of 8,180ºC-days over a freezing season of 276 days. Using the modified Stefan Equation (USACE 2004) and

considering the reservoir as a still body of water with snow cover, we get a design ice depth of 2.2 m. Therefore, any reservoir design must consider the loss of approximately 2.2 m of capacity due to ice.

Another constraint on any potential reservoir upgrades is that the reservoir is currently the only source of drinking water for the station. Additionally, the reservoir can only be filled during the limited period in the summer when Station Creek is flowing with a relatively low sediment load. Therefore, any construction program must include adequate considerations to ensure that the station has sufficient stored water for the winter season

The current reservoir is unlined and seepage through the existing berms was noticeable during the site reconnaissance (Photo 7). We therefore recommend that any new reservoir incorporate a geosynthetic liner to eliminate or significantly reduce seepage out of the reservoir. Such a liner would also require an underdrain system.

4.5.3 Construction Recommendations

Refurbishing the Existing Reservoir (Option 1)

Consideration has been given to upgrading the existing reservoir by placing fill to flatten the outside slopes of the reservoir to 4H:1V. In addition, the fill channel on the north side of the reservoir would be filled in and the inlet culverts on the north side of the reservoir would be removed (Drawing 26).

These upgrades would not increase the under-ice storage capacity of the reservoir; however, they may reduce seepage losses through the reservoir. In addition, the upgrades would reduce the risk of a slope failure on the outside slopes of the reservoir, which would prolong the useful life of the facility by several years.

The major advantage of this option is that it could be undertaken with the construction equipment currently available at the site, possibly over one (1) or two (2) thaw seasons, so that the cost would be minimal. In addition, the reservoir upgrades could be completed with no significant interruption in reservoir operations.

Consideration could also be given to flattening the inside slopes of the reservoir as part of such an upgrade program. However, this would reduce the under-ice capacity of the reservoir and require that the reservoir be taken out of service during construction.

Another option for increasing the depth of under ice storage on the existing reservoir would be to use an insulated floating cover, perhaps in combination with a bubbler unit.

Some thought was given to reducing seepage losses through the existing berms by injecting grout into the berms. It is unlikely that such a program would significantly reduce seepage. It would be impossible to inject grout into areas of the berms that are frozen and if any such ground ice present in ungrouted areas degrades in the future, seepage would immediately begin to occur. Any seepage, through even a small gap or crack in the ground ice, would immediately start a process of thermal erosion of the remaining frozen soil.

Raising or Deepening the Existing Reservoir (Option 2)

Consideration has also been given to increasing the existing storage capacity by increasing the water depth inside the reservoir (Drawing 26). This could be accomplished by lowering the elevation of the floor of the reservoir or by increasing the height of the containment berms.

Lowering the floor of the reservoir is not recommended, as the floor is currently within 1 m of the high water mark in the Fjord. If the floor elevation is further reduced, there is a risk that unfrozen zones (taliks) will be encountered. Such taliks contain super-cooled brine, which may be hydraulically connected to the ocean and could contaminate the reservoir with sea water.

Alternatively, reservoir capacity could be increased by raising the reservoir berms by several metres. For conceptual design purposes, it should be assumed that the inside and outside slopes of the existing reservoir will need to be flattened to 4H:1V. Steeper side slopes may be possible (e.g. 3H:1V); however, this depends on the material properties of the existing berms.

A membrane liner should be installed over the inside slopes and floor of the reservoir. The liner is required to minimize seepage losses from the reservoir and to ensure that the outside slopes do not become unstable. Consideration will need to be given to protect the liner from ice action, either through a sacrificial second liner or by placing fill to serve as liner cover. A sub-drainage system will need to be installed below the membrane liner to prevent liner uplift from water pressure and air pockets that will collect below the liner.

The advantage of raising the containment berms is that it minimizes the volume of earthworks required to increase storage capacity. The primary disadvantage is that it requires that the reservoir be taken out of service during construction. The timing and schedule for the work would therefore become very critical.

The height to which the reservoir could be raised (and hence the available under-ice storage capacity) is limited by the presence of Station Creek to the west of the reservoir. If this option were selected, it may be necessary to shift the creek channel further west. In addition, it may also be necessary to move the existing bridge crossing further downstream, in order to provide an acceptable longitudinal profile for the east bridge approach.

Sheet piles could also potentially be used to increase the storage capacity of the reservoir by increasing the water height in the reservoir. However, it may be necessary to widen the crest of the existing containment berms to allow room for a piling rig to work. Potential concerns also exist due to the unknown permafrost conditions within and below the existing berms. A detailed geotechnical drilling investigation through the existing berms would be required prior to proceeding with sheet piling.

New Reservoir North of the Existing Reservoir (Option 3)

This option would involve construction of a new reservoir or new storage cell, north of the existing reservoir (Drawing 26).

The major advantage of this option is that the new reservoir could be constructed while maintaining operations in the existing reservoir. Unforeseen delays in constructing the new reservoir would therefore not affect the water supply to the weather station.

Construction at this location would use imported, manufactured granular material. For conceptual design, using these materials, the inside and outside reservoir slopes can be graded to 3H:1V. If unprocessed granular material is used, 4H:1V side slopes should be assumed.

The reservoir should be lined with a membrane liner to prevent seepage losses and to prevent instability of the outside slopes. A sub-drainage system will be required below the membrane liner to prevent uplift.

New Reservoir West of Station Creek (Option 4)

Consideration has been given to constructing a new reservoir on the west side of Station Creek (Drawing 26). The advantage of locating the reservoir in this area is that it may be possible to construct the reservoir by excavating below the existing ground surface and using the excavated material to construct the berms. As the soil in this area appears to consist largely of sands and gravels, this approach would reduce the requirement to import material from a borrow source.

The disadvantage of any site on the west side of Station Creek is that it would not be feasible to transfer water from the reservoir to the weather station using a pipeline. Due to the distance and the requirement to cross Station Creek, it would be necessary to haul water to the weather station by truck. Although this is a method which is commonly used in many northern communities, it may require additional station staff and/or equipment. If this option is selected, consideration should also be given to upgrading the existing bridge crossing at Station Creek.

The feasibility of constructing a reservoir at this location by excavating below existing grade and using the material to construct the berms, will depend primarily on the water (ice) content and the fines content of the underlying soils. If the water content were relatively low, it would then be feasible to excavate the reservoir by blasting (in the Spring) and using the blasted material to form the reservoir berms, prior to the thaw season. The sideslopes and berms could be graded and shaped as the material thaws during the thaw season. This was the method used to construct a large earthworks water reservoir in Pangnirtung (Smith et al. 1989).

However, if the excavated material has a high ice content and contains a significant proportion of silt and clay, then it will be very soft when it thaws and it will not be possible to operate construction equipment on it. Therefore, before the feasibility of this option can be evaluated, it would be necessary to drill a number of boreholes on the selected site in order to determine the gradation and water (ice) content of the underlying material.

New Reservoir NE of the Main Station Building (Option 5)

Consideration has also been given to constructing a new reservoir northwest of the weather station (Drawing 26). The advantage of this location is that it would be possible to provide a water pipeline from the reservoir to the station, avoiding truck hauling.

At this location, the water reservoir could be constructed by excavating below the existing ground surface by blasting and by using the blasted material to construct the berms. The feasibility of this method of construction will again depend on the water (ice) content and gradation of the soil that underlies the site. If this option is considered, we recommend further exploration at the site.

One disadvantage of this location is that it would require a relatively long fill line from Station Creek to the reservoir, a distance of 200 to 300 m. In addition, it might be necessary to construct an access road up Station Creek Valley to a filling point on Station Creek.

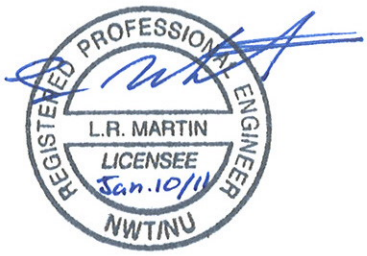
A second disadvantage of this site for the reservoir is that it would greatly inhibit further expansion of other facilities in the vicinity of the weather station buildings and would require relocation of the meteorological equipment compound.

The presence of the reservoir at this location may also cause significant snow drifting around the existing station and other buildings. If this site is preferred, we recommend that a snow drifting study be undertaken to assess this potential concern.

5. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Report Prepared by
WorleyParsons



Lee Martin, B.Sc., P.Eng.
Senior Geotechnical Engineer

Bruce Smith, M.Eng., P.Eng. (AB)
Senior Geotechnical Engineer

Senior Review by

Dr. David Devenny, Ph.D., P.Eng. (AB), P.Geol. (AB)
Technical Director

Prairie Business Unit
Infrastructure & Environment
WorleyParsons Canada Services Ltd.

6. REFERENCES

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7. IMPORTANT INFORMATION ON INTERPRETATION, USE AND LIABILITY OF THIS REPORT

This report has been prepared in accordance with a specific brief and scope of work. It should be read in its entirety.

The responsibility of WorleyParsons is solely to the Client. This report is not intended for, and should not be relied upon, by any third party. No liability is undertaken to any third party.

Ground conditions are subject to continuing natural and man-made processes. It can exhibit a variety of properties that vary from place to place, and can change with time.

Site investigation involves gathering and assimilating data by various means such as inspection, drilling, excavation, probing, sampling, and testing. The collected data is only directly relevant to the place where, and at the time when, the investigation was performed.

Environmental or biological assessment (e.g. mold, fungi, and bacteria) or identification or prevention of pollutants and hazardous materials or conditions are beyond the scope of this report. Other studies should be undertaken if the owner is concerned about the potential for such contamination or pollution.

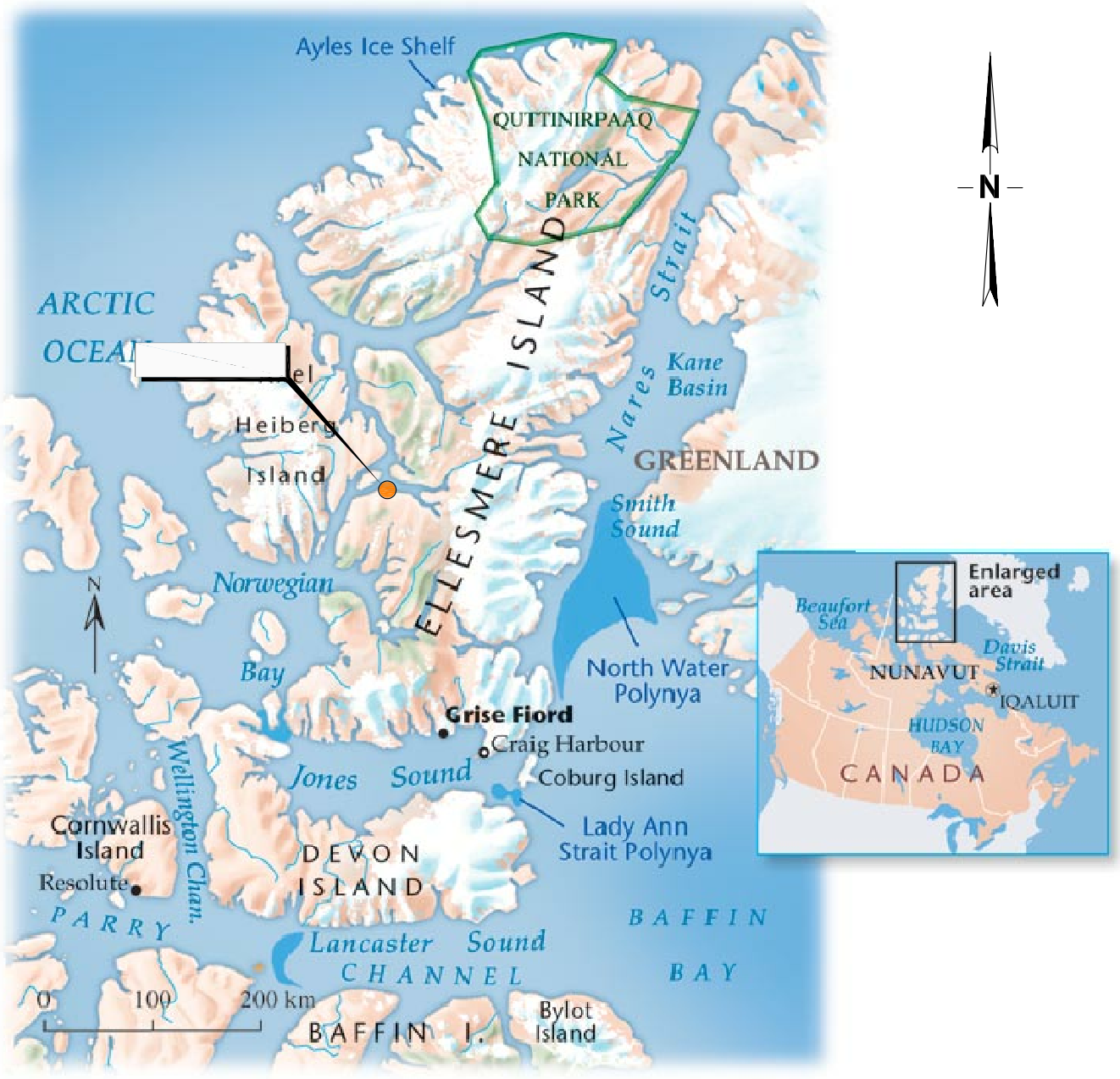
Any interpretation or recommendation given in this report shall be understood to be based on judgment and experience, not on greater knowledge of facts other than those reported.

If different ground or site conditions are encountered during construction activities or subsequent to the investigation performed for this report, either due to natural variability of subsurface conditions or previous construction activities, WorleyParsons should be notified of the differences and provided with an opportunity to review the recommendations contained in this report.

If changes in the nature, design, or location of the project as outlined in this report, are considered, the conclusions and recommendations contained in this report shall not be considered valid. WorleyParsons geotechnical services should review the changes, and either verify or modify the conclusions of this report in writing.

Figures

Public Works and Government Services Canada | Travaux publics et Services gouvernementaux Canada | Real Property Services Western Region | Services Immobiliers Région de l'ouest



SOURCE:
CANADIAN GEOGRAPHIC

DO NOT SCALE DRAWINGS

PRELIMINARY
NOT FOR CONSTRUCTION

Project title/Titre du projet

CIVIL CONSULTING SERVICES

EUREKA, NUNAVUT

Drawing title/Titre du dessin

SITE LOCATION MAP

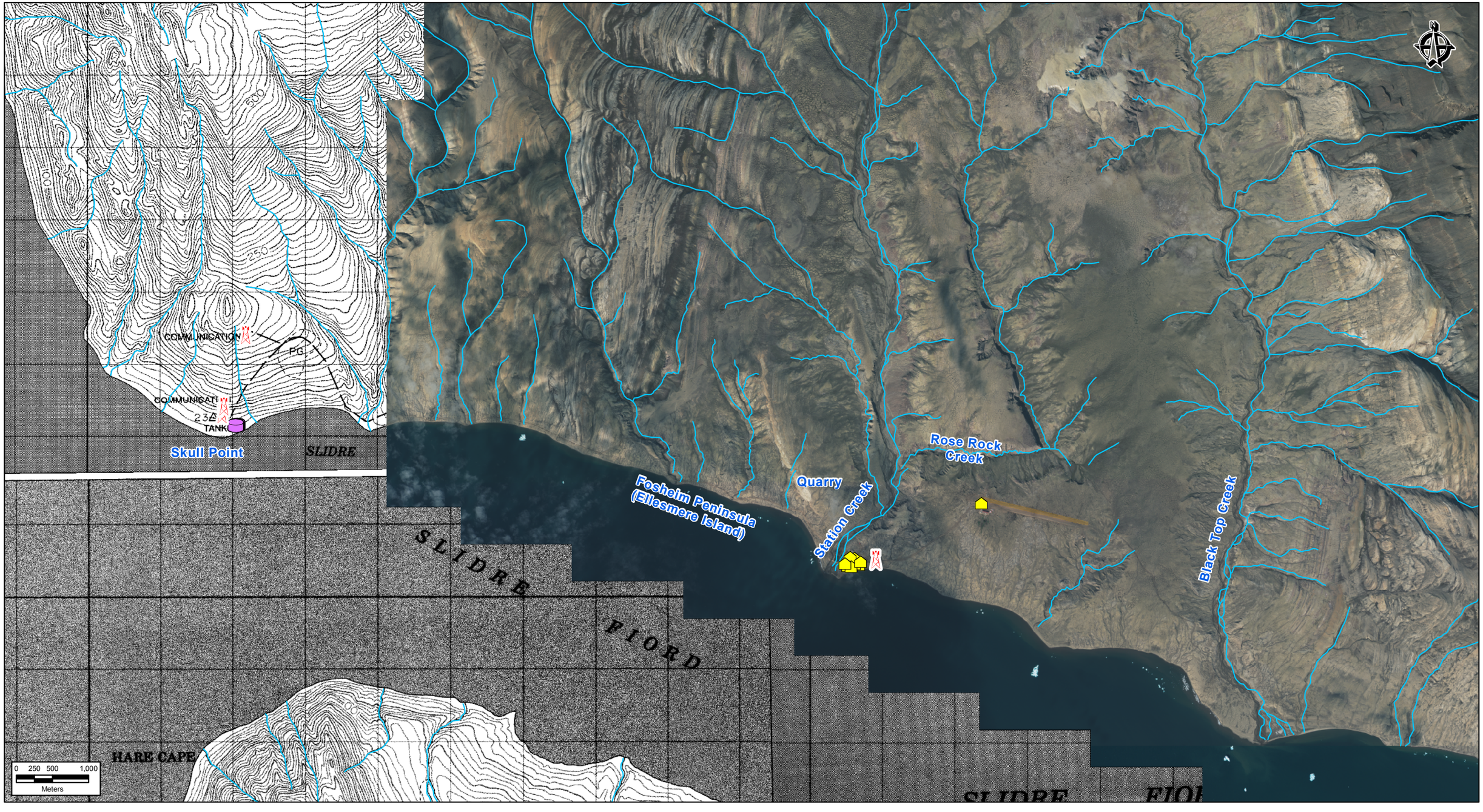
Approved by/Approuve par: J.Q.	PWGSC Project Manager/Administrateur de Projets TPSGC: J.D.	Scale/Echelle: AS SHOWN	
Designed by/Concept par: L.M.	PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC	Date/Date: 2010-12-14	
Drawn by/Dessine par: L.P.	Project No./No. du projet: R.015446.001	Sheet/Feuille: **Figure 4.1**	Revision/ Revision

PWGSC – ANSI A–P– 8.5 X 11

C71130000 sitelac

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CB-ANSIB-MAP-L VERSION: A



Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution. CanVec data courtesy of NRCan.

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This map must be printed at full scale (100%) in order for the scale to remain correct.

Legend

- Building
- Communication Tower
- Tank
- Watercourse
- Runway

DRAWN	YW
CHECK	GVM
DESIGN	YW
APPR.	GVM

Eureka Study
Site Overview Map

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
26 AUG 2010	Figure 4.2	D	WorleyParsons

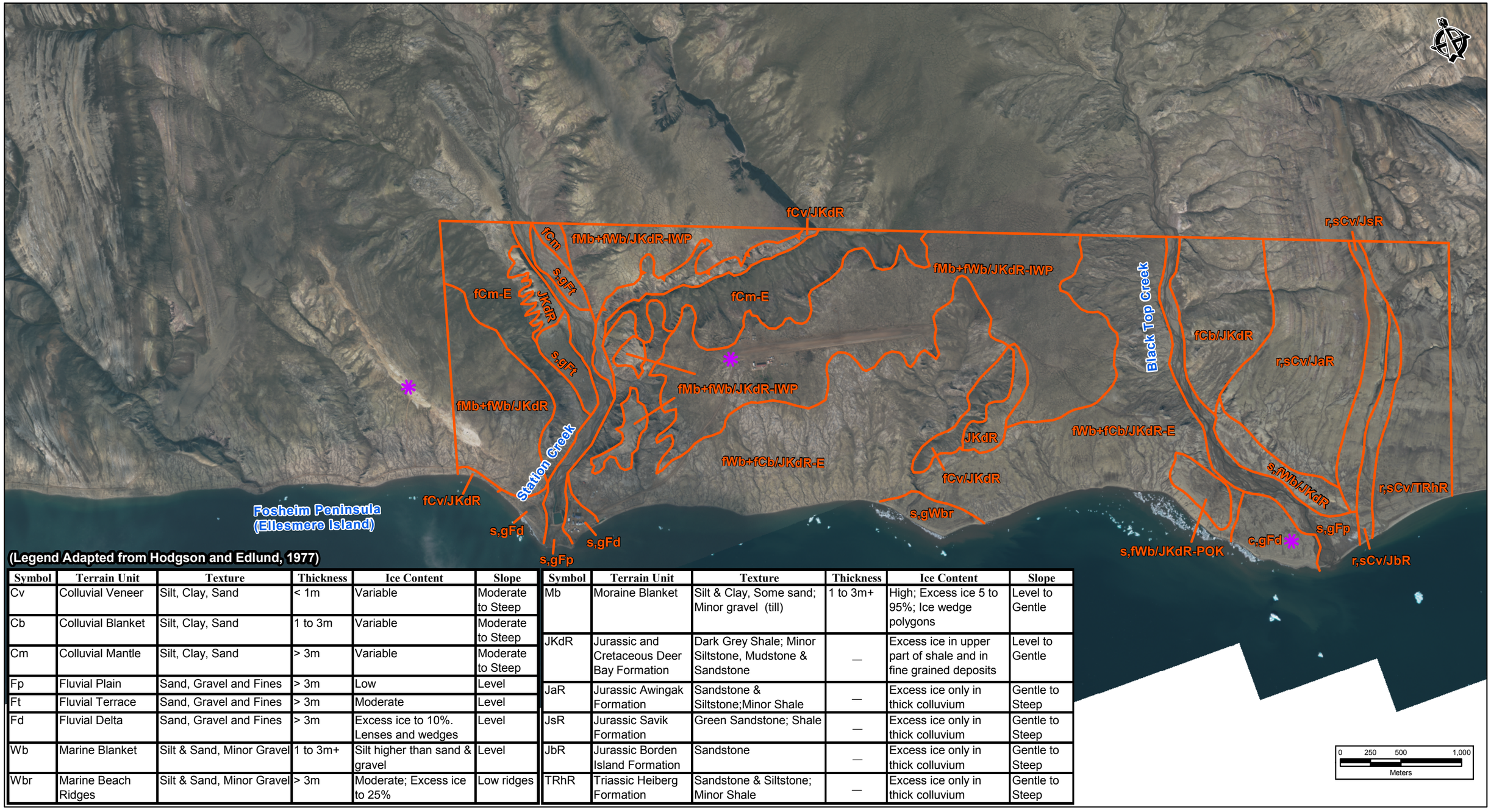
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ANSIB-MAP-L VERSION: A



(Legend Adapted from Hodgson and Edlund, 1977)

Symbol	Terrain Unit	Texture	Thickness	Ice Content	Slope
Cv	Colluvial Veneer	Silt, Clay, Sand	< 1m	Variable	Moderate to Steep
Cb	Colluvial Blanket	Silt, Clay, Sand	1 to 3m	Variable	Moderate to Steep
Cm	Colluvial Mantle	Silt, Clay, Sand	> 3m	Variable	Moderate to Steep
Fp	Fluvial Plain	Sand, Gravel and Fines	> 3m	Low	Level
Ft	Fluvial Terrace	Sand, Gravel and Fines	> 3m	Moderate	Level
Fd	Fluvial Delta	Sand, Gravel and Fines	> 3m	Excess ice to 10%. Lenses and wedges	Level
Wb	Marine Blanket	Silt & Sand, Minor Gravel	1 to 3m+	Silt higher than sand & gravel	Level
Wbr	Marine Beach Ridges	Silt & Sand, Minor Gravel	> 3m	Moderate; Excess ice to 25%	Low ridges

Symbol	Terrain Unit	Texture	Thickness	Ice Content	Slope
Mb	Moraine Blanket	Silt & Clay, Some sand; Minor gravel (till)	1 to 3m+	High; Excess ice 5 to 95%; Ice wedge polygons	Level to Gentle
JKdR	Jurassic and Cretaceous Deer Bay Formation	Dark Grey Shale; Minor Siltstone, Mudstone & Sandstone	—	Excess ice in upper part of shale and in fine grained deposits	Level to Gentle
JaR	Jurassic Awingak Formation	Sandstone & Siltstone;Minor Shale	—	Excess ice only in thick colluvium	Gentle to Steep
JsR	Jurassic Savik Formation	Green Sandstone; Shale	—	Excess ice only in thick colluvium	Gentle to Steep
JbR	Jurassic Borden Island Formation	Sandstone	—	Excess ice only in thick colluvium	Gentle to Steep
TRhR	Triassic Heiberg Formation	Sandstone & Siltstone; Minor Shale	—	Excess ice only in thick colluvium	Gentle to Steep

Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution. CanVec data courtesy of NRCan.

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Symbols:

- Bedrock Escarpment
- IWP Ice Wedge Polygons
- POK Thermokarst
- -E Erosional Channels
- BulkSampleLocation

Textures:

c = Cobbles
r = Rock Rubble
g = Gravel
s = Sand
f = Clay, Silt, Fine Sand

Example:

fMb + fWb/JKdR
Fine grained moraine and marine deposits (with ice wedge polygons) that are 1 to 3+ m thick and overlie Jurassic shale of the Deer Bay Formation.

DRAWN YW
CHECK GVM
DESIGN YW
APPR. LM

Eureka Study
Terrain Unit Mapping
Site Overview Map

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
28 SEP 2010	Figure 4.3	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
C71130000	1:30,000	UTM 16N	NAD 83	11 X 17

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resources & energy

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(Legend Adapted from Hodgson and Edlund, 1977)

Map Symbol	Terrain Unit	Material	Thick-ness	Surface Drainage following Snowmelt	Ice Contents	Slope	Comments
Cv	Colluvial Veneer – Produced by Mass Wasting	Silt, Clay, Sand	<1 m	Well Drained	Variable ice contents. Lower on upper slopes in coarser material; Higher on lower slopes in fine grained material.	Moderate to Steep	Thin weathering and slope deposits developed on bedrock; Texture related to bedrock on which it is developed.
Cb	Colluvial Blanket – Produced by Mass Wasting	Silt, Clay, Sand	1 to 3 m	Moderately Well Drained; May be eroded and channeled where fine grained	Variable ice contents. Lower on upper slopes in coarser material; Higher on lower slopes in fine grained material.	Moderate to Steep	Moderately thick slope deposits overlying bedrock. Texture related to bedrock on which it is developed. May contain reworked till and marine deposits.
Cm	Colluvial Mantle – Produced by Mass Wasting	Silt, Clay, Sand	>3m	Moderately Well Drained; May be eroded and channeled where fine grained	Variable ice contents. Ice wedges in thicker fine grained deposits on lower slopes.	Moderate to Steep	Thicker slope deposits overlying bedrock. Texture related to bedrock on which it is developed. May contain reworked till and marine deposits.
Fp	Fluvial Plain – Actively forming along streams	Sand, Gravel and Fines	>3m	Poorly Drained	Low ice contents. Some lenses may be present. Pore ice in coarse sediments.	Level	Active Floodplain -May contain significant water during high water events. A source of sand and gravel along Station and Blacktop Creeks. Active pit in Station Creek floodplain.
Ft	Fluvial Terrace – Formed along streams in modern times	Sand, Gravel and Fines	>3m	Moderately Well Drained	Moderate Ice contents. Lenses and wedges may be present on inactive surfaces.	Level	Fluvial terraces above floodplains are source of sand and gravel, but ice contents are higher than in floodplain deposits. Some old terraces occur along Station Creek.
Fd	Fluvial Delta – Formed along streams in modern times.	Sand, Gravel and Fines	>3m	Well Drained	Excess ice to 10%. Lenses and wedges may be present.	Level	Old Fluvial deltas of Station and Blacktop Creeks may be sources of sand and gravel.
Wb	Marine Blanket – Formed during higher sea level in post-glacial time.	Silt & Sand, Minor Gravel	1 to 3m+	Moderately Well Drained to Poorly drained	Silt has higher ice contents than sand & gravel.	Level	Thermokarst occurs in marine blanket deposits near Blacktop Creek.
Wbr	Marine Beach Ridges - Formed during higher sea level in post-glacial time.	Silt & Sand, Minor Gravel	>3m	Moderately Well Drained	Moderate ice contents; Excess ice to 25%.	Low ridges	Could be a source of sand.
Mb	Moraine Blanket - Formed at base of glacier during glacial times.	Silt & Clay, Some sand; Minor gravel (till);	1 to 3m+	Moderately Well to Poorly Drained	High Ice contents; Excess ice 5 to 95%; Ice wedge polygons common. Reticulate and massive ice in fine grained sediments above 150 m elevation.	Level to Gentle	Often mixed with fine grained marine deposits below the marine limit.
JKdR	Jurassic and Cretac-eous Deer Bay Formation	Dark Grey Shale; Minor Siltstone, Mudstone & Sandstone	--	Poorly Drained	Excess ice in upper part of shale and in the colluvium, moraine and marine sediments that overlie it.	Level to Gentle	May be eroded and channeled on slopes. This unit has fairly thick moraine, marine and colluvial cover that exhibit ice wedge polygons. Shale could be used for fine grained material where it has lower ice contents (at depth).
JaR	Jurassic Awingak Formation	Sandstone & Siltstone;Minor Shale	--	Well Drained	Excess ice only in locations with thick colluvium	Gentle to Steep	Covered by sandstone rubble, sand and fine grained colluvium usually <1m thick
JsR	Jurassic Savik Formation	Green Sandstone; Shale	--	Well Drained	Excess ice only in locations with thick colluvium	Gentle to Steep	Covered by sandstone rubble, sand and fine grained colluvium usually <1m thick
JbR	Jurassic Borden Island Formation	Sandstone	--	Well Drained	Excess ice only in locations with thick colluvium	Gentle to Steep	Covered by sandstone rubble, sand and fine grained colluvium usually <1m thick
TRhR	Triassic Heiberg Formation	Sandstone & Siltstone; Minor Shale	--	Well Drained	Excess ice only in locations with thick colluvium	Gentle to Steep	Covered by sandstone rubble, sand and fine grained colluvium usually <1m thick

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Public Works and Government Services Canada

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DRAWN YW | CHECK GVM | DESIGN YW | APPR. LM

Eureka Study
Terrain Unit Mapping Legend
1 of 1

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
28 SEP 2010	Figure 4.4	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
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WorleyParsons resources & energy

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ANSIB-MAP-L VERSION: A

522,500 523,000 523,500 8,881,500 524,000

522,000 8,881,500 8,881,000 524,000 524,000 8,881,000 8,880,500

fCm-E

Proposed Fuel Drum Storage

Alternative Proposed Fuel Drum Storage

Airstrip

To Blacktop Creek

Drum Crushing Area of Burial

Waste Disposal

Fort Eureka

To Station

fMb+fWb/JKdR-IWP

fWb+fCb/JKdR-E

0 50 100 200
Meters

(Legend Adapted from Hodgson and Edlund, 1977)

Symbol	Terrain Unit	Texture	Thickness	Ice Content	Slope
Cb	Colluvial Blanket	Silt, Clay, Sand	1 to 3m	Variable	Moderate to Steep
Cm	Colluvial Mantle	Silt, Clay, Sand	> 3m	Variable	Moderate to Steep
Wb	Marine Blanket	Silt & Sand, Minor Gravel	1 to 3m+	Silt higher than sand & gravel	Level
Mb	Moraine Blanket	Silt & Clay, Some sand; Minor gravel (till)	1 to 3m+	High; Excess ice 5 to 95%; Ice wedge polygons	Level to Gentle
JKdR	Jurassic and Cretaceous Deer Bay Formation	Dark Grey Shale; Minor Siltstone, Mudstone & Sandstone	—	Excess ice in upper part of shale and in fine grained deposits	Level to Gentle

522,000 522,500 523,000 8,880,500 523,500

Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution.

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This map must be printed at full scale (100%) in order for the scale to remain correct.

Symbols:

IWP Ice Wedge Polygons
-E Erosional Channels

Textures:

f = Clay, Silt, Fine Sand

Example:

fMb + fWb/JKdR
Fine grained moraine and marine deposits (with ice wedge polygons) that are 1 to 3+ m thick and overlie Jurassic shale of the Deer Bay Formation.

DRAWN	CHECK	DESIGN	APPR.
YW	GVM	YW	LM

Eureka Study
Terrain Unit Mapping
Airstrip Map

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
28 SEP 2010	Figure 4.5	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
C71130000	1:5,000	UTM 16N	NAD 83	11 X 17

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ANSIB-MAP-L VERSION: A

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521,000

8,880,500

fMb+fWb/JKdR

JKdR

JKdR

s,gFd

fWb+fCb/JKdR-E

Water Reservoir

Sewage Lagoon Option 2

To Airport

Sewage Lagoon Option 1

Existing Lagoon

s,gFp

s,gFd

0 25 50 100

Meters

(Legend Adapted from Hodgson and Edlund, 1977)

Symbol	Terrain Unit	Texture	Thickness	Ice Content	Slope
Cb	Colluvial Blanket	Silt, Clay, Sand	1 to 3m	Variable	Moderate to Steep
Fp	Fluvial Plain	Sand, Gravel and Fines	> 3m	Low	Level
Fd	Fluvial Delta	Sand, Gravel and Fines	> 3m	Excess ice to 10%. Lenses and wedges	Level
Wb	Marine Blanket	Silt & Sand, Minor Gravel	1 to 3m+	Silt higher than sand & gravel	Level
Mb	Moraine Blanket	Silt & Clay, Some sand; Minor gravel (till)	1 to 3m+	High; Excess ice 5 to 95%; Ice wedge polygons	Level to Gentle
JKdR	Jurassic and Cretaceous Deer Bay Formation	Dark Grey Shale; Minor Siltstone, Mudstone & Sandstone	—	Excess ice in upper part of shale and in fine grained deposits	Level to Gentle

520,500

521,000

8,880,500

Eureka Civil Consulting Services

Public Works and Government Services Canada

Important Notes:

GeoEye-1 Satellite imagery shown acquired on August 2009, captured at 0.5m resolution.

Produced by WorleyParsons. The information used to create this product is based on the most current data available on the date of issue, and is considered reliable only at the scale at which the data was created and the scale at which the map was published. This drawing is prepared solely for the use of the contractual customer of WorleyParsons and WorleyParsons assumes no liability toany other party for any representations contained in these drawings.
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Symbols:

- Erosional Channels
- New Forcemain
- Cell

Textures:

g = Gravel
s = Sand
f = Clay, Silt, Fine Sand

Example:

fMb + fWb/JKdR
Fine grained moraine and marine deposits (with ice wedge polygons) that are 1 to 3+ m thick and overlie Jurassic shale of the Deer Bay Formation.

DRAWN	YW
CHECK	GVM
DESIGN	YW
APPR.	LM

Eureka Study
Terrain Unit Mapping
Wastewater Treatment Map

DATE	MAP NUMBER	REV.	CONTRACTOR NAME
28 SEP 2010	Figure 4.6	C	WorleyParsons

WP NUMBER	SCALE	PROJECTION	DATUM	ORIG. PAGE SIZE
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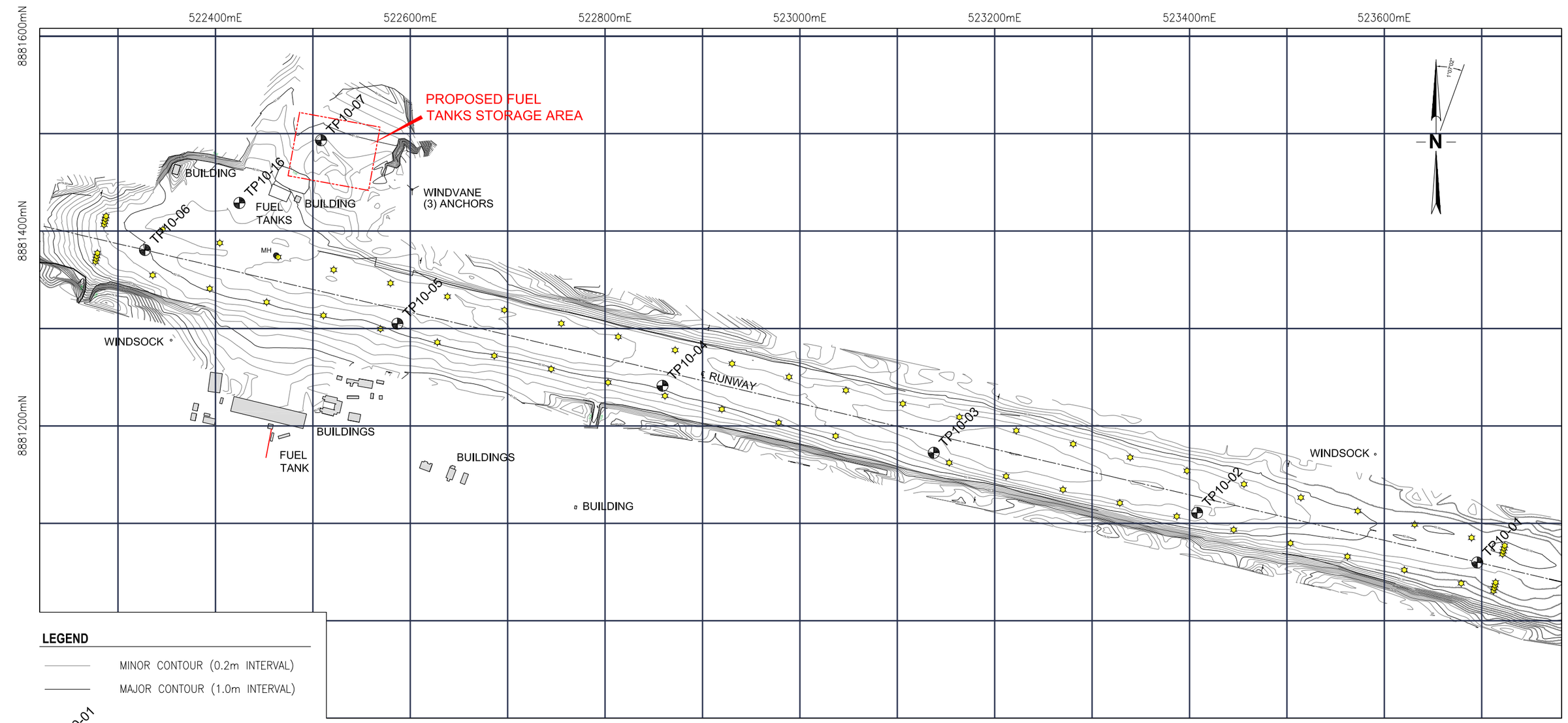
Drawings

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES / SERVICES IMMOBILIERS

Western Region / Région de l'ouest



LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- TP10-01 — TEST PIT LOCATION
- MH — MANHOLE
- RUNWAY LIGHT

0 50 100 150 200m

SCALE 1 : 4,000

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

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DO NOT SCALE DRAWINGS

Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **RUNWAY, APRON AND TAXIWAY**	Approved by/Approuve par **J.Q.** Designed by/Concept par **L.M.** Drawn by/Dessine par **L.P./D.R.H.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.** PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date **2010-12-09**	Project No./No. du projet **R.015446.001** Sheet/Feuille **18** OF **27** Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000 base

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest

520400mE 520600mE 520800mE 521000mE

8880800mN

8880600mN

8880400mN



N

LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** **BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA**	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **SITE PLAN**	Approved by/Approuve par **J.Q.** Designed by/Concept par **L.M.** Drawn by/Dessine par **L.P./D.R.H.**	PWGSC Project Manager/Administrateur de Projets TPSGC **J.D.** PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date **2010-12-09**	Project No./No. du projet **R.015446.001** Sheet/Feuille **25 OF 27** Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

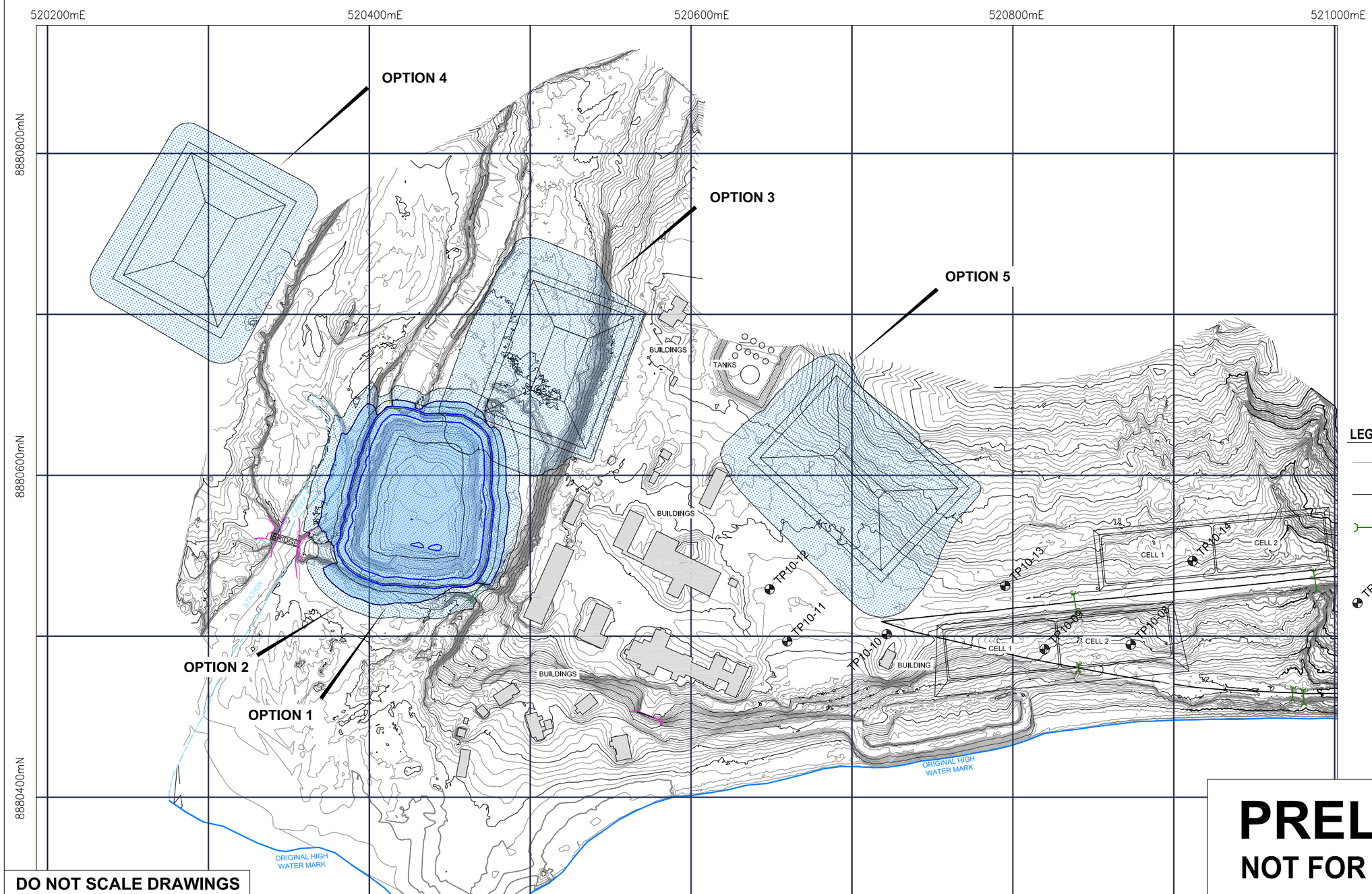
C71130000 base

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region

SERVICES IMMOBILIERS
Région de l'ouest



LEGEND

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (1.0m INTERVAL)
- CULVERT LOCATION
- TP10-09 TEST PIT LOCATION

0 25 50 75 100m

SCALE 1 : 2,500

SOURCE:
Drawing & Survey:
Challenger Geomatics,
Drawing File: 35062 SS.dwg

PRELIMINARY

NOT FOR CONSTRUCTION

DO NOT SCALE DRAWINGS

Client/client **PUBLIC WORKS & GOVERNMENT SERVICES CANADA (PWGSC)** BOX 1408 100-167 LOMBARD AVE WINNEPEG, MANITOBA	Project title/Titre du projet **EUREKA, NUNAVUT CANADA** **CIVIL CONSULTING SERVICES**	Drawing title/Titre du dessin **OPTION 1-5 SITE PLAN**	Approved by/Approuve par J.Q. Designed by/Concept par L.M. Drawn by/Dessine par L.P./D.R.H.	PWGSC Project Manager/Administrateur de Projets TPSGC J.D. PWGSC, Architectural and Engineering Resources Manager/ Ressources Architectural et de Directeur d'Ingénierie, TPSGC Date/Date 2010-12-09	Project No./No. du projet **R.015446.001** Sheet/Feuille **26** OF 27 Revision/ Revision

A0 – PWGSC – ANSI B–L2 – 11X17

C71130000-CI-DPP-0001

Photographs



PHOTO 1: Test pit excavation in progress.



PHOTO 2: Low spots along existing runway.



PHOTO 3: Tundra pool on north side of runway.



PHOTO 4: Power line to Fort Eureka.

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PHOTO 5: Existing reservoir berms showing instability and lack of freeboard.



PHOTO 6: Water reservoir - North Cell Bank.



PHOTO 7: Seepage through water reservoir berms.



PHOTO 8: Existing quarry stone northwest of station.



PHOTO 9: Stockpiles in Station Creek delta.



PHOTO 10: Fluvial terrace above Station Creek.

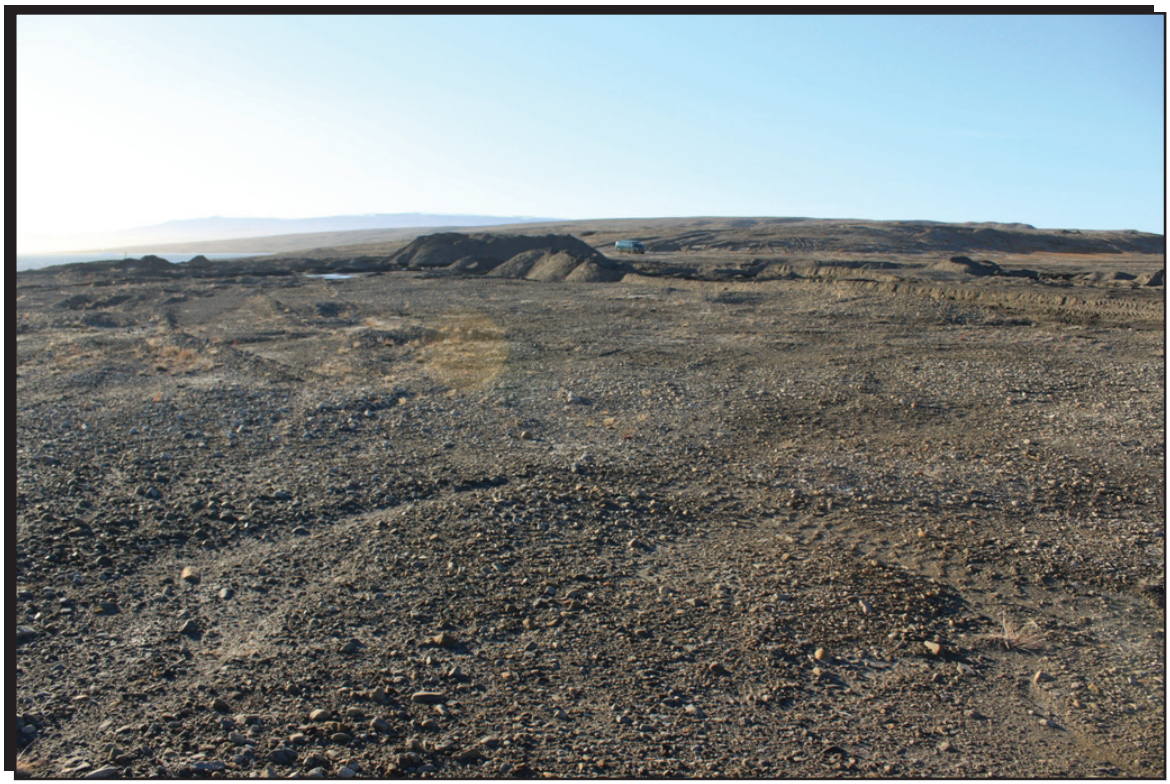


PHOTO 11: Existing stockpile at Blacktop Creek.



PHOTO 12: Stream bank exposure at Blacktop Creek.



PHOTO 13: Stream bank exposure at Remus Creek.



PHOTO 14: Awingak Formation exposure.



PHOTO 15: Heiberg Formation exposure.

Appendices

Appendix 4.1 Test Pit (TP) Logs

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-01**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,060.00 E 523,695.00	Method: Test Pitting	Elevation: 82.95 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 50 mm thick.						
		(CL-ML) Silty Clay (Till) - Firm, moist, dark greyish brown		1-1		5.9		
0.5				1-2		18.5, PI=22	Clay = 26%, Silt = 66%, Sand = 8%, Gravel = 0%	82.5
1.0		- Visible ice						82.0
		End of Hole at a depth of 1.04 m Bucket refusal at 1.04 m in permafrost.						
		Water Levels:						
1.5								81.5
								81.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.04 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-02**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,111.00 E 523,408.00	Method: Test Pitting	Elevation: 82.55 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 100 mm thick.				4.1		82.5
		(CL-ML) Silty Clay (Fill) - Stiff, low plasticity, damp, dark grey in colour		2-1				
				2-2		16.5	Temp. 7.5°C	
		(GW) Clayey Gravel (Fill) - Compact, damp, some cobbles and sand, meduim brown						
0.5								82.0
				2-3		16.1	Temp. 2.3°C	
		(ML) Sandy Silt - Firm, damp, some rootlets and organics, light brown in colour.						
1.0							Temp. 0.2°C	81.5
		(CL-ML) Silty Clay (Till) - Stiff, damp, low plasticity, dark grey, ice poor.		2-4		25.3		
		End of Hole at a depth of 1.40 m Bucket refusal at 1.40 m in permafrost.						
1.5		Water Levels:						81.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.40 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-03**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,172.00 E 523,137.00	Method: Test Pitting	Elevation: 82.65 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 150 mm thick.		3-1		5.9		82.5
0.5		(CL-ML) Silty Clay (Till) - Firm to stiff, low plasticity, damp, dark grey, ice poor.					Temp. 3.7°C	82.0
				3-2		15.2, PI=10	Temp. 2.2°C Clay = 12%, Silt = 44%, Sand = 37%, Gravel = 7%	
1.0							Temp. 0.2°C	81.5
		End of Hole at a depth of 1.25 m Bucket refusal at 1.25 m in permafrost. Water Levels:						
1.5								81.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.25 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-04**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,241.00 E 522,859.00	Method: Test Pitting	Elevation: 82.10 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 210 mm thick.		4-1		3.9	Fines = 18.1%, Sand = 28.9%, Gravel = 53%	82.0
		(CL-ML) Silty Clay (Till) - Firm, low plasticity, moist, dark grey, trace rootlets, ice poor						
0.5		- Stiff, damp		4-2		22.2	Temp. 2.8°C	81.5
							Temp. 1.2°C	
1.0							Temp. <0°C	81.0
		End of Hole at a depth of 1.20 m Bucket refusal at 1.20 m in permafrost. Water Levels:						
1.5								80.5

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Logged By: Lee Martin	Completion Depth: 1.20 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-05**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,305.00 E 522,587.00	Method: Test Pitting	Elevation: 82.21 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 135 mm thick.		5-1		6.2		
		(CL-ML) Silty Clay (Till) - Stiff, low plasticity, damp, dark grey, ice poor						82.0
0.5				5-2		20.5, PI=14	Temp. 2.4°C	
							Temp. 0.9°C	81.5
1.0		End of Hole at a depth of 0.98 m Bucket refusal at 0.98 m in permafrost. Water Levels:						
								81.0
1.5								
								80.5

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

WorleyParsons
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Logged By: Lee Martin	Completion Depth: 0.98 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-06**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,381.00 E 522,328.00	Method: Test Pitting	Elevation: 81.95 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
0		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, very clayey, reddish brown, approx. 50 mm thick.						
		(CL-ML) Silty Clay (Till) - Stiff, low plasticity, damp, dark grey, sandy brown lenses noted throughout, ice poor - trace organics noted at top of colluvium layer		6-1		3.8	Fines = 29.5%, Sand = 51.5%, Gravel = 19%	81.5
0.5							Temp. 3.3°C	
							Temp. 1.7°C	81.0
1.0				6-2		16.2	Temp. <0°C Clay = 25%, Silt = 55%, Sand = 19%, Gravel = 1%	
		End of Hole at a depth of 1.38 m Bucket refusal at 1.38 m in permafrost. Water Levels:						80.5
1.5								80.0

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Logged By: Lee Martin	Completion Depth: 1.38 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-07**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,881,493.00 E 522,508.00	Method: Test Pitting	Elevation: 81.32 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(CL-ML) Clayey Silt (Till) - very soft, moist, dark brownish grey, some organics and rootlets at surface, trace boulders and cobbles noted on surface and in test pit						81.0
				7-1		29.4, PI=17	Temp. 1.0°C	
							Temp. 0.4°C	
0.5							Temp. <0°C	
		- Ice poor permafrost		7-2		43.3		80.5
1.0		End of Hole at a depth of 1.00 m Bucket refusal at 1.00 m in permafrost. Water Levels:						80.0
1.5								79.5

WorleyParsons resources & energy

Logged By: Lee Martin	Completion Depth: 1.00 m
Reviewed By:	Drilled on: 8/15/2010
Groundwater Depth:	Page 1 of 1

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-08**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,495.00 E 520,873.00	Method: Test Pitting	Elevation: 3.78 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
0.0		(SP) Gravelly Sand (Fill) - Loose, moist, some clay and silt, trace cobbles, buried cables and debris, trace organics, medium brown						3.5
0.5							Temp. 2.1°C	
				8-1		13.3	Temp. 0.7°C	3.0
1.0		(CL-ML) Silty Clay (colluvium) - Stiff, low plasticity, moist, trace gravel, sandy, dark grey, ice poor					Temp. <0°C	
1.5				8-2		32.1 PI=9	Clay = 28%, Silt = 70%, Sand = 2%, Gravel = 0%	2.5
		End of Hole at a depth of 1.90 m Bucket refusal at 1.90 m in permafrost.						2.0

WorleyParsons resources & energy

Logged By: Lee Martin	Completion Depth: 1.90 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-09**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,492.00 E 520,820.00	Method: Test Pitting	Elevation: 4.01 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GP) Sandy Gravel (Fill) - Crushed sandstone, compact, damp, pinkish red						
		(SP) Gravelly Sand (Fill) - Loose, moist to wet, some clay and silt, trace cobbles, medium brown						
0.5				9-1		4.8		3.5
1.0		- Ice poor permafrost - Seepage observed (thawing permafrost)						3.0
		(CL-ML) Silty Clay (Colluvium)- Stiff, low plasticity, damp, dark grey, ice poor		9-2		31.4 (PI=11)	Clay = 26%, Silt = 70%, Sand = 4%, Gravel = 0%	
		End of Hole at a depth of 1.40 m Bucket refusal at 1.40 m in permafrost.						
1.5		Water Levels:						2.5

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

WorleyParsons
resources & energy

Logged By: Lee Martin	Completion Depth: 1.40 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-10**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,501.00 E 520,722.00	Method: Test Pitting	Elevation: 7.68 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
0.0		(GP) Sandy Gravel (Fill) - Compact, damp, trace cobbles, some silt and clay, medium brown						7.5
0.5			Grab	10-1		6.4		7.0
1.0		- Water flowing into pit Solid Ice. Native colluvium may be present at 1.1m; however, difficult to ascertain due to presence of solid ice and flowing water.						
		End of Hole at a depth of 1.10 m Bucket refusal at 1.10 m in permafrost. Water Levels:						6.5
1.5								6.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

WorleyParsons
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Logged By: Lee Martin	Completion Depth: 1.10 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-11**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,497.00 E 520,660.00	Method: Test Pitting	Elevation: 7.05 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
0		(GP) Sandy Gravel (Fill) - Compact, damp to moist, trace cobbles, some silt and clay, medium brown.						7.0
0.5				11-1		4.7		6.5
1.0		- Water flowing into pit						6.0
		(CL-ML) Silty Clay (Colluvium) - Stiff, damp, low plasticity, dark grey, ice poor		11-2		22.4		
1.5		End of Hole at a depth of 1.30 m Bucket refusal at 1.30 m in permafrost. Water Levels:						5.5

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.30 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-12**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,529.00 E 520,649.00	Method: Test Pitting	Elevation: 7.54 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GP) Sandy Gravel (Fill) - Compact, moist, some cobbles, some silt and clay, medium brown.						7.5
0.5								7.0
		(CL-ML) Silty Clay (Colluvium) - Stiff, damp, low plasticity, dark grey, ice poor						
1.0		- water flowing in at 0.9m, testpit walls sloughing in						6.5
		End of Hole at a depth of 1.10 m Test pit terminated at 1.10 m because of large volumes of sloughing and water infiltration. Water Levels:						
1.5								6.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.10 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-13**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,531.00 E 520,795.00	Method: Test Pitting	Elevation: 7.62 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(ML) Clayey Silt (colluvium) - Firm, moist, light brown to dark grey, sandy, trace organics and rootlets.						7.5
0.5				13-1		21	Temp. 0.4°C	7.0
							Temp. <0°C	
1.0		(CL-ML) Silty Clay (colluvium) - Stiff, low plasticity, damp, dark grey, ice poor		13-2		30.5		6.5
1.5		End of Hole at a depth of 1.30 m Bucket refusal at 1.30 m in permafrost. Water Levels:						6.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

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Logged By: Lee Martin	Completion Depth: 1.30 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-14**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,547.00 E 520,912.00	Method: Test Pitting	Elevation: 7.85 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(ML) Sandy Silt (colluvium) - Firm, damp, medium brown, trace gravel, trace rootlets and organics						7.5
0.5				14-1		11.4, PI=9	Temp. 1.8°C Clay = 11%, Silt = 26%, Sand = 33%, Gravel = 30%	
		- Ice poor permafrost					Temp. 0.4°C	7.0
1.0		End of Hole at a depth of 0.98 m Bucket refusal at 0.98 m in permafrost. Water Levels:					Temp. <0°C	
1.5								6.5
								6.0

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

WorleyParsons resources & energy

Logged By: Lee Martin	Completion Depth: 0.98 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Environment Canada	Borehole Number: **TP10-15**
Client: Public Works and Government Services	Equipment: Ford Backhoe	Project Number: C71130000
Coordinates: N 8,880,561.00 E 521,014.00	Method: Test Pitting	Elevation: 9.13 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(CL-ML) Silty Clay (colluvium) - Firm, damp to moist, dark brownish grey, trace organics, some sand, trace gravel						9.0
0.5				15-1		22.1, PI=10	Temp. <0°C	8.5
1.0		- Ice poor permafrost with noticeable ice veins					Clay = 21%, Silt = 77%, Sand = 2%, Gravel = 0%	
		End of Hole at a depth of 1.10 m Bucket refusal at 1.10 m in permafrost. Water Levels:						8.0
1.5								7.5

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Logged By: Lee Martin	Completion Depth: 1.10 m
Reviewed By:	Drilled on: 8/16/2010
Groundwater Depth:	Page 1 of 1

Project: Eureka Geotechnical Investigation	Contractor: Hand Excavation	Borehole Number: **TP10-16**
Client: Public Works and Government Services	Equipment: Hand Excavation	Project Number: C71130000
Coordinates: N 8,881,429.00 E 522,425.00	Method: Test Pitting	Elevation: 82.12 m

Sample Type: Shelby Tube | Core Sample | Spt Sample | Grab Sample | No Recovery | Bulk Sample

Depth (m)	Soil Symbol	SOIL DESCRIPTION	Sample Type	Sample Number	Blows/150 mm	Plastic MC Liquid (10 20 30 40)	Other Data	Elevation (m)
		(GC) Granular Surfacing Material - Fine gravel (crushed sandstone) and sand, firm, moist, clayey, reddish brown, approx. 200 mm thick.						82.0
		(CL-ML) Silty Clay (Till) - Firm, moist, low plasticity, dark greyish brown						
0.5		End of Hole at a depth of 0.50 m Test pit terminated at 0.5 metres in native clayey till. Water Levels:						81.5
1.0								81.0
1.5								80.5
2.0								80.0

WorleyParsons
resources & energy

Logged By: Lee Martin	Completion Depth: 0.50 m
Reviewed By:	Drilled on: 8/17/2010
Groundwater Depth:	Page 1 of 1

WP STANDARD LOG EUREKA.GPJ WORLEY PARSONS LAB.GDT 10/12/10

Appendix 4.2 Laboratory Testing

Table: 1

Summary of Petrographic Analysis of Coarse Aggregate Test Report

CSA 23.2-04 15A

Project:	Worley Parsons Materials Testing - 2010	Sample No.:	L-31(Bulk 4)
Client:	Worley Parsons Canada Services Ltd.	Date Received:	September 2, 2010
Project No.:	C12201471	Date Tested:	October 5, 2010
Source:	Eureka, NT	Petrographer:	MS
Description:	Gravel, sandy, trace silt	Office:	Calgary

Rock Type	Petrographic Multiplier	25 - 19 mm % in fraction	19 - 13 mm % in fraction	13 - 10 mm % in fraction	10 - 5 mm % in fraction	Weighted Average %
Good - High Strength						
QUARTZITE/SANDSTONE	1				28.3	28.3
CARBONATE	1				3.0	3.0
CHERT	1				4.1	4.1
MIGMATITE	1				26.1	26.1
GRANITE	1				19.2	19.2
Fair - Medium Strength						
QUARTZITE/SANDSTONE - weak	3				2.7	2.7
SHALE - weak	3				4.3	4.3
SILTSTONE	3				1.9	1.9
GRANITE - weathered	3				2.0	2.0
MIGMATITE - weathered	3				0.8	0.8
Poor - Low Strength						
SILTSTONE - weak	6				1.3	1.3
QUARTZITE/SANDSTONE - weak	6				1.9	1.9
SHALE - highly weathered	6				1.0	1.0
GRANITE - highly weathered	6				0.6	0.6
Deleterious						
IRONSTONE	10				2.8	2.8
SHALE-friable	10				0.0	0.0
Petrographic Number :		**Not Tested**	**Not Tested**	**Not Tested**	**172**	
Percent of Fraction in Sample:		4.0	8.0	4.0	13.0	

Weighted Average Petrographic Number: **172**

Weighted Average Chert Content: **4.1 %**

Weighted Average Ironstone Content: **2.8 %**

Petrographer: _____

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Table: 2

Summary of Petrographic Analysis of Coarse Aggregate Test Report

CSA 23.2-04 15A

Project:	Worley Parsons Materials Testing - 2010	Sample No.:	L-32(Bulk 6)
Client:	Worley Parsons Canada Services Ltd.	Date Received:	September 2, 2010
Project No.:	C12201471	Date Tested:	October 5, 2010
Source:	Eureka, NT	Petrographer:	WJ
Description:	Gravel, sandy, trace silt	Office:	Calgary

Rock Type	Petrographic Multiplier	25 - 19 mm % in fraction	19 - 13 mm % in fraction	13 - 10 mm % in fraction	10 - 5 mm % in fraction	Weighted Average %
Good - High Strength						
QUARTZITE/SANDSTONE	1				26.1	26.1
CARBONATE	1				7.1	7.1
CHERT	1				3.5	3.5
MIGMATITE	1				23.6	23.6
GRANITE	1				11.3	11.3
Fair - Medium Strength						
QUARTZITE/SANDSTONE - weak	3				3.4	3.4
SHALE - weak	3				5.7	5.7
SILTSTONE	3				1.5	1.5
GRANITE - weathered	3				2.0	2.0
MIGMATITE - weathered	3				0.5	0.5
Poor - Low Strength						
SILTSTONE - weak	6				0.9	0.9
QUARTZITE/SANDSTONE - weak	6				6.7	6.7
SHALE - highly weathered	6				3.3	3.3
GRANITE - highly weathered	6				1.2	1.2
Deleterious						
IRONSTONE	10				1.2	1.2
SHALE-friable	10				2.0	2.0
Petrographic Number :		**Not Tested**	**Not Tested**	**Not Tested**	**215**	
Percent of Fraction in Sample:		8.0	10.0	7.0	9.0	

Weighted Average Petrographic Number: **215**

Weighted Average Chert Content: **3.5 %**

Weighted Average Ironstone Content: **1.2 %**

Petrographer: 

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MOISTURE CONTENT TEST RESULTS

Project: Worley Parsons Materials Testing - 2010
Project No.: C12201471
Client: Worley Parsons Canada Services Ltd.
Address: Eureka, NT

Sample No.: L-1 - L-22
Date Tested: 9/15/2010
Tested By: MS
Page: 1 of 2

B.H. Number	Sample Number	Depyh (m)	Tare Mass (g)	Mass of Wet Soil & tare (g)	Mass of Dry Soil & tare (g)	Moisture Content (%)	Visual Description of Soil EBA Work Method WM4400
1-1	L-1		249.3	1742.5	1659.0	5.9	GRAVEL, sandy, some silt, some clay
1-2	L-2	0.5	129.3	910.0	788.1	18.5	CLAY, silty, trace sand, brown, moist to wet
2-1	L-3		5.1	282.2	271.4	4.1	SAND and GRAVEL, silty, some clay, brown, moist
2-2	L-4	0.5	5.0	149.8	129.3	16.5	SAND and GRAVEL, silty, some clay, brown, moist
2-3	L-5	0.5	5.1	128.9	111.7	16.1	CLAY, silty, some sand, trace organics, dark brown, moist
2-4	L-6	1.3	5.1	117.5	94.8	25.3	CLAY, silty, trace sand, dark brown, moist to wet
3-1	L-7		5.1	232.6	219.9	5.9	SILT, sandy, some clay, some gravel, trace organics, brown
3-2	L-8	0.75	125.8	960.3	850.0	15.2	CLAY, silty, sandy, trace gravel, brown, moist
4-1	L-9	0	5.3	153.4	147.8	3.9	GRAVEL, sandy, some silt, some clay
4-2	L-10	0.4	5.2	218.6	179.8	22.2	CLAY, silty, same sand, trace organics, brown, moist to wet
5-1	L-11	0	11.8	340.8	321.6	6.2	SAND, silty, some gravel, brown, moist
5-2	L-12	0.5	11.9	339.9	284.2	20.5	CLAY, silty, trace sand, coal specs, brown, moist
6-1	L-13	0	5.1	240.8	232.1	3.8	SAND, some gravel, some silt, some clay brown, moist
6-2	L-14	1	127.6	961.9	845.4	16.2	CLAY, silty, some sand, trace gravel, black, moist (organic soil)
7-1	L-15	0.2	11.4	358.2	279.5	29.4	CLAY, silty,trace sand, some organics, dark bown, wet
7-2	L-16	0.6	11.6	206.4	147.5	43.3	CLAY, some silt, dark brown to grey, very wet
8-1	L-17	0.75	5.1	207.3	183.5	13.3	SAND, coarse, gravelly,some silt, dark brown, very wet
8-2	L-18	1.5	127.8	1118.5	877.5	32.1	CLAY, silty, trace sand, dark brown to grey, very wet
9-1	L-19	0.5	11.8	241.4	230.8	4.8	SAND, coarse, gravelly,some silt, brown to grey, wet
9-2	L-20		115.0	961.5	759.4	31.4	CLAY, silty, trace sand, dark brown to grey, very wet
10-1	L-21	0.5	11.8	296.0	279.0	6.4	SAND, gravelly, silty, some clay, dark brown to grey, moist
11-1	L-22	0.5	11.4	324.7	310.6	4.7	GRAVEL, coarse sand, trace silt, brown, moist

Tested in accordance with ASTM standard D2216, subject to review .
issued for internal use

EBA Engineering Consultants Ltd.

MOISTURE CONTENT TEST RESULTS

Project: Worley Parsons Materials Testing - 2010
Project No.: C12201471
Client: Worley Parsons Canada Services Ltd.
Address: Eureka, NT

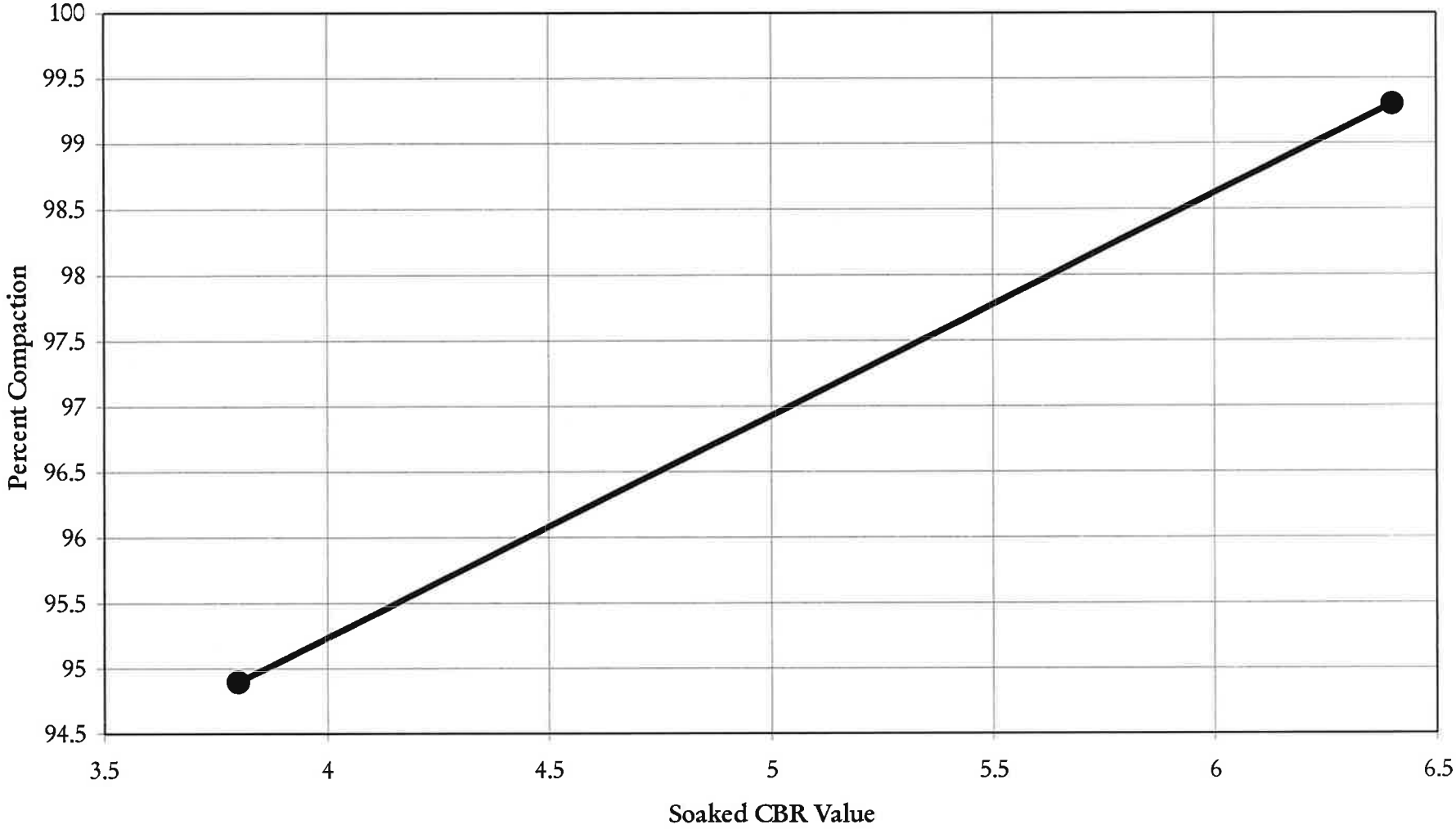
Sample No.: L-23 - L-27
Date Tested: 9/15/2010
Tested By: MS
Page: 2 of 2

B.H. Number	Sample Number	Depth (m)	Tare Mass (g)	Mass of Wet Soil & tare (g)	Mass of Dry Soil & tare (g)	Moisture Content (%)	Visual Description of Soil EBA Work Method WM4400
11-2	L-23	1.1	5.0	232.6	191.0	22.4	SILT, clayey, trace sand, dark grey, very wet
13-1	L-24	0.5	5.2	193.6	160.9	21.0	SAND, silty, clayey, some boulders, brown, wet
13-2	L-25	1	5.3	178.0	137.6	30.5	CLAY silty, dark grey, very wet
14-1	L-26	0.5	247.3	1225.5	1125.7	11.4	CLAY, silty, some sand, trace gravel, dark brown, moist to wet
15-1	L-27	1	125.5	1365.8	1141.4	22.1	CLAY, silty, trace sand, dark brown, moist to wet

Tested in accordance with ASTM standard D2216, subject to review .
issued for internal use

EBA Engineering Consultants Ltd.

Worley Parsons Material Testing 2010
Bulk 1 L-28



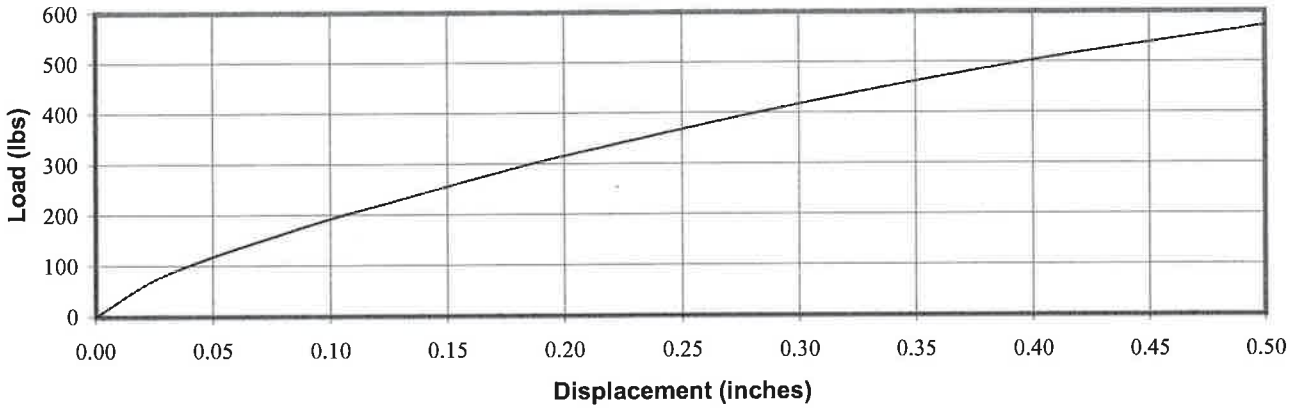
CALIFORNIA BEARING RATIO (CBR) TEST REPORT

ASTM D1883

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-28
Client:	Worley Parsons Canada Services Ltd.	Max. Dry Density by: ASTM D698	1800 kg/m³
Project No.:	C12201471	Optimum Moisture Content:	16.0 %
Test Date:	September 21, 2010	CBR Specimen Density:	1788 kg/m³
Soaking Time:	94.0 Hours	CBR Speciman Compaction	99.3 %
Description:	CLAY, silty, sandy	Surcharge Mass:	4.54 kg
Oversize 19mm:	0.0%	Total Swell (% of intial height):	0.20 %

CBR Before Soaking

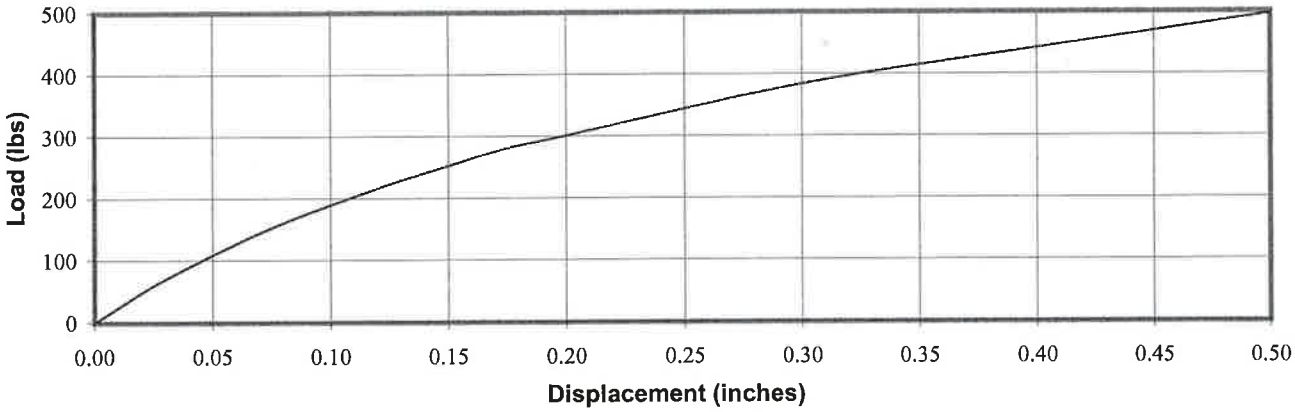
Mold A



Bearing Ratio unsoaked % = **6.7** Moisture Content = **16.3 %**

CBR After Soaking

Mold A



Bearing Ratio soaked % = **6.4** Moisture Content = **16.2 %** M.C. @ 25.4mm = **19.3%**

Remarks:

Reviewed By: _____ P.Eng.

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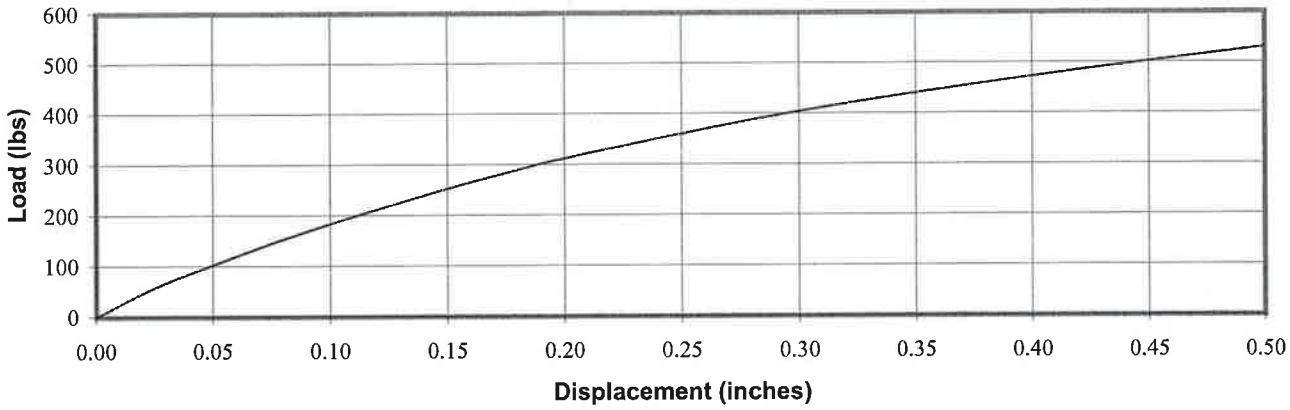
CALIFORNIA BEARING RATIO (CBR) TEST REPORT

ASTM D1883

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-28
Client:	Worley Parsons Canada Services Ltd.	Max. Dry Density by: ASTM D698	1800 kg/m³
Project No.:	C12201471	Optimum Moisture Content:	16.0 %
Test Date:	September 21, 2010	CBR Specimen Density:	1709 kg/m³
Soaking Time:	94.0 Hours	CBR Speciman Compaction	94.9 %
Description:	CLAY, silty, sandy	Surcharge Mass:	4.54 kg
Oversize 19mm:	0.0%	Total Swell (% of intial height):	0.15 %

CBR Before Soaking

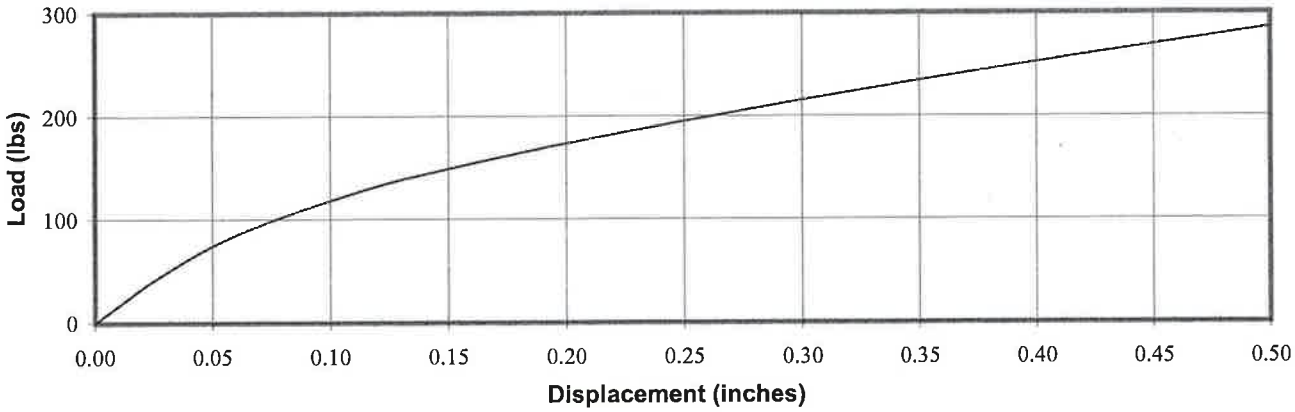
Mold A



Bearing Ratio unsoaked % = **6.6** Moisture Content = **16.4 %**

CBR After Soaking

Mold A



Bearing Ratio soaked % = **3.8** Moisture Content = **16.7 %** M.C. @ 25.4mm = **18.7%**

Remarks:

Reviewed By: _____ P.Eng.

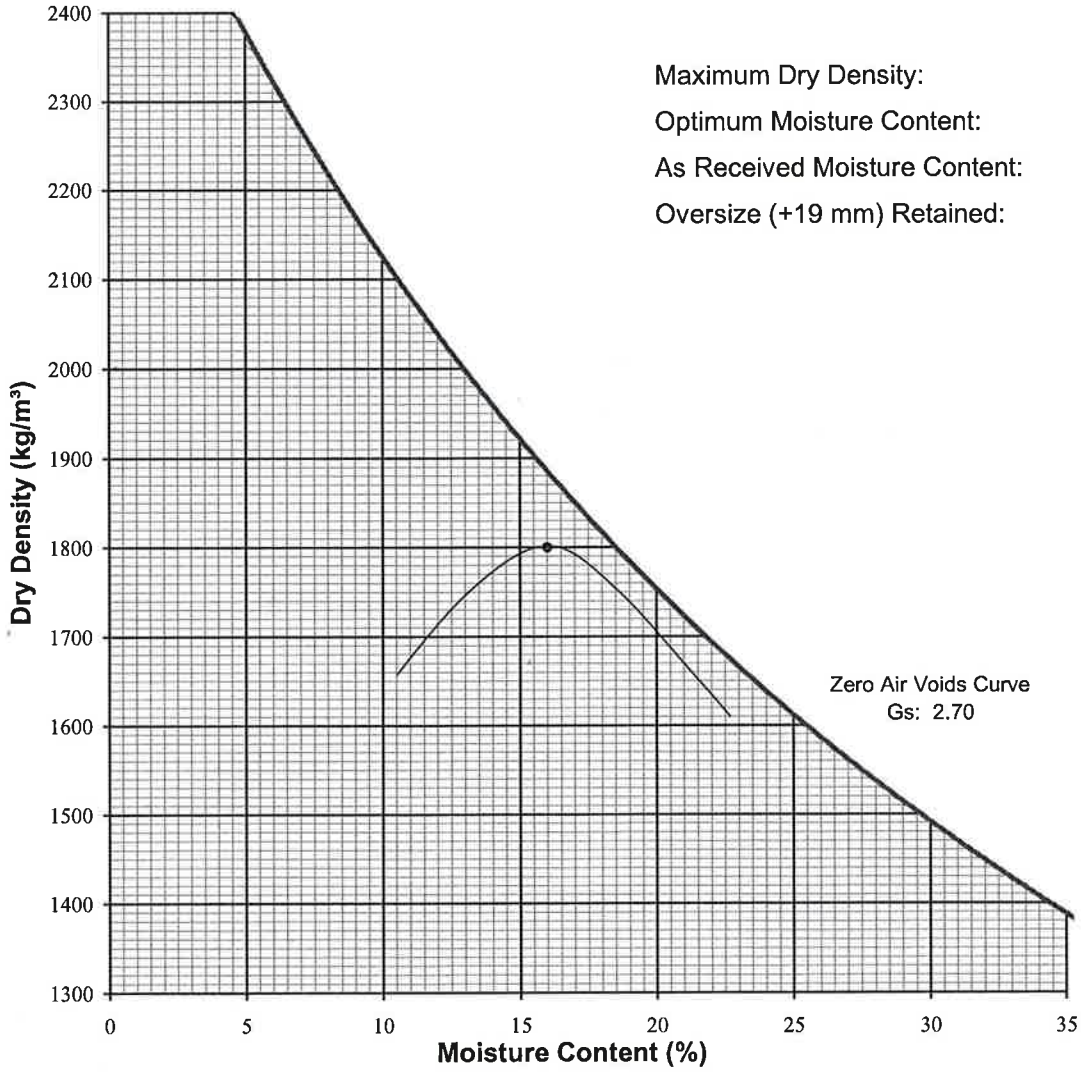
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MOISTURE-DENSITY RELATIONSHIP (Proctor) REPORT

ASTM D698 (Standard Proctor)

Project:	Worley Parsons Materials Testing - 2010	Sample No.:	L-28
Project No.:	C12201471	Sampled By:	Client
Client:	Worley Parsons Canada Services Ltd.	Date Received:	2-Sep-10
Attention:	Lee Martin	Test Date:	16-Sep-10
E-mail:	Lee.Martin@WorleyParsons.com	Test Method:	Method A
Source:	Bulk 1	Compaction:	Manual
Sample Location:	Eureka, NT		
Sample Description:	CLAY, silty, sandy		



Maximum Dry Density:	**1800**	kg/m³
Optimum Moisture Content:	**16.0**	%
As Received Moisture Content:	0.0	%
Oversize (+19 mm) Retained:	0.0	%

Remarks:

Reviewed By: C Meagher P.Eng.

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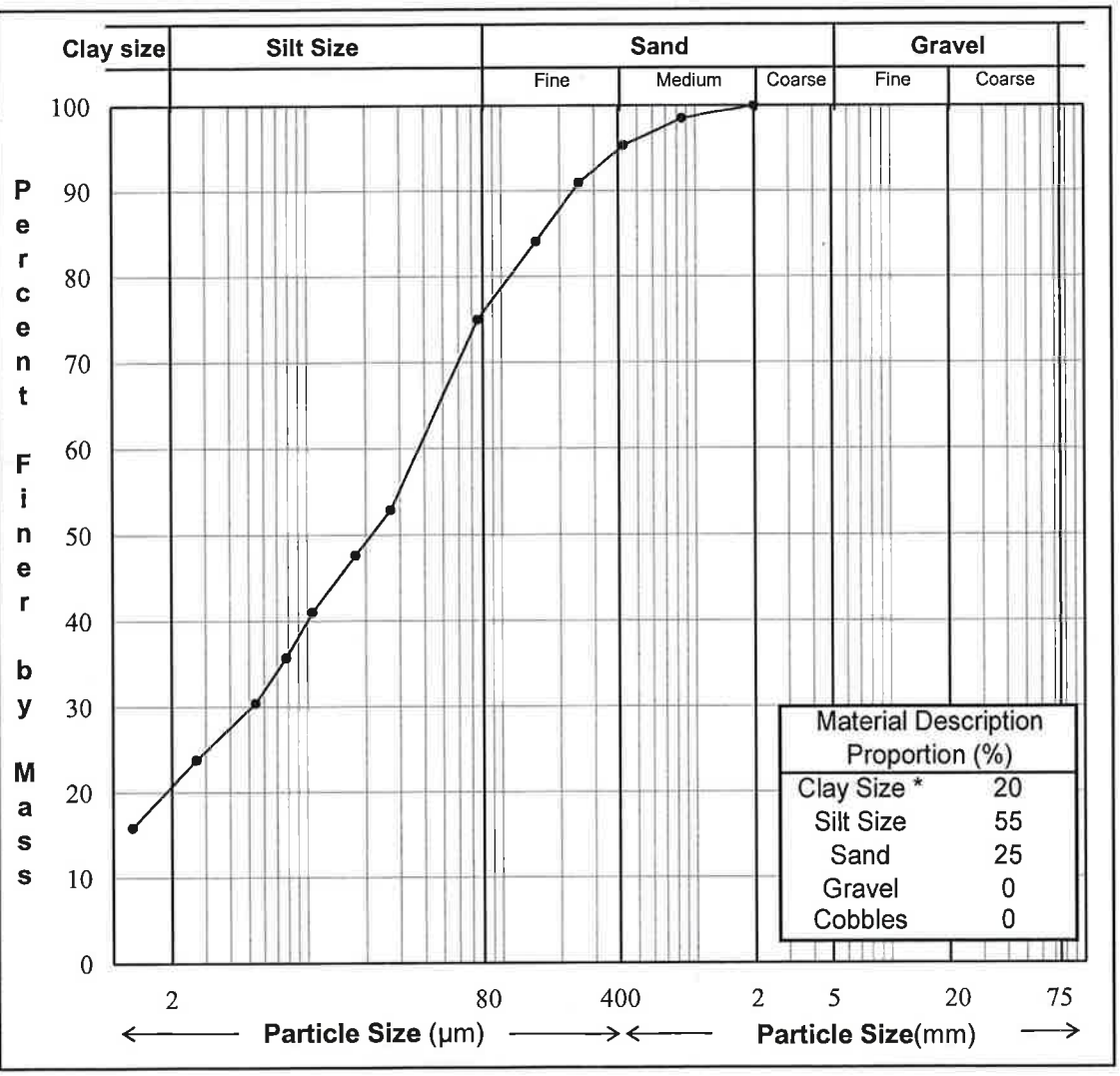
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-28
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	Bulk 1
Project No.:	C12201471	Depth:	Colluvium
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	CLAY, silty, sandy		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	
2 mm	100
850 µm	98
425 µm	95
250 µm	91
150 µm	84
75 µm	75
27 µm	53
18 µm	48
11 µm	41
8 µm	36
5 µm	30
3 µm	24
1 µm	16



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand

Sample Number: L-2

Borehole Number: 1-2

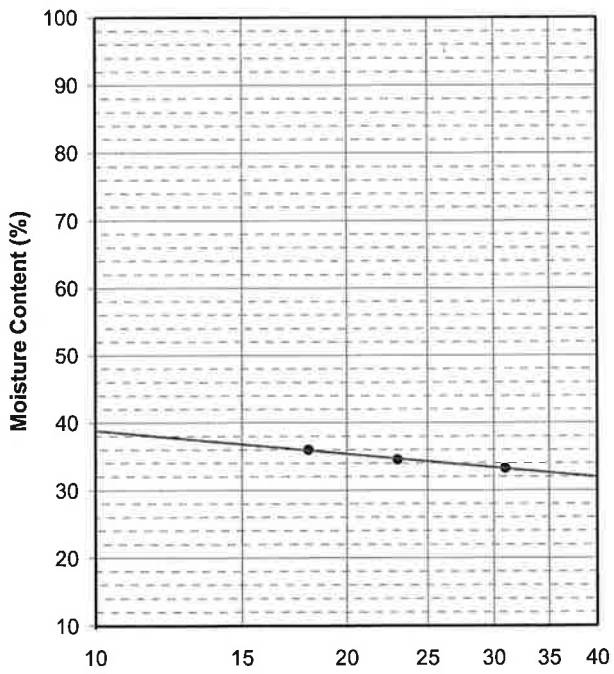
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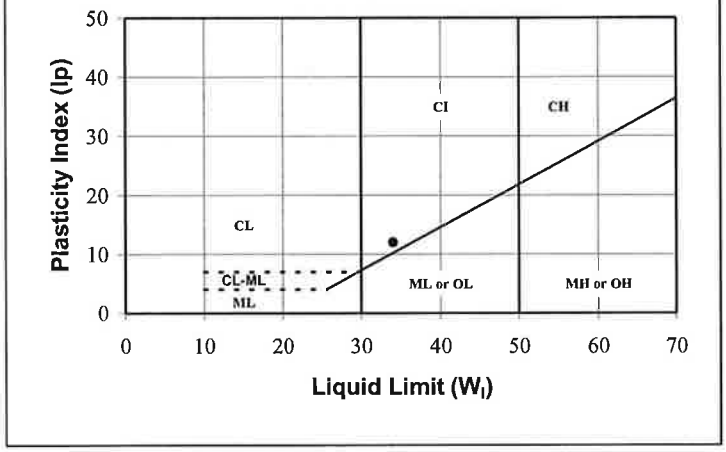
Date Sampled: _____ Sampled By: _____

Date Tested: 28-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	27.33	27.01	910
Mass Dry Soil + Tare	26.58	26.28	788.1
Mass of Tare	23.18	22.98	129.3
Mass of Water	0.75	0.73	121.9
Mass of Dry Soil	3.40	3.30	658.8
Moisture Content (%)	22.1	22.1	18.5

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	31	23	18
Tare Number	c	d	e
Mass Wet Soil + Tare	51.21	53.14	51.19
Mass Dry Soil + Tare	43.42	44.62	42.91
Mass of Tare	20.00	19.95	19.90
Mass of Water	7.79	8.52	8.28
Mass of Dry Soil	23.42	24.67	23.01
Moisture Content (%)	33.3	34.5	36.0





Natural Moisture (%)	18.5
Liquid Limit (%)	34
Plastic Limit (%)	22
PLASTICITY INDEX	**12**

Soil Description: Medium Plasticity

Mod.USCS Symbol: **CI**

Remarks: _____

reviewed by: CPM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, sandy, trace gravel

Sample Number: L-8

Borehole Number: 3-2

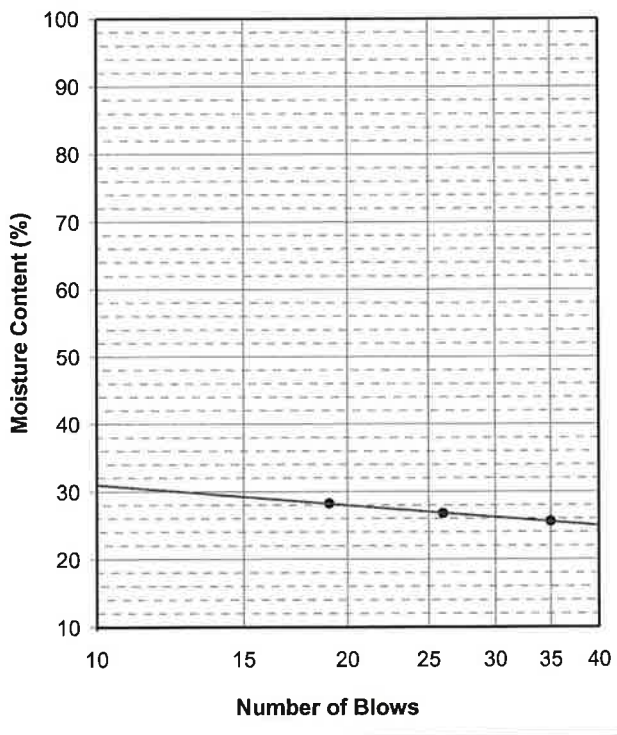
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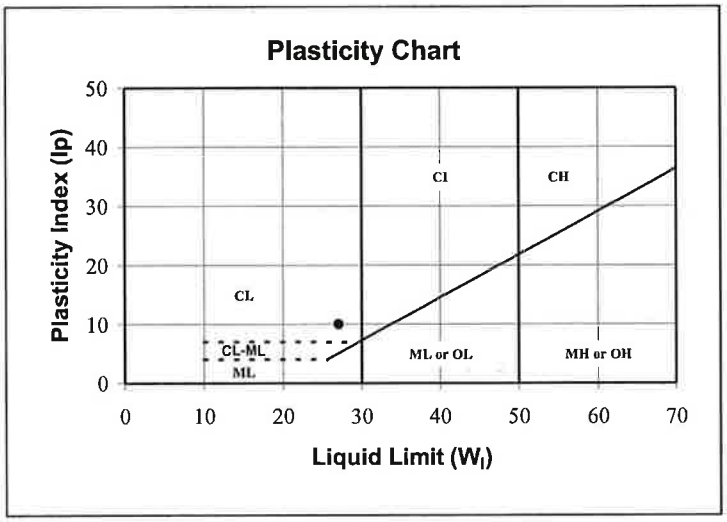
Date Sampled: _____ Sampled By: _____

Date Tested: 28-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	20.87	20.24	960.3
Mass Dry Soil + Tare	20.29	19.72	850
Mass of Tare	16.94	16.74	125.8
Mass of Water	0.58	0.52	110.3
Mass of Dry Soil	3.35	2.98	724.2
Moisture Content (%)	17.3	17.4	15.2

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	35	26	19
Tare Number	c	d	e
Mass Wet Soil + Tare	46.78	49.11	51.20
Mass Dry Soil + Tare	40.66	42.26	43.59
Mass of Tare	16.73	16.67	16.63
Mass of Water	6.12	6.85	7.61
Mass of Dry Soil	23.93	25.59	26.96
Moisture Content (%)	25.6	26.8	28.2





Natural Moisture (%)	15.2
Liquid Limit (%)	27
Plastic Limit (%)	17
PLASTICITY INDEX	**10**

Soil Description: Low Plasticity

Mod.USCS Symbol: **CL**

Remarks: _____

reviewed by: CRM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand
trace coal specs

Sample Number: L-12

Borehole Number: 5-2

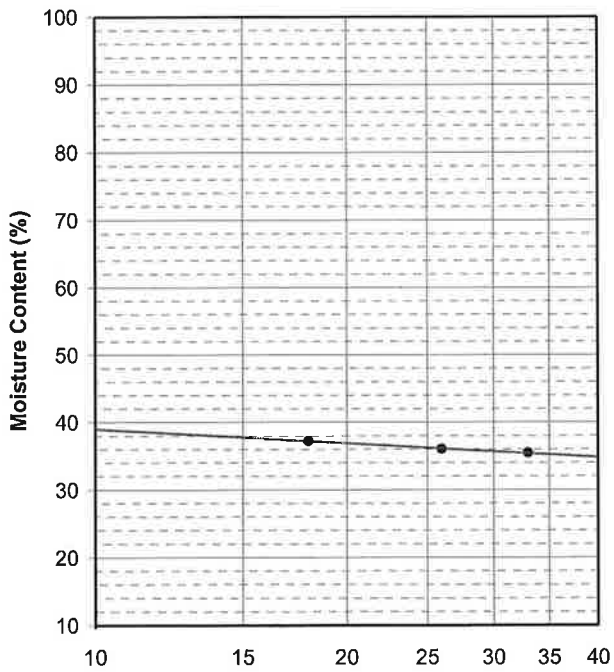
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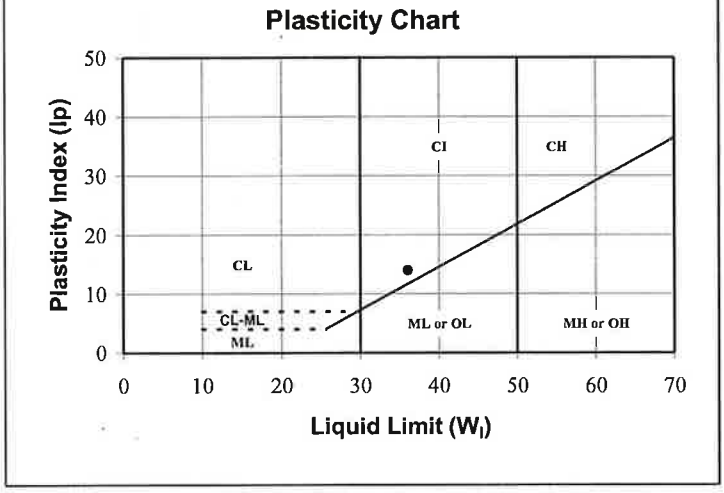
Date Sampled: Sampled By:

Date Tested: 30-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	20.68	20.20	339.9
Mass Dry Soil + Tare	19.94	19.55	284.2
Mass of Tare	16.56	16.55	11.9
Mass of Water	0.74	0.65	55.7
Mass of Dry Soil	3.38	3.00	272.3
Moisture Content (%)	21.9	21.7	20.5

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	33	26	18
Tare Number	c	d	e
Mass Wet Soil + Tare	51.32	47.20	56.54
Mass Dry Soil + Tare	42.29	39.15	45.65
Mass of Tare	16.82	16.82	16.43
Mass of Water	9.03	8.05	10.89
Mass of Dry Soil	25.47	22.33	29.22
Moisture Content (%)	35.5	36.1	37.3





Natural Moisture (%)	20.5
Liquid Limit (%)	36
Plastic Limit (%)	22
PLASTICITY INDEX	**14**

Soil Description: Medium Plasticity

Mod.USCS Symbol:

Remarks:

reviewed by: CAM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand some organics

Sample Number: L-15

Borehole Number: 7-1

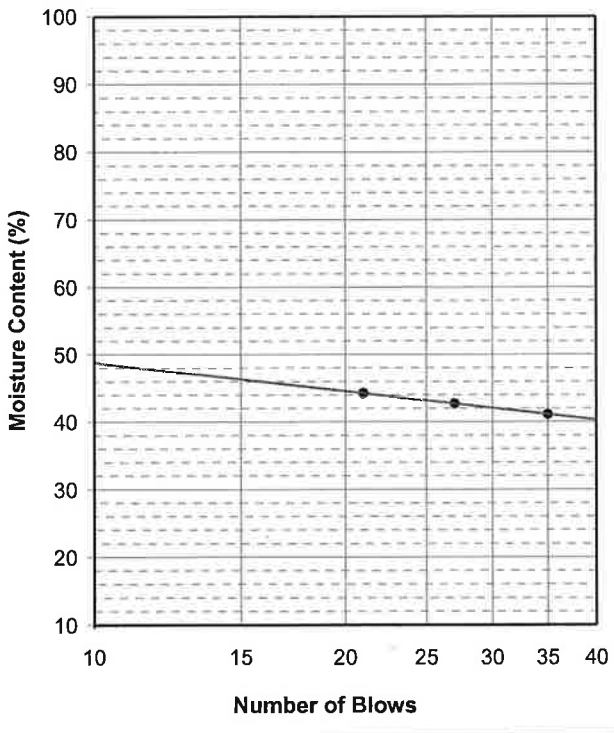
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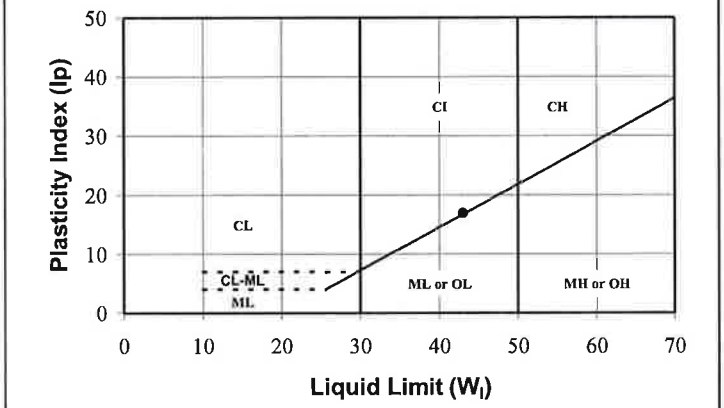
Date Sampled: Sampled By:

Date Tested: 28-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	20.10	20.15	358.2
Mass Dry Soil + Tare	19.37	19.42	279.5
Mass of Tare	16.58	16.69	11.4
Mass of Water	0.73	0.73	78.7
Mass of Dry Soil	2.79	2.73	268.1
Moisture Content (%)	26.2	26.7	29.4

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	35	27	21
Tare Number	c	d	e
Mass Wet Soil + Tare	47.80	45.38	45.34
Mass Dry Soil + Tare	38.70	36.86	36.77
Mass of Tare	16.57	16.91	17.41
Mass of Water	9.10	8.52	8.57
Mass of Dry Soil	22.13	19.95	19.36
Moisture Content (%)	41.1	42.7	44.3





Natural Moisture (%)	29.4
Liquid Limit (%)	43
Plastic Limit (%)	26
PLASTICITY INDEX	17

Soil Description: Medium Plasticity

Mod.USCS Symbol: **CI**

Remarks:

reviewed by: CPM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand

Sample Number: L-18

Borehole Number: 8-2

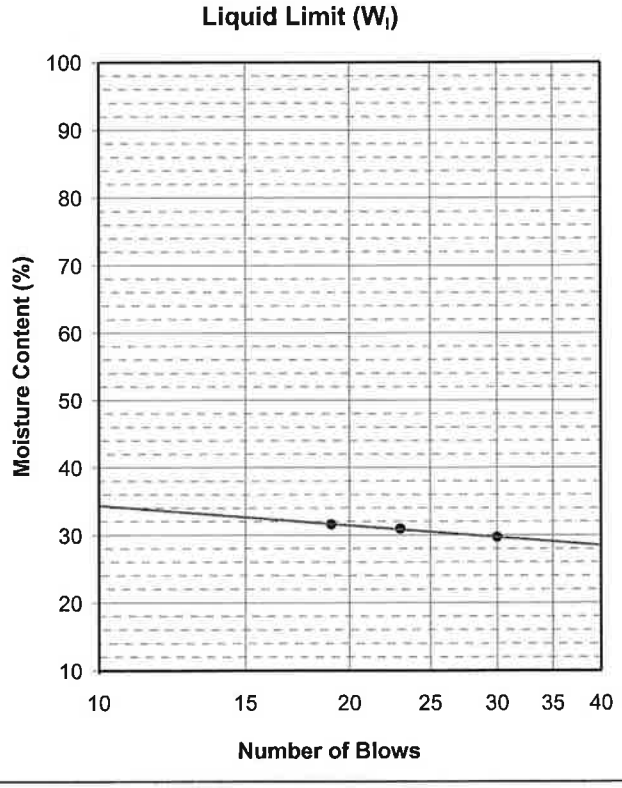
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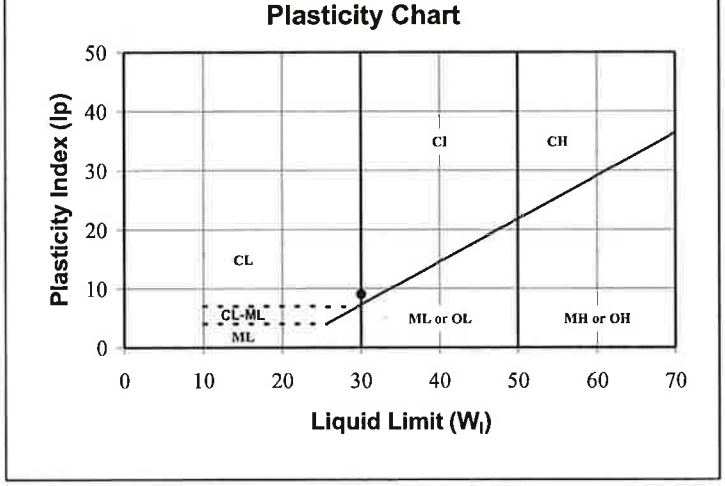
Date Sampled: Sampled By:

Date Tested: 28-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	19.79	19.21	1118.5
Mass Dry Soil + Tare	19.31	18.80	877.5
Mass of Tare	17.01	16.85	127.8
Mass of Water	0.48	0.41	241.0
Mass of Dry Soil	2.30	1.95	749.7
Moisture Content (%)	20.9	21.0	32.1

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	30	23	19
Tare Number	c	d	e
Mass Wet Soil + Tare	42.71	49.03	48.08
Mass Dry Soil + Tare	36.74	41.36	40.62
Mass of Tare	16.63	16.57	17.02
Mass of Water	5.97	7.67	7.46
Mass of Dry Soil	20.11	24.79	23.60
Moisture Content (%)	29.7	30.9	31.6





Natural Moisture (%)	32.1
Liquid Limit (%)	30
Plastic Limit (%)	21
PLASTICITY INDEX	9

Soil Description: Low to Medium Plasticity

Mod.USCS Symbol: **CL - CI**

Remarks:

reviewed by:

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand

Sample Number: L-20

Borehole Number: 9-2

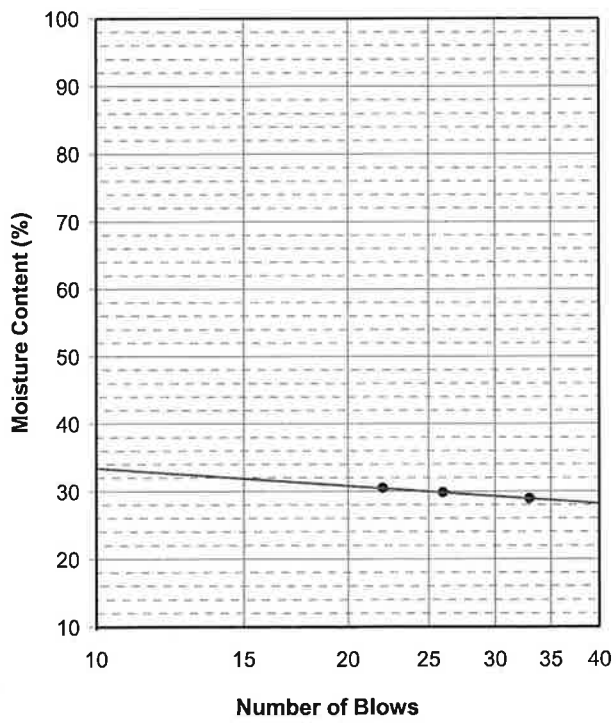
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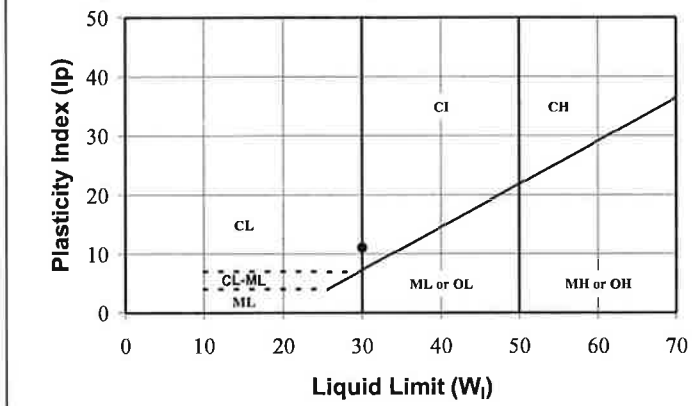
Date Sampled: _____ Sampled By: _____

Date Tested: 28-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	20.49	20.86	961.5
Mass Dry Soil + Tare	19.90	20.24	759.4
Mass of Tare	16.88	16.88	115
Mass of Water	0.59	0.62	202.1
Mass of Dry Soil	3.02	3.36	644.4
Moisture Content (%)	19.5	18.5	31.4

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	33	26	22
Tare Number	c	d	e
Mass Wet Soil + Tare	44.16	49.58	53.11
Mass Dry Soil + Tare	37.98	42.04	44.60
Mass of Tare	16.63	16.75	16.68
Mass of Water	6.18	7.54	8.51
Mass of Dry Soil	21.35	25.29	27.92
Moisture Content (%)	28.9	29.8	30.5





Natural Moisture (%)	31.4
Liquid Limit (%)	30
Plastic Limit (%)	19
PLASTICITY INDEX	**11**

Soil Description: Low to Medium Plasticity

Mod.USCS Symbol: **CL - CI**

Remarks: _____

reviewed by: CM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, sandy, gravelly

Sample Number: L-26

Borehole Number: 14-1

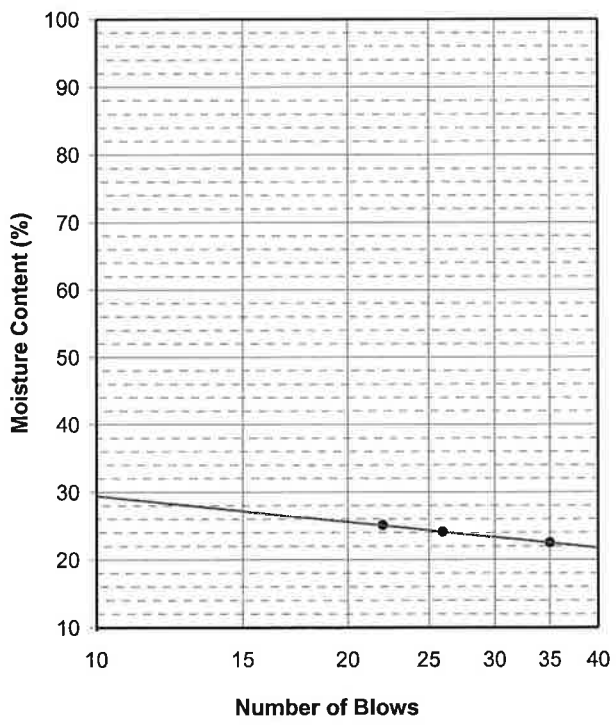
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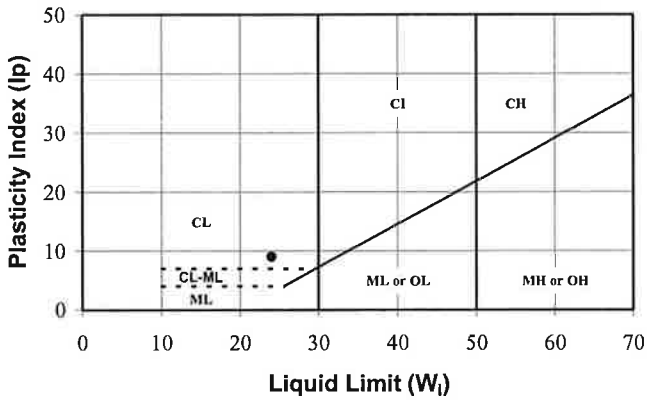
Date Sampled: Sampled By:

Date Tested: 30-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	20.79	20.68	1225.5
Mass Dry Soil + Tare	20.27	20.14	1125.7
Mass of Tare	16.80	16.57	247.3
Mass of Water	0.52	0.54	99.8
Mass of Dry Soil	3.47	3.57	878.4
Moisture Content (%)	15.0	15.1	11.4

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	35	26	22
Tare Number	c	d	e
Mass Wet Soil + Tare	47.94	43.73	48.34
Mass Dry Soil + Tare	42.19	38.48	42.06
Mass of Tare	16.64	16.73	17.02
Mass of Water	5.75	5.25	6.28
Mass of Dry Soil	25.55	21.75	25.04
Moisture Content (%)	22.5	24.1	25.1





Natural Moisture (%)	11.4
Liquid Limit (%)	24
Plastic Limit (%)	15
PLASTICITY INDEX	**9**

Soil Description: Low Plasticity

Mod.USCS Symbol: **CL**

Remarks:

reviewed by: CAM

EBA Engineering Consultants Ltd.

ATTERBERG LIMITS TEST FORM

ASTM D4318

Project: Worley Parsons Material Testing

Project Number: C12201471

Sample Description: CLAY, silty, trace sand

Sample Number: L-27

Borehole Number: 15-1

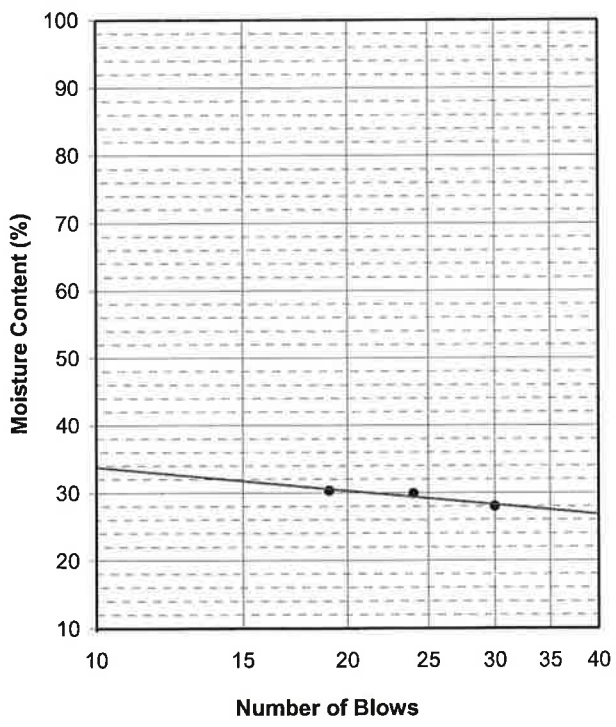
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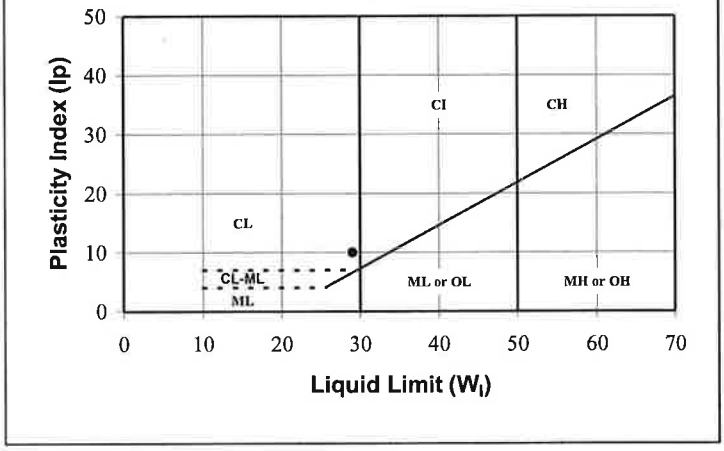
Date Sampled: Sampled By:

Date Tested: 30-Sep-10 Tested By: JB

Plastic Limit Test			Natural Moisture
Trial Number	1	2	
Tare Number	a	b	
Mass Wet Soil + Tare	19.95	20.00	1365.8
Mass Dry Soil + Tare	19.43	19.47	1141.4
Mass of Tare	16.72	16.79	125.5
Mass of Water	0.52	0.53	224.4
Mass of Dry Soil	2.71	2.68	1015.9
Moisture Content (%)	19.2	19.8	22.1

Liquid Limit Test			
Trial Number	1	2	3
No. of Blows	30	24	19
Tare Number	c	d	e
Mass Wet Soil + Tare	49.01	46.28	45.83
Mass Dry Soil + Tare	42.09	39.51	39.05
Mass of Tare	17.37	16.85	16.68
Mass of Water	6.92	6.77	6.78
Mass of Dry Soil	24.72	22.66	22.37
Moisture Content (%)	28.0	29.9	30.3





Natural Moisture (%)	22.1
Liquid Limit (%)	29
Plastic Limit (%)	19
PLASTICITY INDEX	**10**

Soil Description: Low to Medium Plasticity

Mod.USCS Symbol: **CL - CI**

Remarks:

reviewed by: CM

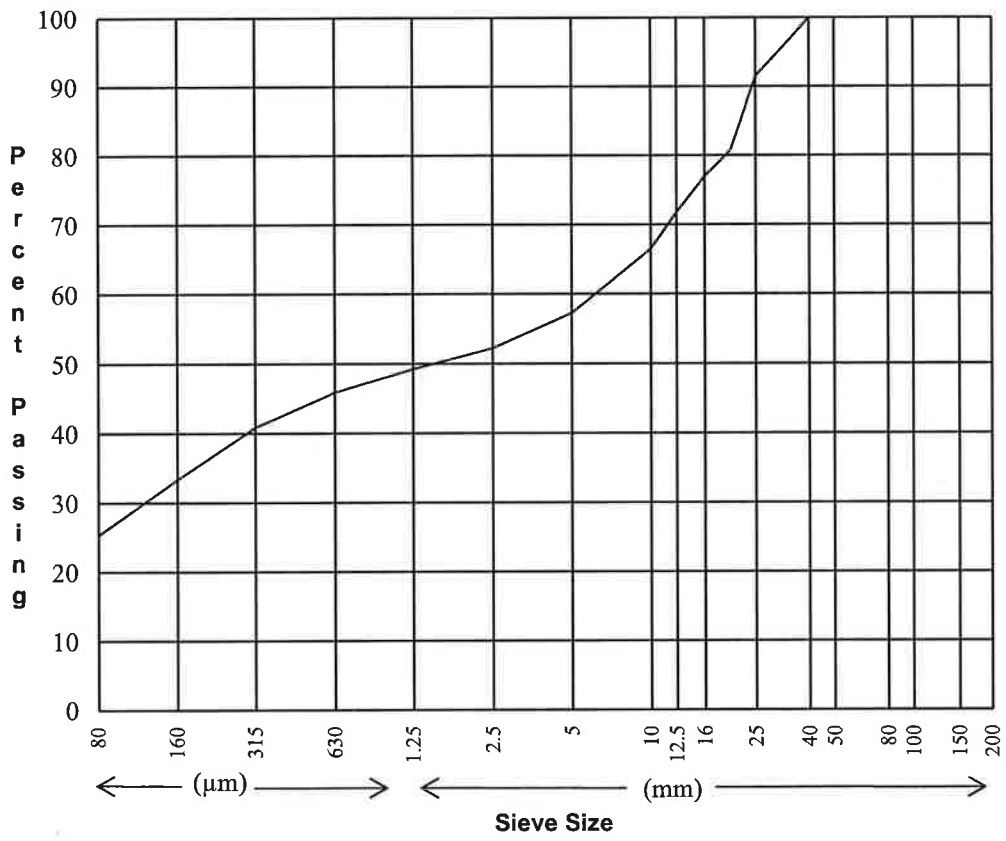
EBA Engineering Consultants Ltd.

AGGREGATE ANALYSIS TEST REPORT

ASTM C136, C117

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-1
Client:	Worley Parsons Canada Testing Ltd.	Date Sampled:	N/A
Project No.:	C12201471	Sampled By:	By Client
Attention:	Lee Martin	Date Tested:	August 17, 2010
Description:	GRAVEL, sandy, some silt, some clay	Tested By: JB	Lab: Calgary
Source:	1-2	No. Crushed Faces:	
Location:	Eureka, NT	Moisture Content:	5.9%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	92
20 mm	81
16 mm	77
12.5 mm	72
10 mm	67
5.00 mm	57
2.5 mm	52
1.25 mm	49
630 µm	46
315 µm	41
160 µm	33
80 µm	25.4



Remarks:

Reviewed By: C P Magnan P.Eng.

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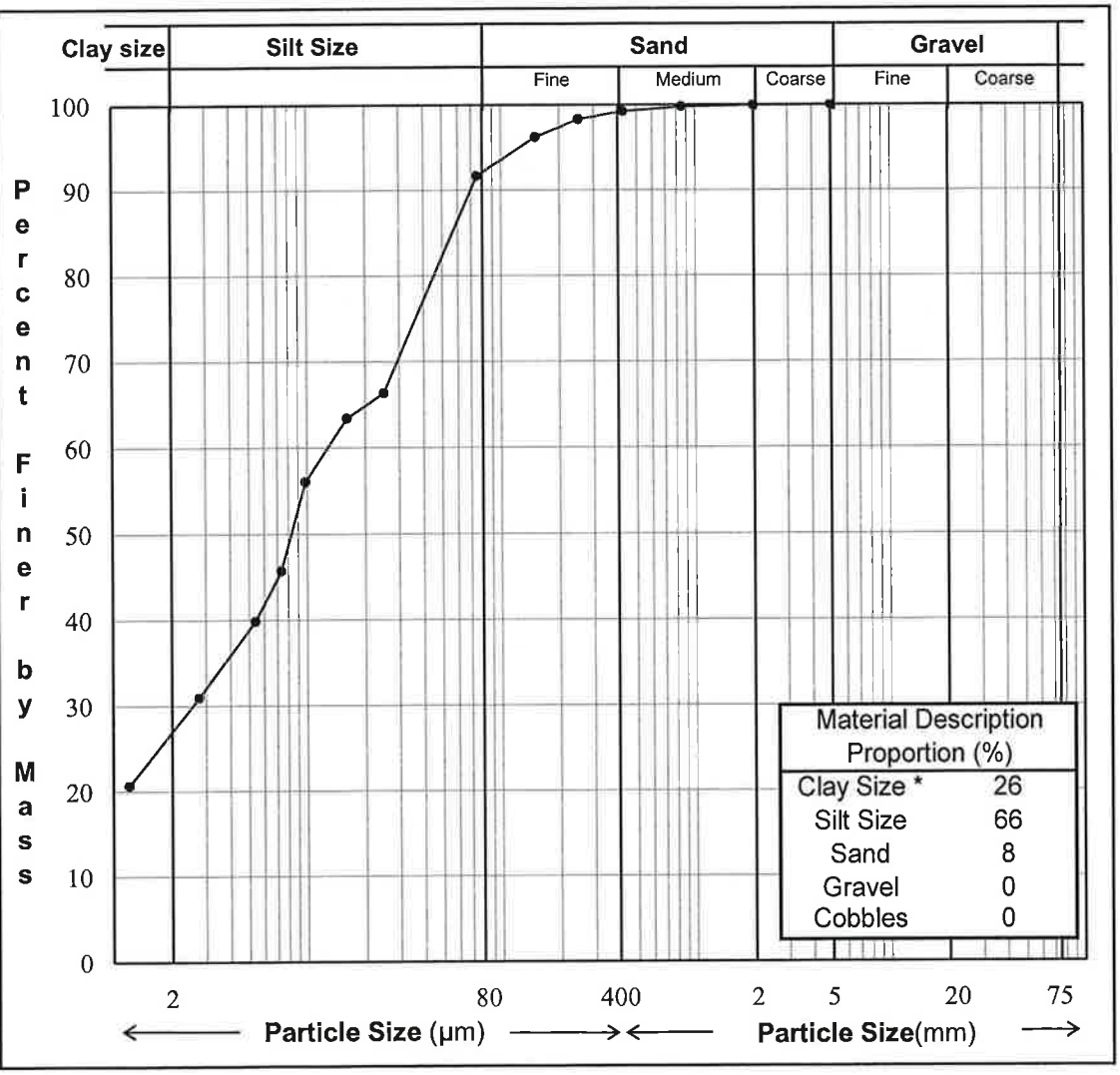
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-2
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	1 - 2
Project No.:	C12201471	Depth:	0.5 m
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	CLAY, silty, trace sand		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	100
2 mm	100
850 µm	100
425 µm	99
250 µm	98
150 µm	96
75 µm	92
25 µm	66
16 µm	63
10 µm	56
7 µm	46
5 µm	40
3 µm	31
1 µm	21



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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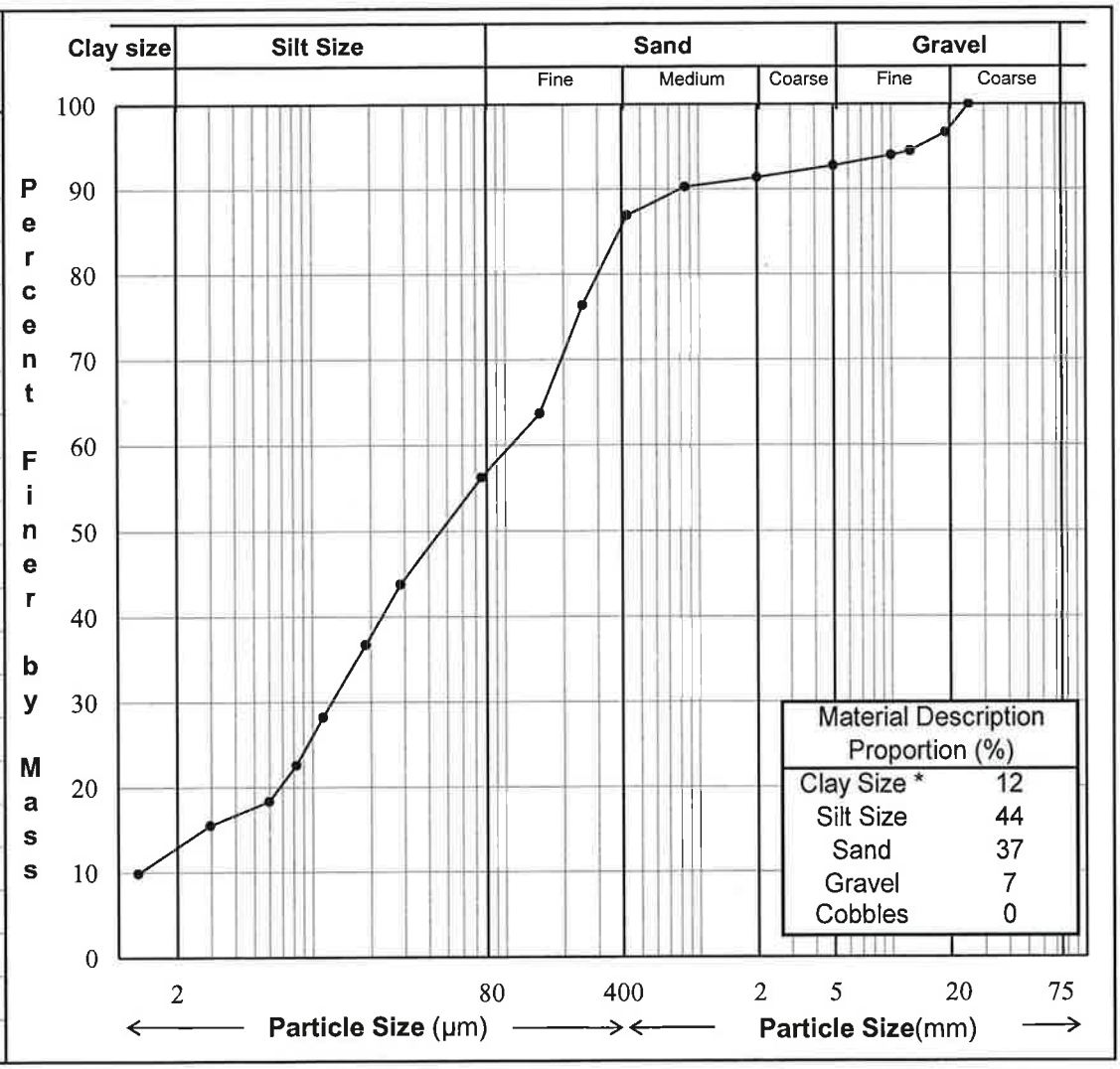
EBA Engineering Consultants Ltd. eba

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-8
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	3-2
Project No.:	C12201471	Depth:	0.75 m
Location:	Eureka, NT	Date Tested	September 27, 2010
Description **:	CLAY, silty, sandy, trace gravel		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	100
19 mm	97
13 mm	94
10 mm	94
5 mm	93
2 mm	91
850 µm	90
425 µm	87
250 µm	76
150 µm	64
75 µm	56
29 µm	44
19 µm	37
11 µm	28
8 µm	23
6 µm	18
3 µm	16
1 µm	10



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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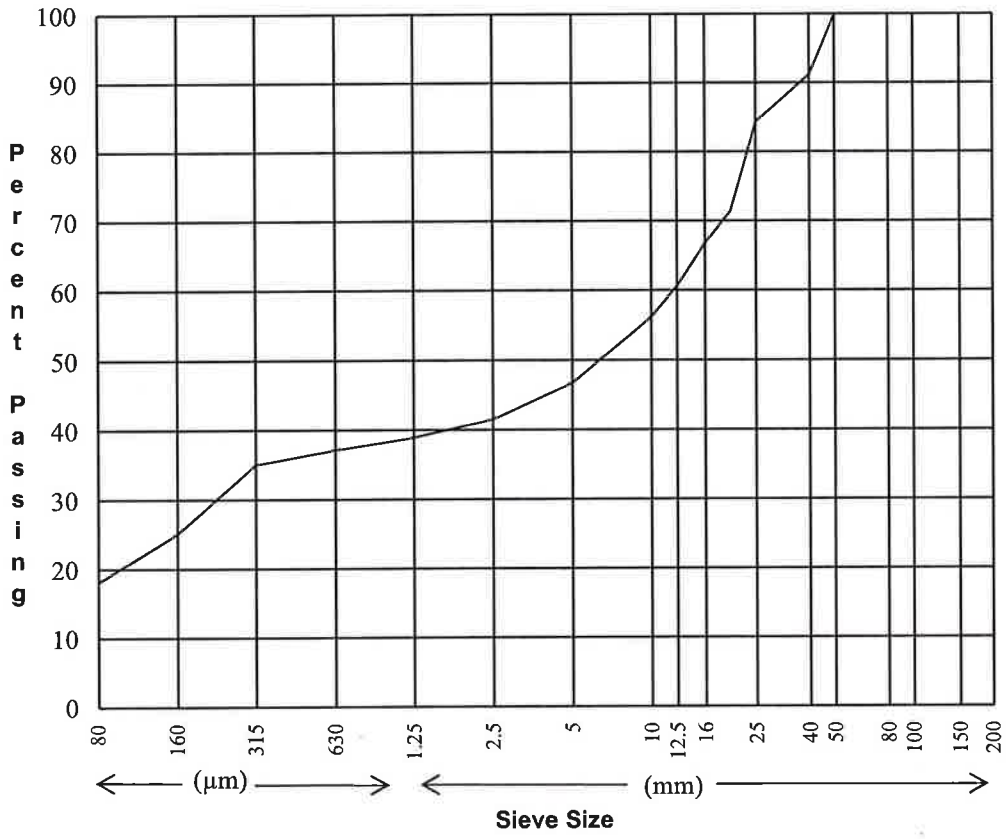
EBA Engineering Consultants Ltd. eba

AGGREGATE ANALYSIS TEST REPORT

ASTM C136, C117

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-9
Client:	Worley Parsons Canada Testing Ltd.	Date Sampled:	N/A
Project No.:	C12201471	Sampled By:	By Client
Attention:	Lee Martin	Date Tested:	September 27, 2010
Description:	GRAVEL, sandy, some silt, some clay	Tested By: JB	Lab: Calgary
Source:	4-1	No. Crushed Faces:	
Location:	Eureka, NT	Moisture Content:	3.9%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	100
40 mm	91
25 mm	84
20 mm	71
16 mm	67
12.5 mm	61
10 mm	56
5.00 mm	47
2.5 mm	42
1.25 mm	39
630 µm	37
315 µm	35
160 µm	25
80 µm	18.1



Remarks:

Reviewed By: C.P. Magnan P.Eng.

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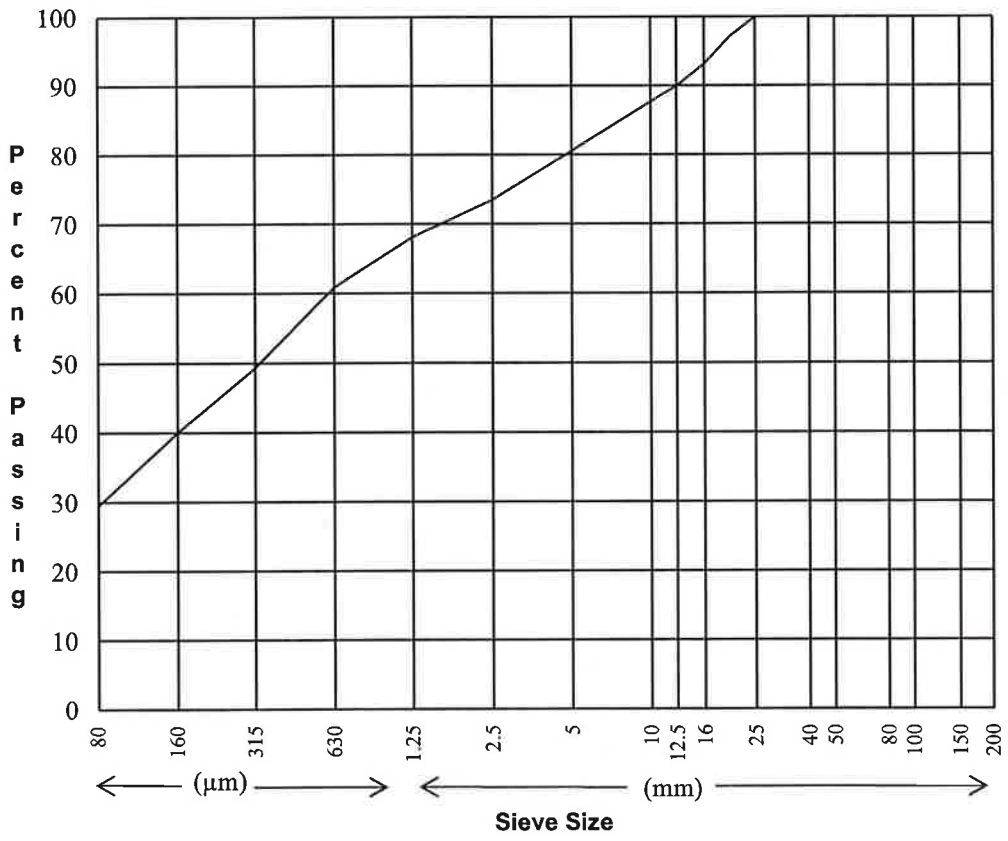
EBA Engineering Consultants Ltd.

AGGREGATE ANALYSIS TEST REPORT

ASTM C136, C117

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-13
Client:	Worley Parsons Canada Testing Ltd.	Date Sampled:	N/A
Project No.:	C12201471	Sampled By:	By Client
Attention:	Lee Martin	Date Tested:	September 27, 2010
Description:	SAND, some gravel, some silt, some clay	Tested By: JB	Lab: Calgary
Source:	6-1	No. Crushed Faces:	
Location:	Eureka, NT	Moisture Content:	3.8%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	97
16 mm	93
12.5 mm	90
10 mm	88
5.00 mm	81
2.5 mm	73
1.25 mm	68
630 µm	61
315 µm	49
160 µm	40
80 µm	29.5



Remarks:

Reviewed By: C. Mageau P. Eng.

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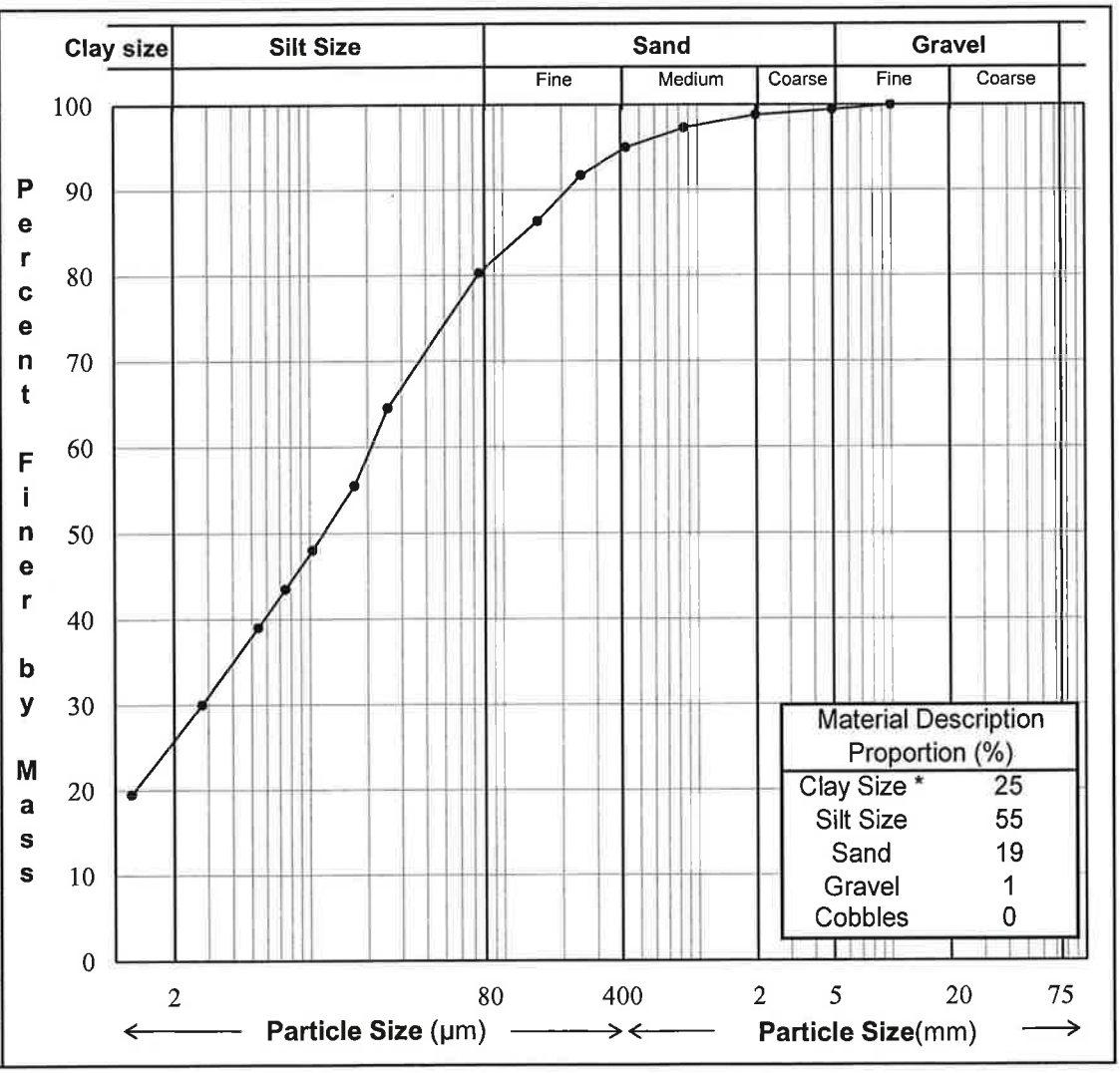
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-14
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	6 - 2
Project No.:	C12201471	Depth:	1.0 m
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	CLAY, silty, some sand, trace gravel (organic soil)		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	100
5 mm	99
2 mm	99
850 µm	97
425 µm	95
250 µm	92
150 µm	86
75 µm	80
25 µm	65
17 µm	56
10 µm	48
7 µm	44
5 µm	39
3 µm	30
1 µm	20



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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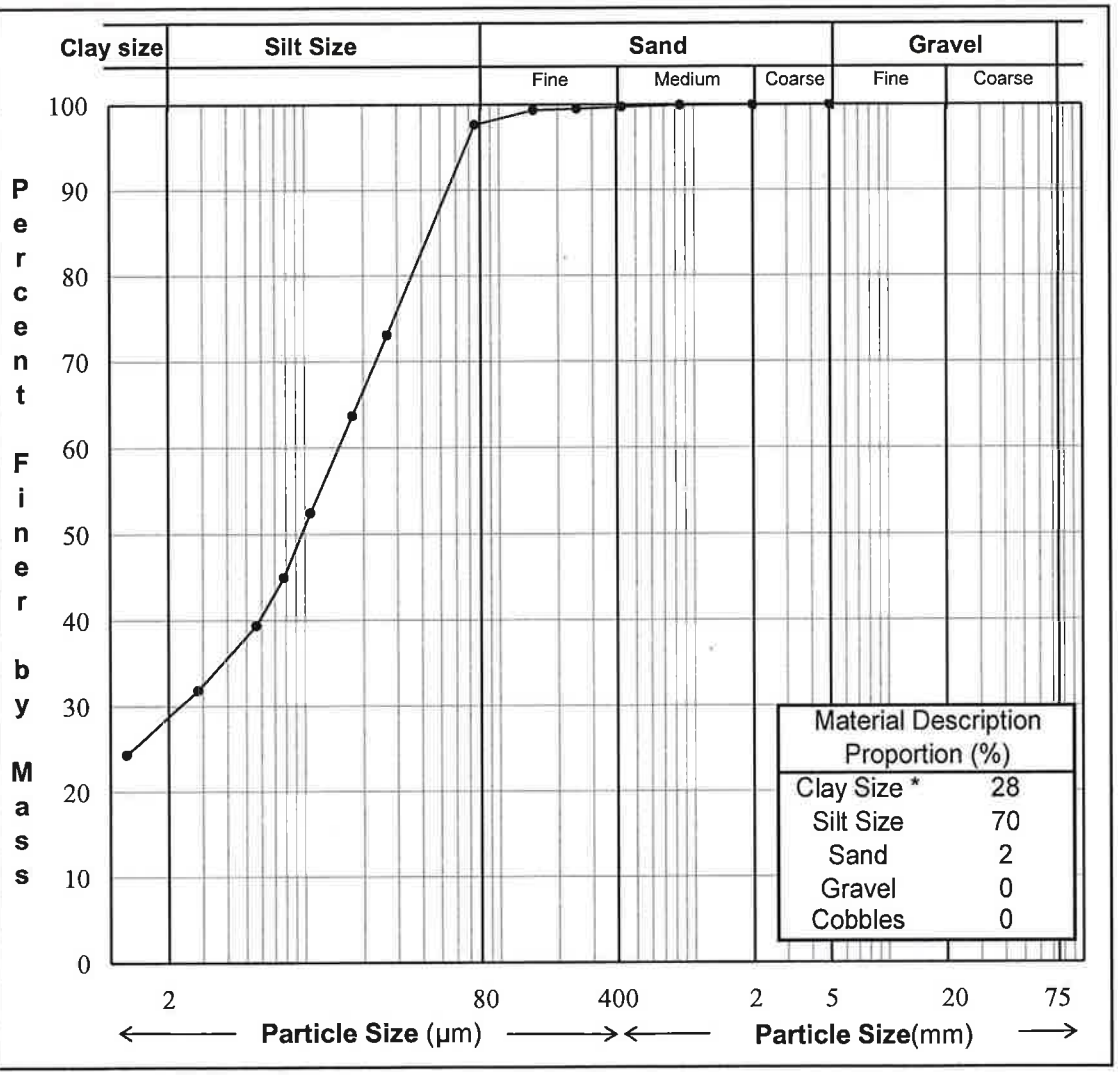
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-18
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	8-2
Project No.:	C12201471	Depth:	1.5 m
Location:	Eureka, NT	Date Tested	September 27, 2010
Description **:	CLAY, silty, trace sand		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	100
2 mm	100
850 µm	100
425 µm	100
250 µm	100
150 µm	99
75 µm	98
27 µm	73
18 µm	64
11 µm	52
8 µm	45
6 µm	39
3 µm	32
1 µm	24



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

Reviewed By: _____ P.Eng.

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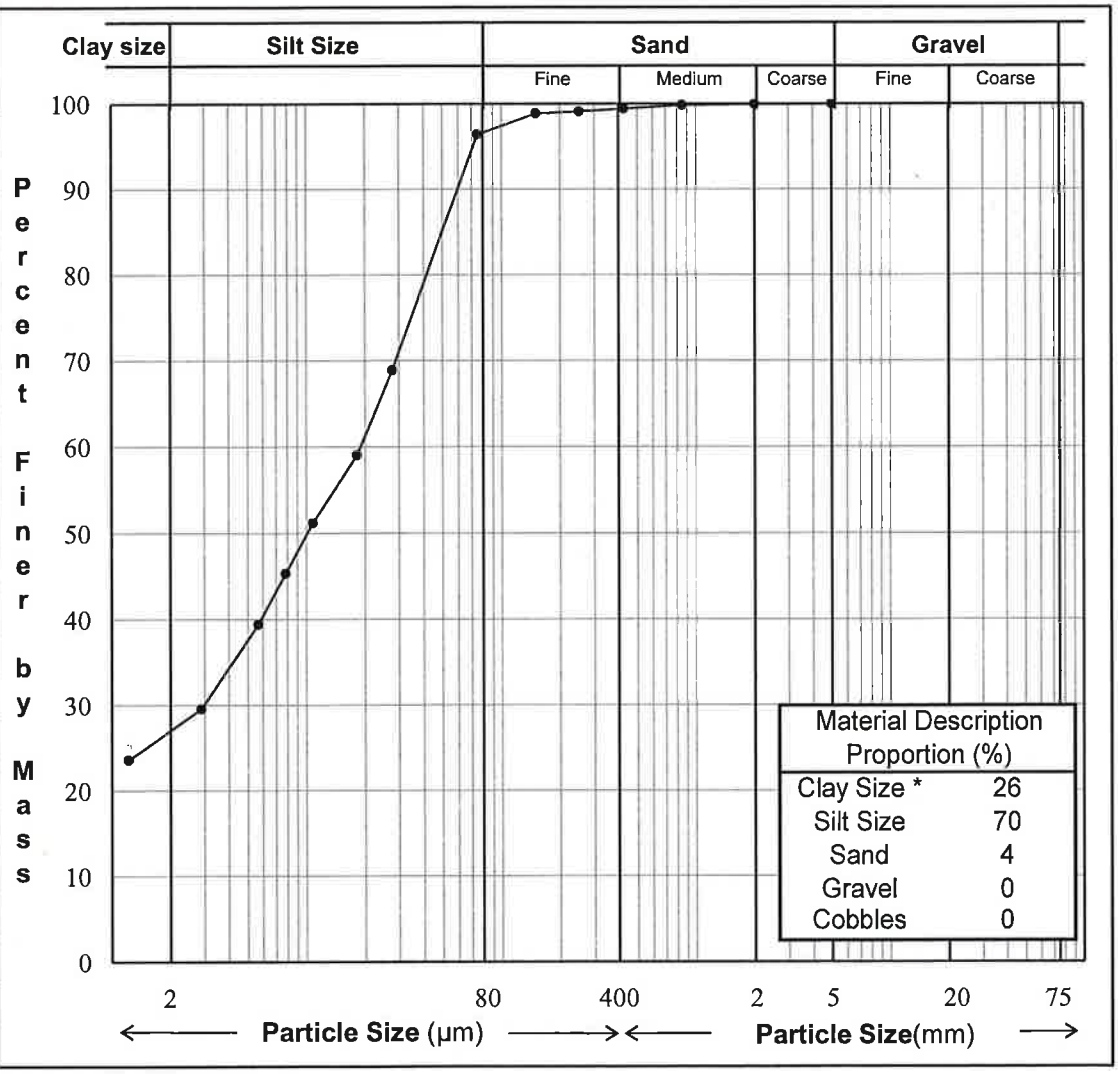
EBA Engineering Consultants Ltd. eba

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-20
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	9-2
Project No.:	C12201471	Depth:	
Location:	Eureka, NT	Date Tested	September 27, 2010
Description **:	CLAY, silty, trace sand		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	100
2 mm	100
850 µm	100
425 µm	99
250 µm	99
150 µm	99
75 µm	96
28 µm	69
18 µm	59
11 µm	51
8 µm	45
6 µm	39
3 µm	30
1 µm	24



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

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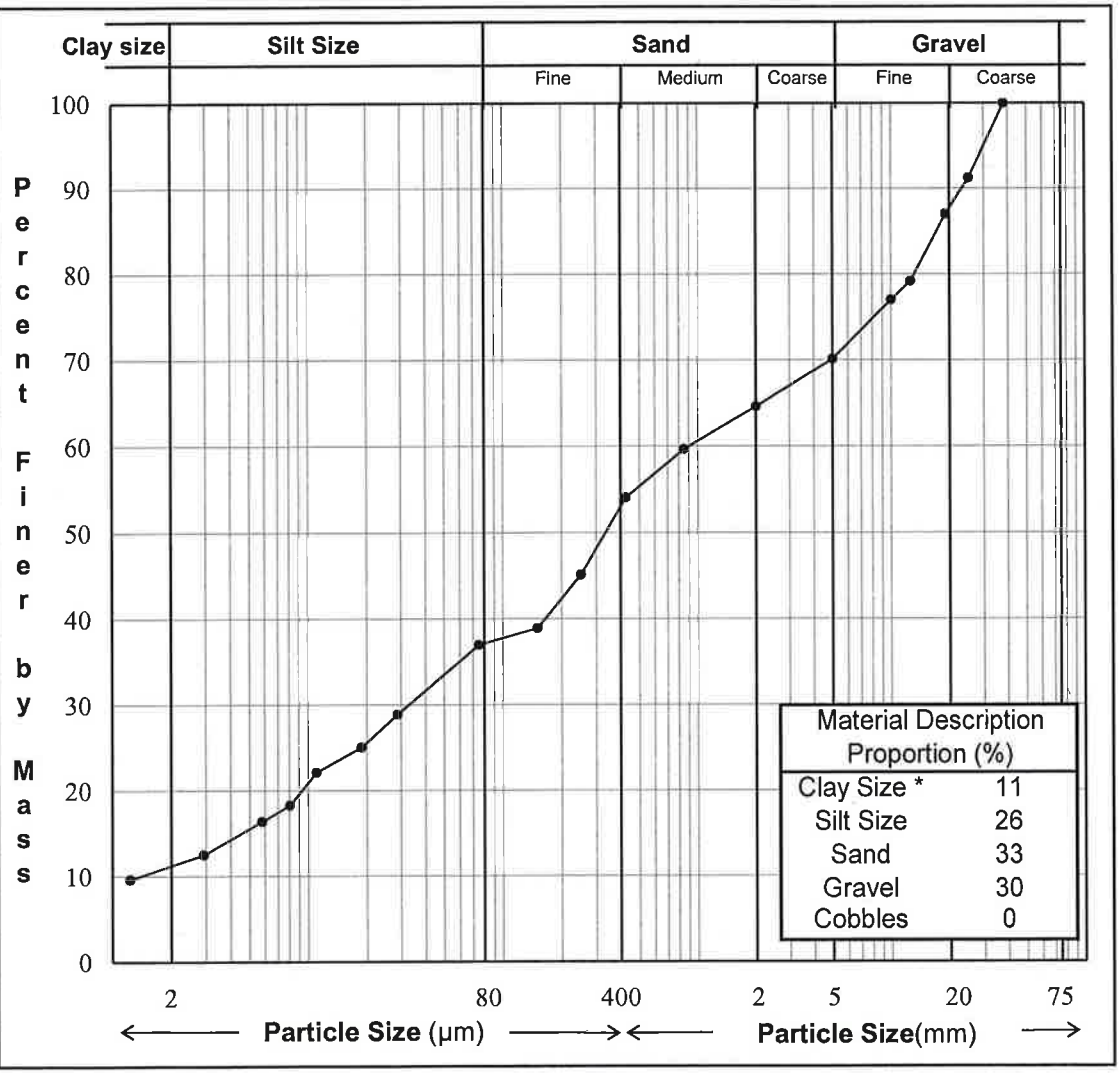
EBA Engineering Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-26
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	14 - 1
Project No.:	C12201471	Depth:	0.5 m
Location:	Eureka, NT	Date Tested	September 30, 2010
Description **:	CLAY, silty, sandy, gravelly		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	91
19 mm	87
13 mm	79
10 mm	77
5 mm	70
2 mm	65
850 µm	60
425 µm	54
250 µm	45
150 µm	39
75 µm	37
29 µm	29
19 µm	25
11 µm	22
8 µm	18
6 µm	16
3 µm	13
1 µm	10



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

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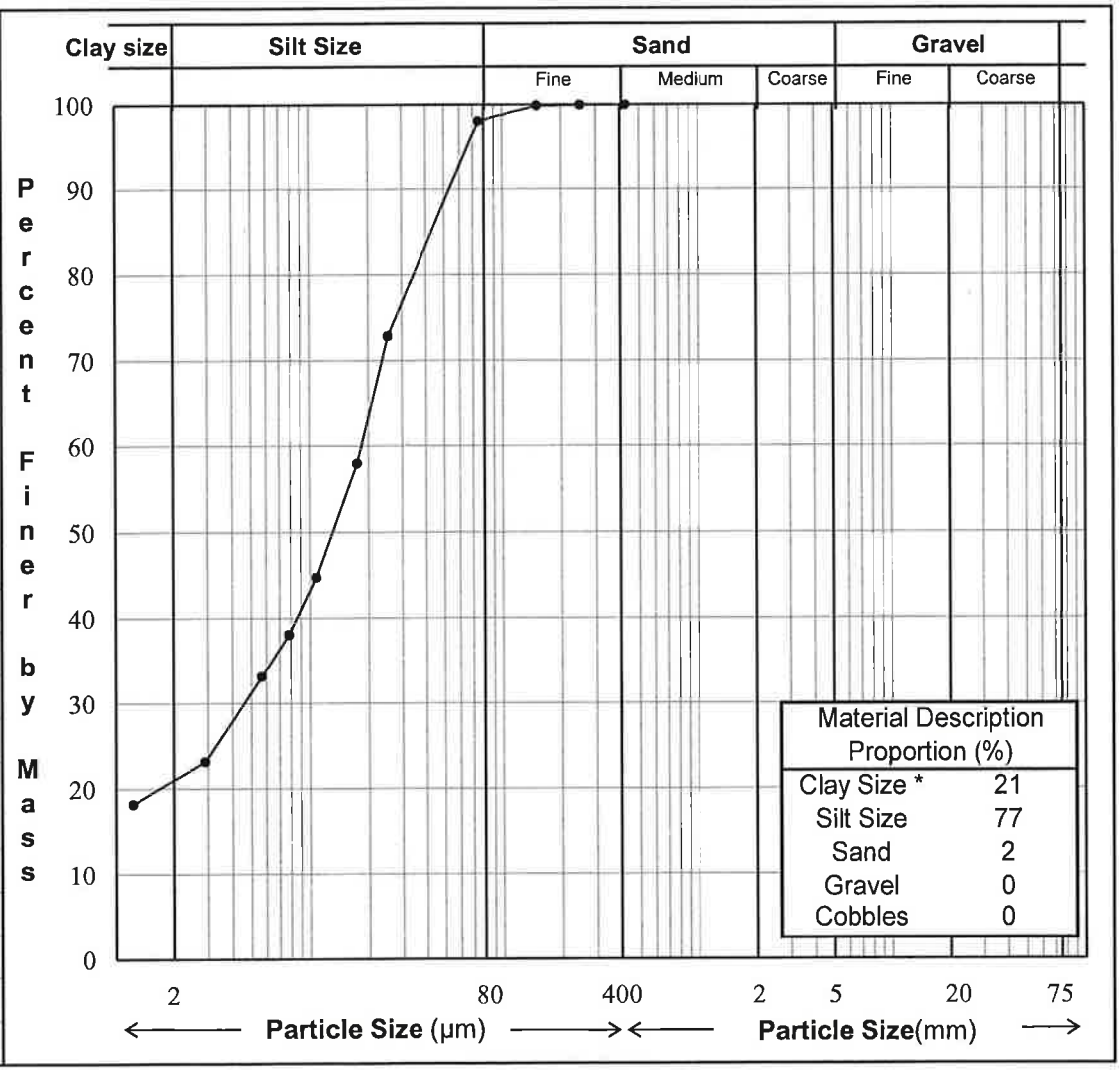
EBA Engineering Consultants Ltd. eba

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-27
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	15 - 1
Project No.:	C12201471	Depth:	1.0 m
Location:	Eureka, NT	Date Tested	September 30, 2010
Description **:	CLAY, silty, trace sand		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	
2 mm	
850 µm	
425 µm	100
250 µm	100
150 µm	100
75 µm	98
25 µm	73
17 µm	58
11 µm	45
8 µm	38
6 µm	33
3 µm	23
1 µm	18



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

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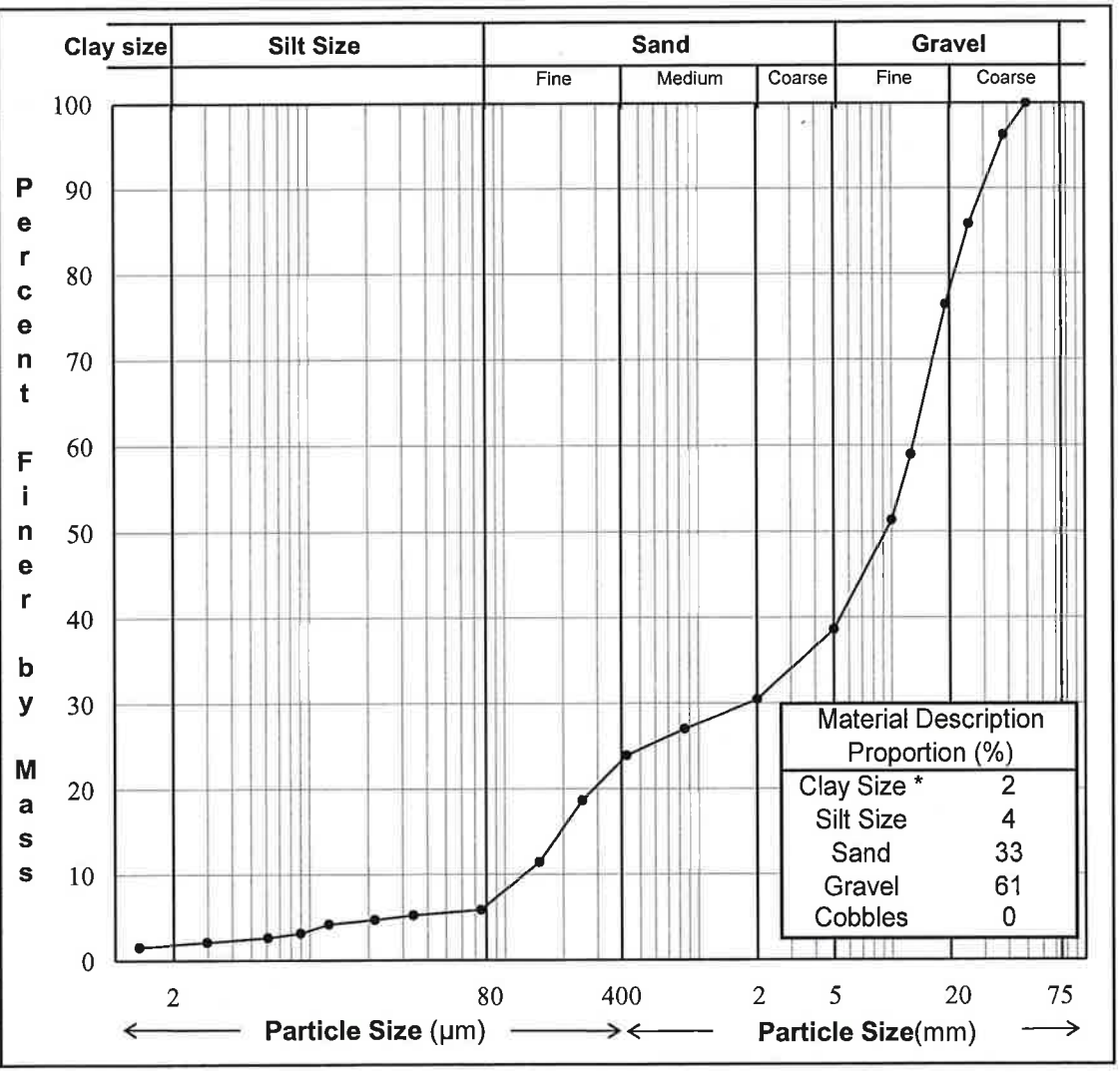
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PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-29
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	Bulk 2
Project No.:	C12201471	Depth:	Pier
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	Gravel, sandy, trace silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	96
25 mm	86
19 mm	76
13 mm	59
10 mm	51
5 mm	39
2 mm	30
850 µm	27
425 µm	24
250 µm	19
150 µm	11
75 µm	6
34 µm	5
22 µm	5
13 µm	4
9 µm	3
6 µm	3
3 µm	2
1 µm	2



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

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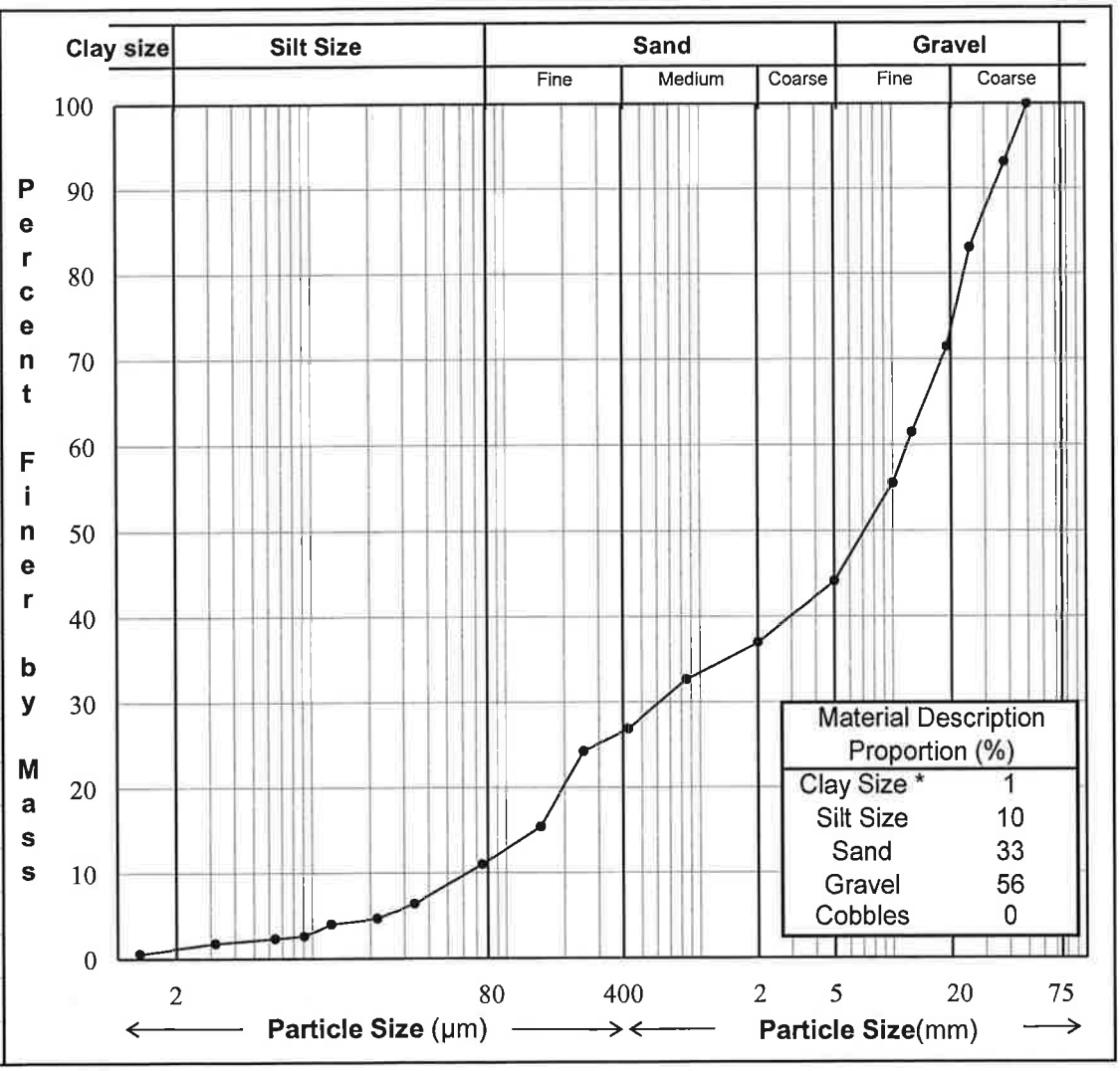
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PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-30
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	Bulk 3
Project No.:	C12201471	Depth:	Sandstone
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	Gravel, sandy, some silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	93
25 mm	83
19 mm	71
13 mm	62
10 mm	56
5 mm	44
2 mm	37
850 µm	33
425 µm	27
250 µm	24
150 µm	15
75 µm	11
34 µm	6
22 µm	5
13 µm	4
9 µm	3
6 µm	2
3 µm	2
1 µm	1



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

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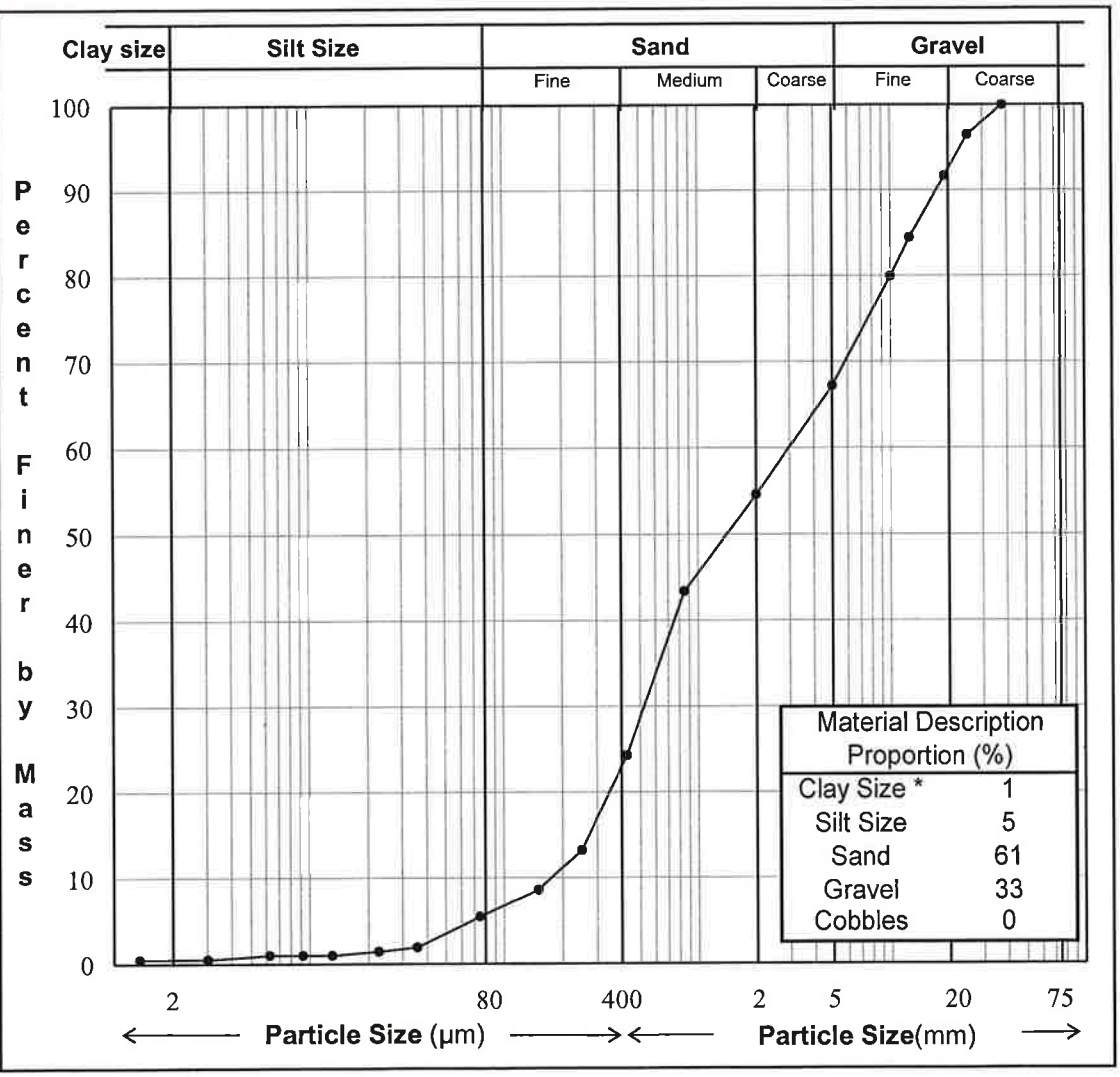
EBA Engineering Consultants Ltd. eba

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-31
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	Bulk 4
Project No.:	C12201471	Depth:	Blacktop Cr.
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	SAND, gravelly, trace silt, trace clay		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	96
19 mm	92
13 mm	84
10 mm	80
5 mm	67
2 mm	55
850 µm	43
425 µm	24
250 µm	13
150 µm	9
75 µm	5
36 µm	2
23 µm	1
13 µm	1
9 µm	1
6 µm	1
3 µm	0
1 µm	0



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

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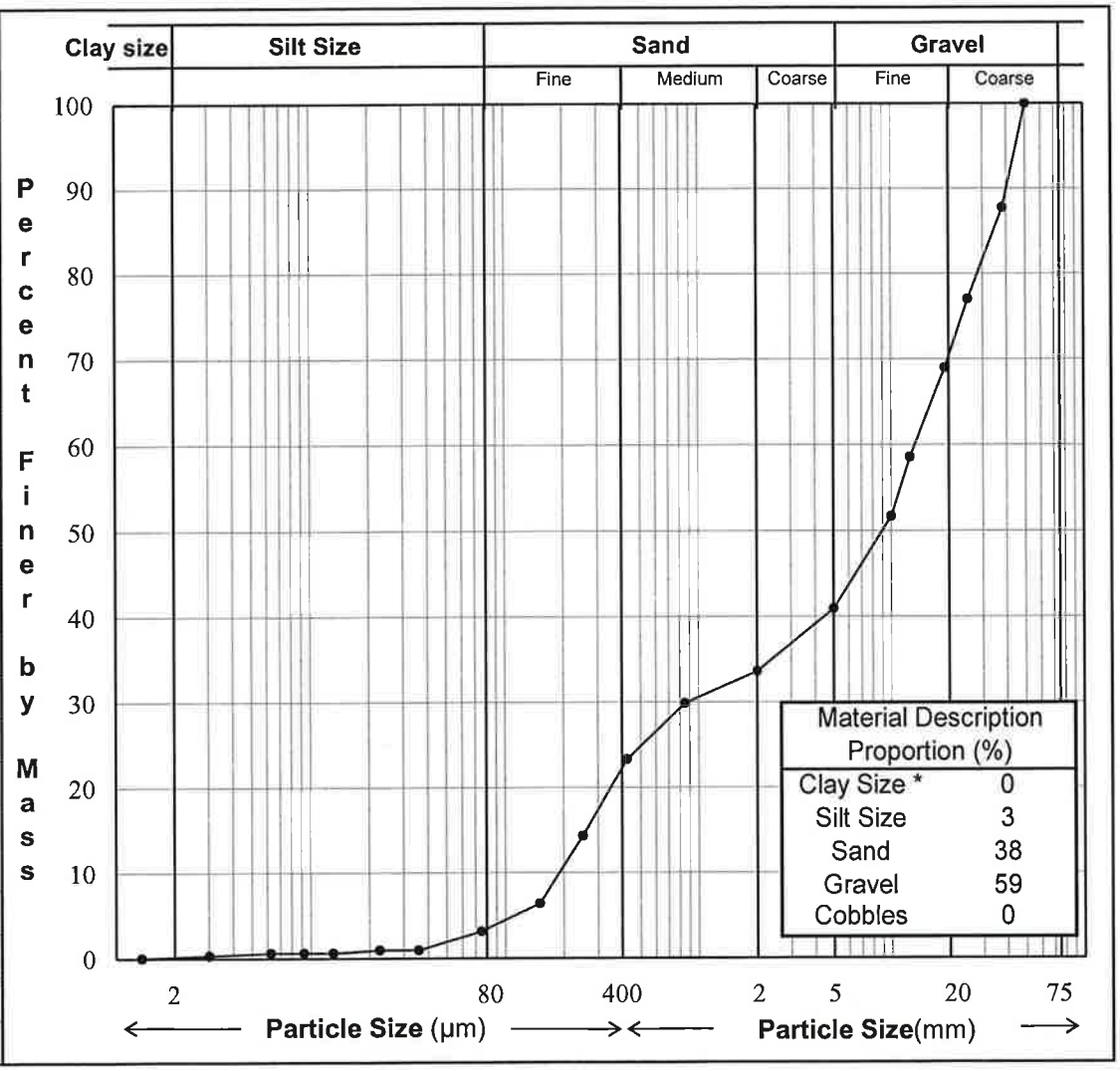
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PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	Worley Parsons Material Testing - 2010	Sample No.:	L-32
Client:	Worley Parsons Canada Services Ltd.	Borehole/ TP:	Bulk 6
Project No.:	C12201471	Depth:	Remus Cr.
Location:	Eureka, NT	Date Tested	September 14, 2010
Description **:	GRAVEL, sandy, trace silt		

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	88
25 mm	77
19 mm	69
13 mm	59
10 mm	52
5 mm	41
2 mm	34
850 µm	30
425 µm	23
250 µm	14
150 µm	6
75 µm	3
36 µm	1
23 µm	1
13 µm	1
9 µm	1
6 µm	1
3 µm	0
1 µm	0



Remarks: * The upper clay size of 2 µm is as per the Canadian Foundation Manual.

** The description is behaviour based & subject to EBA description protocols.

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PERCENTAGE OF FLAT & ELONGATED PARTICLES

ASTM D 4791 - 05

Project No:	C12201471	**Sample No.:**	L-31
Project:	Worley Parsons Material Testing - 2010	**Date Sampled:**	N/A
Client:	Worley Parsons Canada Ltd.	**Sampled By:**	Client
		Date Tested:	22-Sep-10
Attention:	Lee Martin **Fax:**	**Tested By:**	JB
Email:	Lee.Martin@WorleyParsons.Com **Ph:** 403.247.5733	**Office:**	Calgary

Description: SAND, gravelly, trace silt, trace clay
Source: Bulk 4
Sample Location: Eureka, NT
Supplier: Worley Parsons Canada Ltd.

Flat: Ratio of width to thickness greater than 4
Elongated: Ratio of length to width greater than 4

Sample No.	Size Fraction (mm)		Proportion of Sample in Size Fraction (%)	Percentage by mass of sample (%)			
				flat	elongated	flat and elongated	neither flat nor elongated
L-31	50.0	37.5	4.0				
	37.5	25.0	4.0				
	25.0	19.0	8.0	0.0	0.0	5.2	94.8
	19.0	12.5	4.0	5.2	0.0	23.9	70.9
	12.5	9.5	13.0	9.5	0.0	16.2	74.3
	9.5	4.75	12.0				
			Weighted Average (9.5 mm retained)*			**26.7%**	**4:1 Ratio**

* Size fractions which have not been analysed are not included for the calculation

Remarks:

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PERCENTAGE OF FLAT & ELONGATED PARTICLES

ASTM D 4791 - 05

Project No:	C12201471	**Sample No.:**	L-32
Project:	Worley Parsons Material Testing - 2010	**Date Sampled:**	N/A
Client:	Worley Parsons Canada Ltd.	**Sampled By:**	Client
		Date Tested:	22-Sep-10
Attention:	Lee Martin **Fax:**	**Tested By:**	JB
Email:	Lee.Martin@WorleyParsons.Com **Ph:** 403.247.5733	**Office:**	Calgary

Description: GRAVEL, sandy, trace silt
Source: Bulk 6
Sample Location: Eureka, NT
Supplier: Worley Parsons Canada Ltd.

Flat: Ratio of width to thickness greater than 4
Elongated: Ratio of length to width greater than 4

Sample No.	Size Fraction (mm)		Proportion of Sample in Size Fraction (%)	Percentage by mass of sample (%)			
				flat	elongated	flat and elongated	neither flat nor elongated
L-32	50.0	37.5	12.0				
	37.5	25.0	11.0	7.8	0.0	0.0	92.2
	25.0	19.0	8.0	17.7	0.0	4.4	78.0
	19.0	12.5	10.0	5.2	0.0	19.0	75.8
	12.5	9.5	7.0	11.9	0.0	16.7	71.4
	9.5	4.75	11.0				
			Weighted Average (9.5 mm retained)*			**14.9%**	**4:1 Ratio**

* Size fractions which have not been analysed are not included for the calculation

Remarks:

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Appendix 5 Digital Topographic Survey Report

FIELD REPORT – 2010

Topographic Survey
Eureka Weather Station
Eureka, Nunavut



PREPARED FOR:

WorleyParsons Canada Services Ltd.

PREPARED BY:

Ron Robinson, C.L.S., A.L.S.
Kris Jewett, P.Eng, C.L.S., A.L.S.

October 14, 2010 2010

INUKSHUK NUNASI
Geomatics

Inukshuk File 35062

EXECUTIVE SUMMARY

From August 14th to August 20th, 2010, Inukshuk Nunasi Geomatics (ING) carried out a topographic survey of the Eureka Weather Station including air strip; water reservoir; proposed lagoon locations; and buildings, as required by WorleyParsons Canada Services Ltd. The purpose of the survey was to derive elevations of the existing surfaces to facilitate the design of a lagoon and airstrip upgrade.

Surveyed co-ordinates and elevations were based on published values for GSD Monument 749167A and confirmed by means of check ties to NRCan Geodetic Survey Division (GSD) Monument 749167 along with post process to Canadian Active Control System (CACS) Station M059000 as well as using the NRCan Precise Point Positioning (PPP) Web site.

The survey included all areas required under the contract, as well as additional areas requested by WorleyParsons on site representative.

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2 Project Execution & Equipment ..... - 4 -
2.1 Project Planning ..... - 4 -
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2.3 GPS Processing and Adjustment ..... - 7 -
2.4 Scanner Processing and Adjustment ..... - 7 -
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1 Introduction

From August 14th to August 20th, 2010, Inukshuk Nunasi Geomatics (ING) carried out a topographic survey of the Eureka Weather Station, Nunavut, including the air strip; water reservoir; proposed lagoon locations; and buildings, as required by WorleyParsons Canada Services Ltd. The purpose of the survey was to derive elevations of the existing surfaces to facilitate the design of a lagoon and airstrip upgrade.

The topographic survey was performed with Real Time Kinematic (RTK) GPS using Leica 1200 Systems; Total Station survey using Lieca Robotic TPS 1201; and scanning using Lieca C10 3D Scanner.

Presented in this report are the results of the topographic survey.

2 Project Execution & Equipment

2.1 Project Planning

Prior to mobilization a field execution plan was developed taking into consideration the survey scope along with factors such as remoteness of project area, weather conditions and time available to execute the field project. Analysis was performed at Inukshuk's Calgary office to evaluate the appropriate survey data collection equipment for the project that would be cost effective; reliable; accurate; provide redundancy in the case of equipment failure; and gather the maximum amount of data in a short period of time.

A total of three survey data collection systems were dedicated and used on the project including Real Time Kinematic (RTK) GPS using Leica 1200 Systems; Total Station survey using Lieca Robotic TPS 1201; and scanning using Lieca C10 3D Scanner.

RTK GPS was chosen for topographic pick-up at the airstrip and water reservoir along with potentially using for topographic data collection at the Weather Station. RTK GPS requires a radio connection to a local base station but doesn't need a line of visual site therefore if fog or snow were encountered the RTK GPS would not be affected. Ionosphere activity may be a factor for RTK as during the summer of 2010 there has been significant Ionosphere activity which has had a detrimental effect on GPS positioning.

Robotic TPS 1201 would be used to pick-up buildings and as back up to RTK GPS for topographic data collection. The TPS 1201 is a one person system and data collection at times can be collected as expediently as RTK GPS. The TPS 1201 is a line of site instrument and therefore fog or snow would affect productivity.

The Lieca C10 3D Scanner is a leading edge data collection instrument enabling the gathering of data points at spacing of a few centimeters to a radius of 200 metres with an accuracy of less than 10 mm. All objects within the scanner field of views are captured allowing the preparation of comprehensive three dimensional plans showing all buildings, features and surfaces.

The 3D Scanner would be used in congested areas around the Weather Station and for gathering topographic shots in the areas of the proposed lagoons. The Scanner is a line of site instrument therefore fog, rain or snow would affect productivity.

Before mobilizing to Eureka, all three systems were checked and tested by the project party chief to confirm operator expertise and identify any technical issues. In addition the project party chief was briefed on the execution plan and survey scope.

In addition to the GPS equipment, the field crew was also equipped with:

- Laptop with Leica software
- Personal protective equipment
- First aid kit
- Personal gear
- Tripods and prisms

The laptop with Leica software was used by the field crew to initially verify and inspect the integrity of the daily field data that had been collected in addition to reviewing the completeness and precision of the survey. The remaining equipment was taken for safety and communication.

2.2 Field Execution

The field data was collected from August 14th to August 20th, 2010 utilizing the Leica 1200 GPS Systems, Lieca Robotic TPS 1201 and Lieca C10 3D Scanner.

The survey covered all areas specified under the contract including:

1. The airstrip portion of the topographic survey is to include runway; taxiways; adjacent areas; airstrip buildings; signage and lighting; windsock; navigation aids.

2. The runway is to have a 5 point cross section at 20 metre intervals over the length of the 1500 metre runway plus an additional 3 point cross section on the shoulder on each side of the runway also at 20m intervals.

3. The sewage lagoon topo survey is to include the sites for the two proposed lagoon options with elevations obtained at a spacing of no further than 20 metres.

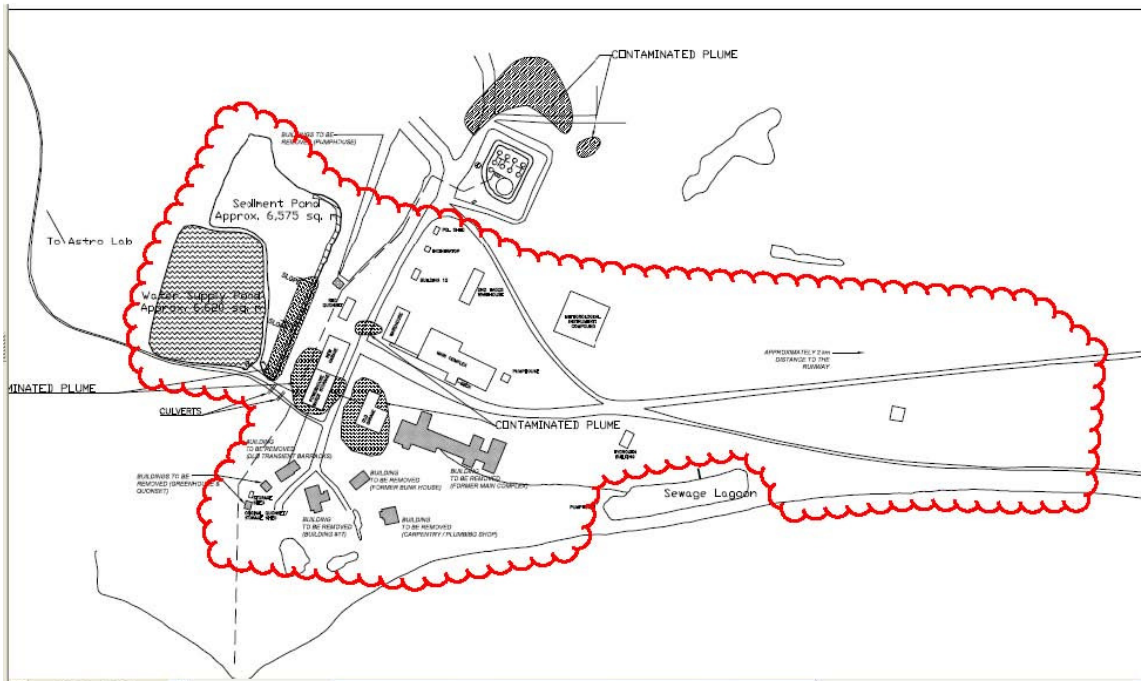
4. In addition to the above, we would gather topographic data between the proposed sewage lagoons and the ordinary high-water mark (OHM) of the adjacent fiord at a maximum spacing of 20m.

5. We would survey a 3 point cross section at 20m intervals along the routes of the proposed force main between the lagoon options and the main weather station.

6. The weather station area survey will include all occupied or abandoned buildings, utilities and obtain topographic data around the buildings and reservoir at a minimum of 20m spacing.
7. Soundings are required in the water supply reservoir and sediment pond at a maximum spacing of 20m.

8. Topographic survey doesn't include the existing lagoon; fuel storage; access roads between weather station and airstrip.

9. In general all topographic data will be gathered at a maximum spacing of 20m with additional shots as is necessary to accurately and unambiguously define features and break lines at a relative accuracy of 15mm or less.



Survey Area at Weather Station and Proposed Lagoon Sites

10. Survey will be tied to the local GSD monuments including Canadian Active Control Station (CACS) Eureka.

11. Deliverables include ASCII point files in grid and ground; 1:1000 ACAD drawing with 0.2m contours; survey report

NRCan Geodetic Survey Division (GSD) Monuments 749167A and 749167, in the project area and adjacent to the airstrip were located and used as reference points for the survey project. The GSD published station coordinates for both monuments were derived using GPS methods with the CGVD28 elevations designated as Fourth Order or Consult Agency. The GSD Reports for each of the monuments are appended to this report.

The airstrip survey was performed using RTK GPS. A base station GPS receiver was set on 749167A with a rover receiver used to gather topographic data around the air strip along with surveying the buildings adjacent to the airstrip. The Lieca Robotics was used to fill in some gaps in the GPS data to achieve the desired point density.

Quality control during the RTK and Robotics survey was maintained in each set-up by re-tieing at least two previous observed points such as ground shots, fixed features such as landing lights or control points.

RTK GPS was also used to survey the ordinary high water mark (OHWM) of Slidre Fiord adjacent to Eureka; the water reservoir; and as requested by WorleyParsons on site representative, cross sections were obtained along Station Creek next to the water reservoir.

8 control points to be used during the 3D Scanner survey on the main Weather Station were also set using RTK GPS.

A total of 29 3D Scanner set-ups were used to survey the Weather Station buildings and adjacent areas along with the site of the proposed lagoon. The Scanner position for each set up was derived from resection using control points set by RTK GPS and overlapping control points set in each scan.

2.3 GPS Processing and Adjustment

Leica Geomatics Office software (LGO) was used to process all data. Final processing relative to GSD published values was performed in the Inukshuk's Calgary office and the results are given in this report.

Surveyed NAD83 CSRS co-ordinates were based on GSD monument 749167A with an onsite check to GSD Monument 749167. The horizontal position checked within 0.07m and vertical checked within 0.040m of published values.

In addition static GPS data gathered at each monument was post processed relative to the local Canadian Active Control System M059000, CACS-Eureka. The published horizontal position of 749167A and 749167 checked within 0.15 m horizontally and 0.20 m vertically of processing to CACS M059000. The coordinate comparisons between 749167A, 749167 and CACS-Eureka are shown in the Control Co-ordinate Comparison appended to this report.

In reviewing the vertical data for GSD 749167A and 749167 it is noted that although CGVD28 elevations are published for each monument, the elevations accuracy are classed as Consult Agency and Fourth Order.

Considering the poor accuracy of the published CGVD28 elevations for the GSD monuments we defaulted to use an Ellipsoid-Geoid based elevation derived from the published NAD83CSRS Ellipsoid Height and HTv2.0 Geoid. Appended to this report are the GSD Monument reports for the published ellipsoid heights and HTv2.0 Geoid Separation in addition to the ACP Report for CACS Eureka.

2.4 Scanner Processing and Adjustment

The control points set using RTK were integrated in the 3D Scanner processing with adjustments made as necessary. The nature of the Scanner data with the overlapping surfaces and overlapping control points facilitates the isolation of errors and the adjustment of control point values. The overlapping control is compared with overlapping features or surfaces to add in redundancy. Using the cyclone processing software the mean absolute error in the control network is 0.011m which is seen in the appended registration diagnostics report.

Appended to this report is a listing of final coordinates for scanner control points along with their residuals.

3 Summary

This report summarizes a RTK GPS, Robotic Total Station and 3D Scanner topographic survey conducted from August 14th to August 20th, 2010, by Inukshuk Nunasi Geomatics at the Eureka Weather Station, Nunavut. The survey included the air strip; water reservoir; proposed lagoon locations; buildings; in addition to a survey of cross sections along Station Creek.

Surveyed co-ordinates and elevations were based on published values for GSD Monument 749167A and confirmed by means of check ties to GSD Monument 749167 along with post process to Canadian Active Control System (CACS)

Station M059000 as well as using the NRCan Precise Point Positioning (PPP) Web site.

Weather conditions and Ionosphere activity were not factors during the survey allowing the Inukshuk party chief to survey all data required in the project scope on schedule principally using the 3D Scanner and RTK GPS. Over 2200 data points were surveyed using RTK GPS with another 2.6 gigs of Scanner data.

Under separate cover is published a ACAD dwg file; CSV file with grid coordinates; and TXT file with ground co-ordinates.

NRCan GSD - ACP Report

****
CANADIAN ACTIVE CONTROL SYSTEM
ACTIVE CONTROL POINT (NAD83CSRS)
****

SITE IDENTIFICATION

Site name : EUREKA
ID code : EUR2
Geodetic Station No : M059000
Location : Eureka, NU

SITE INFORMATION

EUR2 is a continuously tracking GNSS site of the CACS network. Antenna is located on the roof of the Environment Canada Weather Station building in Eureka, Nunavut.

Antenna is mounted on the New Environment Canada Weather Station building in Eureka, Nunavut. Antenna mounted on steel pole secured to railing attached to platform on roof of new building. Platform secured to buildings steel beam infrastructure.

STATION COORDINATES

Reference system : NAD83CSRS

X =   78805.61 m Y = -1109591.58 m Z = 6259356.55 m

Latitude : N79 59' 20.1677
Longitude : W85 56' 15.1804
Ellipsoidal Height :   28.68 m

Geoid Separation (HT2.0) :   7.116 m
Orthometric Height (CGVD28) :   22.0 m
Adjustment Net : M05715
Epoch : 2002.0

Note:

The coordinates above are the most accurately known positions for this station relative to the NAD83CSRS coordinate system. Although these coordinates are very accurate within the Canadian Spatial Reference System and with respect to the defined NAD83 datum, they may not be consistent with NAD83 coordinates officially adopted and published by provincial agencies for monumented geodetic control points.

ANTENNA HEIGHT

Height of antenna is the vertical offset from the monument mark to the antenna L1 phase center. The L2 phase center is currently 0.029 m above the L1 phase center.

09-Oct-2005 14:00:00 UT to Present - L1 height: 0.091 m

GPS EQUIPMENT ON SITE

The following equipment is presently in operation at the site:

GPS Receiver : AOA SNR-12 ACT
Antenna Type : Dorne Margolin AOAD/M_T
Frequency Standard Type : Rubidium
Meteorological Sensor : Humidity, Pressure, Temperature.

CGVD28 - Canadian Geodetic Vertical Datum 1928, mean sea level (adopted, public vertical reference system). The average height of the surface of the sea for all stages of the tide. Usually determined by averaging height readings observed hourly over a minimum period of 19 years.

FOR FURTHER INFORMATION CONTACT :

NATURAL RESOURCES CANADA
GEODETIC SURVEY DIVISION
INFORMATION SERVICES
615 Booth Street
Ottawa, Ontario
K1A 0E9
Telephone: 613-995-4410
Fax: 613-995-3215
Internet: information@geod.nrcan.gc.ca

2010-08-26

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Natural Resources Canada
Geodetic Survey Division
615 Booth Street, Ottawa, Ontario
Telephone: 613-995-4410
Fax: 613-995-3215
Internet: information@geod.nrcan.gc.ca

Horizontal Datum: NAD83CSRS
Vertical Datum: CGVD28
Note: Users of Geodetic Survey Division markers must obtain permission from the landowner before entering private property.

Selection Criteria : **Radial Search**

.1 km 79 59 38 85 49 059

Data Type Requested : **Any Horizontal or Vertical stations (NAD83CSRS/CGVD28)**

Number of Stations Retrieved : 2

Definition of Reference Systems

NAD83(CSRS) : North American Datum 1983 (Canadian Spatial Reference System). The updated three-dimensional realization of the NAD83 reference system, still based on the GRS80 reference ellipsoid. In agreement with the US, this realization is defined in terms of a common procedure for transforming from recent versions of the International Terrestrial Reference Frame (ITRF). This realization is based on a 7-parameter transformation from ITRF96 (7 parameters were computed but the scale set to zero in order to adopt the scale of ITRF). Incremental transformations between ITRF96 and other ITRF realizations are used to update the transformation to any version of ITRF. NAD83(CSRS) is consequently a more accurate and stable realization of NAD83 that can be accurately referenced to other global and regional reference frames. The absolute accuracy of NAD83(CSRS) is of the order of a couple of cm or better, the accuracy of recent versions of the ITRF.

It is important to realize that NAD83(Original) and NAD83(CSRS) are based on the same fundamental NAD83 reference system. They are merely different realizations or adjustments with different levels of error. Taking into account these errors, NAD83(Original) and NAD83(CSRS) are completely compatible with one another.

NAD83(Original) : North American Datum 1983 (Original). The near-geocentric three dimensional reference system for the U.S., Canada and Central America, based on the Geodetic Reference System 1980 (GRS80) reference ellipsoid. Although originally intended to be geocentric, it is now known to be offset from the true geocenter by about 2 m due to the limited accuracy of absolute positioning at the time.

NAD83(Original) adjustments were based on a set of VLBI constraints from the first NAD83 adjustment. This set of constraint coordinates was used as the definition of NAD83(Original) until the last federal horizontal control adjustment in 1993. Note that these adjustments were 2D horizontal (latitude and longitude) solutions only. Some provinces still use these solutions for their horizontal networks but most have or are moving to the NAD83(CSRS) realization of the NAD83 reference system. The absolute accuracy of NAD83(Original) varies from several cm to over a couple of meters, with an average of about 0.3 meters. However, these errors are locally fairly coherent so that the relative accuracy can be much better.

NAD27 : North American Datum 1927. A non-geocentric horizontal control datum for the U.S., Canada and Mexico, defined by a coordinate and azimuth with origin at Meades Ranch, on the Clarke 1866 reference ellipsoid.

CGVD28 : The Canadian Geodetic Vertical Datum 1928 (CGVD28): Official height reference system in Canada The reference frame for the CGVD28 is the mean sea level at six tide gauges in dates of 1928. These tide gauges were located on both the Pacific and Atlantic Oceans as well as on the St-Lawrence River. The datum is propagated across Canada (mostly southern Canada) by a first-order levelling network and is accessible to users through some 80,000 federal benchmarks.

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SITE IDENTIFICATION

Unique Number : 749167
Name : EUREKA DOP
Established by : Geodetic Survey Division
Province : NT
Prov. Identifier : None

NTS Map No : 049G15

STATION COORDINATES

Horizontal Datum : NAD83CSRS
Method : Global Positioning System
Latitude : N79° 59' 38.4637" +/- 0.011 m Std Dev. (68% confidence level)
Longitude : W85° 49' 58.5226" +/- 0.004 m Std Dev. (68% confidence level)
Ellipsoid Height : 85.56 m +/- 0.042 m Std Dev. (68% confidence level)
Geoid Separation (HTv2.0) : 7.154 m
Agency : Geodetic Survey Division
Adjustment Net : M04711
Coordinate Version No. : 3.0.1.BM.3
Epoch : 1997.0
UTM : Zone = 16 Scale Factor = .9996 N = 8881145.15 m E = 522636.56 m
XYZ Coords. : X = 80791.80 m Y = -1108898.31 m Z = 6259511.19 m

Horizontal Datum : ITRF2005
Latitude : N79° 59' 38.5028"
Longitude : W 85° 49' 58.6274"
Ellipsoid Height : 85.73 m
Epoch : 1997.0
XYZ Coords. : X = 80791.16 m Y = -1108897.19 m Z = 6259511.57 m

VERTICAL DATA

Vertical Datum : CGVD28
Elevation : 78.3 m
Order : Fourth Order
Method : Differential
Adjustment Line : NOVA1987
Published Year : 1987

STATION MARKER INFORMATION AND LOCATION

Marker Type : Brass/Bronze Tablet Or Cap
Inspected in : 2004
Status : Good
Inspection Comments : None

Accessible by four wheel drive and a walk of less than 50 m

STA IS LOCATED ON FOSHEIM PEN OF ELLESMERE IS AT THE AIR- STRIP OF THE EUREKA WEATHER STA, ON BRADLEY AIR SERVICE PRO- PERTY, 1 M S OF SW COR OF THE SLEEPING QUARTERS. IT IS MKD BY A GSC BR TAB ON 1.8 M OF COPPERWELD ROD PROTRUDING 10 CM AGL. THERE IS A 10 CM CONC CAP REINFORCING THE PLUG STPD 749167. IT CAN BE REACHED BY AIRCRAFT.

REFERENCE STATIONS INFORMATION:

Reference name, Marker type, AZ/DIR/BRNG (DEG MIN SEC), (H)orizontal or (S)loped distance (m),

and Diff. in elev. (cm)

749167A AZ BRASS/BRONZE TABLET OR CAP 181 05' 18 S 16.04
749167B AZ BRASS/BRONZE TABLET OR CAP 263 26' 03 S 2.48

HISTORICAL COORDINATES NOTE: Coordinates listed below are no longer maintained by GSD.

Horizontal Datum : NAD83
Method : Multiple Methods
Latitude : N79° 59' 38.40468"
Longitude : W85° 49' 58.61344"
UTM : Zone = 16 Scale Factor = .9996 N = 8881143.307 m E = 522636.109 m

Horizontal Datum : NAD27
Method : Doppler Positioning
Latitude : N79° 59' 34.73300"
Longitude : W85° 49' 59.88500"
UTM : Zone = 16 Scale Factor = .9996 N = 8880899.057 m E = 522632.609 m

PROJECTS IDENTIFIERS:
ASTRO74 CACRC74 D268601 DOPPLER D268701 D268302 JUNCTION
FRMNAD83 JUNE90 PRIMDOP PRIM_HORI

Station 2 of 2

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SITE IDENTIFICATION

Unique Number : 749167A
Name : EUREKA REF A
Established by : Geodetic Survey Division
Province : NU
Prov. Identifier : None
NTS Map No : 049G15

STATION COORDINATES

Horizontal Datum : NAD83CSRS
Method : Global Positioning System
Latitude : N79° 59' 37.9467" +/- 0.006 m Std Dev. (68% confidence level)
Longitude : W85° 49' 58.5793" +/- 0.004 m Std Dev. (68% confidence level)
Ellipsoid Height : 85.00 m +/- 0.042 m Std Dev. (68% confidence level)
Geoid Separation (HTv2.0) : 7.153 m

Agency : Geodetic Survey Division
Adjustment Net : M04711
Coordinate Version No. : 3.0.1.BM.3
Epoch : 1997.0
UTM : Zone = 16 Scale Factor = .9996 N = 8881129.11 m E = 522636.58 m
XYZ Coords. : X = 80792.64 m Y = -1108913.98 m Z = 6259507.86 m

Horizontal Datum : ITRF2005
Latitude : N79° 59' 37.9858"
Longitude : W 85° 49' 58.6841"
Ellipsoid Height : 85.17 m
Epoch : 1997.0
XYZ Coords. : X = 80791.99 m Y = -1108912.86 m Z = 6259508.23 m

VERTICAL DATA

Vertical Datum : CGVD28
Elevation : 77.9 m
Order : Consult Agency (Unique Condition)
Method : Consult Agency
Adjustment Line : NOVA2004
Published Year : 2004

STATION MARKER INFORMATION AND LOCATION

Marker Type : Brass/Bronze Tablet Or Cap
Inspected in : 1996
Status : Good
Inspection Comments : None

LOCATED ON FOSHEIM PEN OF ELLESMERE ISLAND AT THE AIRSTRIP OF THE EUREKA WEATHER STATION, ON BRADLEY AIR SERVICE PROPERTY, 16.04 M FROM MAIN STATION "749167". MARKED BY A BRASS TABLET SET ON A COPPER ROD.

HISTORICAL COORDINATES NOTE: Coordinates listed below are no longer maintained by GSD.

None

PROJECTS IDENTIFIERS:
GPS

Number of Stations Retrieved : 2

35062 - Eureka Airstrip Survey - Control Co-Ordinate Comparison									
Monument Name	**Published NAD83 CSRS**			**Surveyed NAD83 CSRS (Fixed to 749167A)**					
	Northing	**Easting**	**Elev.**	**Northing**	**Easting**	**Elev.**	**ΔN**	**ΔE**	**ΔH**
749167	8881145.150	522636.560	78.406	8881145.218	522636.522	78.447	0.068	-0.038	0.041
749167A	8881129.110	522636.580	77.847	Held Fixed			—	—	—
CACS-Eureka	8880539.099	520617.802	21.564	—	—	—	—	—	—
				Surveyed NAD83 CSRS(Fixed to CACS-Eureka)					
				Northing	**Easting**	**Elev.**	**ΔN**	**ΔE**	**ΔH**
		749167		8881145.063	522636.413	78.257	-0.087	-0.147	-0.149
		749167A		8881128.955	522636.471	77.657	-0.155	-0.109	-0.190
		CACS-Eureka		Held Fixed			—	—	—
				Surveyed NAD83 CSRS (Fixed to PPP)					
				Northing	**Easting**	**Elev.**	**ΔN**	**ΔE**	**ΔH**
		749167		—	—	—	—	—	—
		749167A		8881128.959	522636.491	77.715	-0.151	-0.089	-0.132
		CACS-Eureka		—	—	—	—	—	—

Notes: Elevations shown are Orthometric, HTv2
All co-ordinate comparisons shown are relative to published values
Coordinates for CACS Eureka was computed using X, Y and Z values from ACP Report .