# PHASE 2 ENVIRONMENTAL SITE ASSESSMENT
# HIGHLANDS PARK LANDFILL
# SW 21-39-1-W5M
# LACOMBE COUNTY, ALBERTA

Prepared for:

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Parkland GEO

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# 1.0 INTRODUCTION

Parkland Geotechnical Consulting Ltd. (ParklandGEO) was commissioned to undertake a Phase 2 - Environmental Site Assessment (ESA) of the former Lacombe County landfill, in the south west corner of SW 21-39-1-W5M in Lacombe County, Alberta. The development is expected to be within the 300 m regulatory setback for the landfill. For the purposes of this report this landfill will be referred to as the Highland Park Landfill. The purpose of this study was to delineate the Highlands Park Landfill to determine the distance between the proposed Highlands Park development on Lot 2, Block 1, Plan 062 0435 and the nearest edge of the former landfill. The study also assessed the potential environmental impacts from the landfill on the proposed development. A Key Plan illustrating the location of the subject site is shown on Figure 1, in Appendix A. The Site Plan of the Area is shown on Figure 2.

The details of the proposed scope of work for this assessment were outlined in ParklandGEO's proposals PRO1444, dated July 29, 2008. Authorization for this investigation was given by Mr. Peter Chadwick of ISL Engineering and Land Services Ltd.

# 2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION

## 2.1 SITE DESCRIPTION

The Highlands Park Landfill site is about 7 acres and it is located in the southwest corner of SW 21-39-1-W5M, Lacombe County, Alberta. The land use of this quarter section and the surrounding area is primarily agricultural. The summer village of Birchcliff, which is located on the eastern shores of Sylvan Lake, is about 1.5 km southwest of the site.

The site slopes towards the southwest towards Sylvan Lake with a surface elevation ranging from 1004.5 m within the landfill to 988 m in the southwest corner. The rectangular landfill site is about 90 m long in the north-south direction and 310 m in the east-west direction. Although the site is about 7 acres, the landfill is located in the eastern section and encompass about 1.5 acres.

## 2.2 HISTORICAL LAND-USE

The site was used by the County of Lacombe as a landfill in the late 1970s for the disposal of household and construction waste. This is confirmed by a review of aerials from that time. When landfill operations ceased in the mid 1980s, the site was closed, capped and allowed to return to agricultural use. Aerials from 1978, 1982, 1987, and 2002 are shown in Figures 4 to 7 in Appendix A. The County of Lacombe and the Government of Alberta entered into a land usage agreement on January 12, 1989 with the purpose of restricting what the land could be used for. The majority of the land is currently unused grass lands with a small section in east of the site used for agricultural crops.

# 3.0 ISSUES AND ASSESSMENT CRITERIA

Development adjacent to a landfill must address both regulatory and technical issues. The primary technical issues for development near sanitary landfills include leachate movement and landfill gas generation. The location of the delineated landfill and its setback limit is presented in Figure 3, in Appendix A.

## 3.1 REGULATORY ISSUES

According to the development regulations outlined in the *"Subdivision and Development Regulation - AB Regulation 212/95.Sec. 13(1) - 15(1)," (Municipal Government Act, Province of Alberta*), the minimum setback for a sensitive land use such as a residential development from a closed landfill is 300 m. This planning Act has provisions which allow a developer to apply to the municipality for a relaxation by providing information which shows the proposed development will not be adversely impacted by the landfill. A condition of the waiver regulation is that the application must be reviewed by Alberta Environment (AENV). The waiver application must be supported by sufficient technical information to address the potential issues and concerns over the project.

The assessment process for this site is complicated due to the age of the former landfill and limited documentation of the siting/approvals processes for this landfill, land agreements or relative responsibilities of the stakeholder parties. It is assumed, that this landfill site was approved within the context of regulatory criteria in force at the time. In terms of closure and post closure requirements, the landfill facility would need to meet the regulatory criteria in force in mid to late 1980s.

## 3.2 LEACHATE GENERATION

Infiltration of precipitation into a landfill in combination with the initial moisture present in the waste and moisture production during bio-degradation of waste materials contribute to the production of as "landfill leachate". Above the static water table gravity causes water (ie. leachate) to move down through the waste mass towards the water table. For landfills where the waste comes into contact with the water table, the groundwater moving away from the trench, either laterally down-gradient or vertically downward from the landfill, would also be considered leachate. Through the decomposition process of sanitary waste, chemicals compounds dissolve into solution degrading the quality of the water. Typical leachate parameters include major ions such as chlorides, sulphates, nitrates; trace metals such as manganese, nickel and lead and hydrocarbons. In significant quantities some of these leachate parameters may be of concern to down-stream groundwater and surface water resources.

Typical landfills in Alberta are designed to restrict and/or control seepage into and out of a landfills through the use of surface caps, grading and base liners. The other less typical option is to allow wetting of the waste to help break down or compost the material. Initial observations at this site indicated a thin cover layer and minimal features to prevent seepage from the base. From general experience, surface water will infiltrate downward to the static water table and the groundwater in the water table will move southwest through low permeable siltstone bedrock towards Sylvan Lake. The local water table is about 6.5 to 7.0 m below the surface.

## 3.3 LANDFILL GAS GENERATION

All landfills which contain biodegradable organic waste produce landfill gas, though the rate of production will vary between landfills and even within different areas of the same landfill. Since landfill gas is a by-product of waste decomposition, factors that control waste decomposition, such as moisture content, pH etc. also determine the rate of landfill gas production. The decomposition of sanitary waste will generate volatile landfill gas such as methane, carbon dioxide and small amounts of nitrogen and oxygen. Trace quantities of volatile organic compounds or VOCs (e.g. vinyl chloride, benzene) and other noxious gases (e.g. hydrogen sulfide) may also be present depending on the landfill operating and disposal practices. For example, acceptance of liquid wastes may contribute to the presence of VOCs, and disposal of gypsum board or sulphur contaminated soil will contribute to the presence of hydrogen sulfide in landfill gas. Gas generation typically reaches a peak and then decreases over time as the amount of organic decomposable waste remaining in the landfill diminishes.

As gas concentrations build up within the landfill gas will tend to move from areas of high to low pressures through voids in the waste or fractures and low permeable soil zones in the surrounding subgrade to escape into the atmosphere. In instances where the landfill area is capped with low permeable materials, the gases may travel laterally into the subgrade before finding an escape pathway to the atmosphere. The extent of impact will be dependent on the cap & surrounding subgrade characteristics and the gas pressure levels within the landfill.

Landfill gas is of most concern when it migrates laterally (or vertically) through the subgrade to possibly collect in a confined space such as a basement or manhole vault. If landfill gas accumulates in a confined space explosive or anoxic conditions may develop. Concentrations of methane gas of between 5 to 15 percent in the atmosphere are potentially explosive. The Lower Explosive Limit (LEL) of methane is about 5 percent (50,000 ppmv). Typical landfill designs uses barriers such as clay liners to restrict migration of landfill gas and promote migration via preferential (designed) pathways for possible venting or flaring. When high concentration methane gas escapes to the atmosphere quickly dilutes to levels within the explosive limits. The other primary component of landfill gas is carbon dioxide. Since carbon dioxide is heavier than air it has the potential to accumulate in confined spaces in concentrations sufficient to displace air, resulting in an oxygen deficient environment.

A small portion of landfill gas may be comprised of compounds such as, hydrogen sulphide or mercaptans, which cause unpleasant nuisance odours that are normally detectable to humans at low concentrations. These compounds may pose a health hazard at high concentrations, but the concentrations typically found in landfills are usually well below these concentrations.

## 3.4 TECHNICAL ASSESSMENT CRITERIA

Based on the standards of today, the main parameters and criteria for assessment of groundwater chemistry are the performance standards for a Class II landfill as listed Section 6(11) of the Code of Practice[1] as summarized below.

**TABLE 1**
**PERFORMANCE STANDARDS FOR LANDFILLS**

| Chemical | Concentration(mg/L) |
|---|---|
| Chloride (Cl) | 250 |
| Sodium (Na) | 200 |
| Sulphate ($SO_4$) | 500 |
| pH | 6.5 to 8.5 units |

These assessment parameters are considered to be indicator parameters. AENV's May 2004 draft *"Standards for Landfills in Alberta"*[2] provide an extended program for groundwater quality testing at landfill sites. For comparison purposes, the groundwater chemistry results of testing are also referenced to the present Tier 1 Groundwater Remediation values[3].

All soluble chemicals which move via groundwater, travel at a speed which is a function of the groundwater velocity (ie. contaminants do not move faster than the groundwater). The test parameters above are considered to be highly soluble materials which move relatively fast in groundwater and thus are used as indicator parameters for delineation of the front edge of a leachate plume. Other more complex chemical compounds will move slower, at a fraction of the groundwater velocity. It should be understood that the present assessment criteria were not in force at the time of this landfill site selection or closure.

There are no specific provincial regulations for methane adjacent to former landfills. However, methane is addressed in AENV's draft *"Standards for Landfills in Alberta"*[2], based on the document *"The Guidance Document on Management of Methane Gas Adjacent to Landfills"*[4]. It is understood that these two documents are considered to be the applicable Provincial standards with respect to assessment criteria for methane control adjacent to landfills.

1 "Code of Practice for Landfills". Alberta Environment Protection. Queen's Printer for Alberta. Sections 6(1) through 6 (14).

2 "Standards for Landfills in Alberta". Alberta Environment, June 2007.

3 "Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines", Alberta Environment (June 2007)

4 "The Guidance Document on Management of Methane Gas Adjacent to Landfills" , prepared for Alberta Environment, by CH2M Gore & Storrie Limited (1999).

# 4.0 FIELD INVESTIGATIONS AND METHODOLOGY

The scope of work for the investigation was to delineate the extent of the landfill area and to test groundwater and gas samples from wells located on the subject site. The work program for this assessment included:

- Drilling, installing and sampling three monitoring wells around the site including one well within the landfill area, one well about 10 m from the landfills western edge, and one well about 50 m from the landfills western edge along the southern border of the site.

- Drilling a total of 15 probes in the eastern section of the property in an attempt to delineate the landfill's western and southern edges.

- Determining the groundwater elevations, accumulated soil and groundwater headspace vapours, and the presence or absence of phase-separated hydrocarbon product (free product) in the monitoring wells.

- Subjecting all groundwater samples to detailed chemical testing for Potability, phenols, oil and grease, and trace elements/heavy metals testing would be undertaken on basic Code of Practice criteria. Indicator tests (pH, EC, Cl, Na, $SO_4$) would also be undertaken on the remaining samples.

- The well casings would be screened for methane using a gas detector and air samples would be taken for volatile organic vapours using a tedlar bags and a vacuum pump. The gas samples would be tested for methane gas.

- Comparing the results of the chemical testing to the pertinent provincial assessment criteria and prepare a summary report.

## 4.1 BOREHOLE DRILLING

On September 12, 2008, a total of 15 probes and 3 monitoring wells were drilled around the eastern perimeter of the site. Two of the monitoring wells were place outside of the landfills perimeter, as defined by the probes. Monitoring Well 1 was installed within the landfills footprint about 25 m from the western edge. The monitoring wells were installed from 5.0 to 7.2 m below grade, while the probes ranged from 1.5 to 4.5 m below grade. The location of the monitoring wells, probes, and landfills southwestern edge are shown on the Site Plan, Figure 2, in Appendix A.

Groundwater monitoring wells were installed at three of the borehole locations. General construction of the monitoring well sites consisted of slotted well screen throughout the lower portion of the borehole intercepting the groundwater interface with 1.5 to 3 m of solid PVC pipe to bring the well casing up above the ground level. In all wells a sand filter pack was placed around the screened pipe, using Sil-9 silica sand, to permit groundwater and gas flow into the well casing. A bentonite chip seal was placed above the sand to just below ground level to seal the top of the well and minimize the amount of surface water entering into the borehole and possibly contaminating subsoils or groundwater. The wells were capped and a locking case was installed around all monitoring well locations.

The groundwater levels were measured on September 22, 2008. The observed groundwater level in Monitoring Well 2 was 6.6 m with Monitoring Wells 1 and 3 being dry. Groundwater samples were taken from Monitoring Well 2 on October 1, 15, and 31, 2008. The head-space in the wells was measured for volatile organic carbons (VOC's) on September 22, 2008. Gas samples were taken from Monitoring Wells 1 through 3 on October 15, 2008.

### 4.2 SOIL SAMPLING

The soil profile encountered at the borehole locations were logged using the Modified Unified Soil Classification System. Soil samples were collected from below the ground surface at 1.0 m depth intervals using the following standard sampling procedures:

- Soil samples were collected directly from the auger. The outside 5 to 10 mm layer of soil was trimmed from the sample to minimize the potential of cross contamination.

- Each sample was quickly transferred to a plastic bag which was sealed leaving an air pocket for field VOC measurement.

- The field samples were screened for VOC's using an RKI Eagle Portable Gas Detector calibrated with hexane to a known standard. The ambient temperature headspace (ATH) screening procedure was as follows:

    1. The soil samples were place in a warm environment (truck) with ambient air temperature conditions of approximately 25 $^{o}$ C for approximately a half-hour to facilitate the release of VOC's into the air space (head-space) within the bag.

    2. The head-space was then tested by inserting the gas detector instrument probe through the side of the sealed plastic bag. This was done using the methane response mode of the Portable Gas Detector, and was repeated using the no methane response mode. The no methane response mode results were subtracted from the methane response mode results to give the actual methane readings. The measured gas concentrations are expressed in parts-per-million by volume (ppmv).

### 4.3 GROUNDWATER SAMPLING

Groundwater samples were retrieved from Monitoring Well 2 on October 1, 15, and 31, 2008, using the following procedure:

- Groundwater levels were measured prior to sampling. The water surface was checked for the possible presence of phase-separated hydrocarbon product by visually examining the initial groundwater sample recovered from Monitoring Well 2.

- A small volume of groundwater was bailed from Monitoring Well 2 prior to sampling due to the limited amount of water available. Typically at least three times the water volume in the well casing is bailed prior to sampling. A sample was retrieved from the well for laboratory testing. Each groundwater sample was recovered with a clean, clear disposable bailing tube. The groundwater samples were placed in containers of varying size with preservatives appropriate for the testing required.

- The laboratory samples were stored in insulated coolers and transported to AGAT Laboratories in Calgary.

## 4.4 METHANE GAS SAMPLING

On October 15, 2008, the head-space in the well casing above the groundwater table was screened for VOC concentrations using the ATH method similar to the procedure described in Section 4.2 above. The wells were opened and immediately covered to decrease the volume of gas escaping. Then gas samples were obtained by drawing gas out of the casing and filling the tedlar bag with two gas volumes (releasing the gas) and collecting the third gas volume. The tedlar bag was sealed, kept in a dark cooler and shipped to AGAT laboratories for chemical analysis. The wells were allowed to recover for a few minutes prior to inserting the gas tech probe. The ATH concentrations were measured in parts-per-million by volume (ppmv) for methane and no-methane responses.

## 4.5 LABORATORY PREPARATION AND QUANTIFICATION METHODS

The preparation and quantification methods used in the analysis of soil and groundwater samples are shown in Appendix C. The preparation and quantification of all samples was undertaken by AGAT Laboratories of Calgary. All laboratory technical reports are kept on file for reference purposes and copies of the certificates of analyses including Quality Assurance certificates are provided in Appendix C.

# 5.0 PHASE 2 - ESA RESULTS

## 5.1 SOIL PROFILE

The general soil profile in the area was 0.2 m of topsoil on top of silty clay overlying hard siltstone bedrock.

Waste and debris materials was found in six of the probes and within Monitoring Well 1 starting from 0.5 to 3.2 m below grade and extending to 0.8 to 4.0 m below grade. Detailed soil descriptions and VOC's profiles from the soil samples are presented on the borehole logs in Appendix B. Definitions of the terminology and symbols used on the borehole logs are provided on the explanation sheets in Appendix B. The following is a brief description of the soil types encountered in the borehole locations.

### 5.1.1 Topsoil

A 200 mm thick topsoil layer was encountered in all monitoring wells and probes. The topsoil was clayey, moderately organic, black and dry. Within the landfill area, the topsoil contained construction material (asphalt, metals, cement) presumably having been dug up from agricultural activities over the years due to a thin 0.3 m clay cover over the debris.

### 5.1.2 Silty Clay

Deposits of silty clay were encountered below the topsoil in Monitoring Wells 1 and 2 and in all probes. This clay was also found below the waste layer in Monitoring Well 1 and Probes 5, 11, and 13. This silty clay was medium plastic of a firm to stiff consistency with some sand and little gravel.

### 5.1.3 Bedrock

The local bedrock formation was encountered in all monitoring wells as well as in Probe 1, 14, and 15 at a depth ranging from 0.3 to 4.2 m below grade. The predominant bedrock material encountered was a silt stone. This upper bedrock surface is considered to be weak, weathered rock which has the consistency of a very hard soil. The upper bedrock is expected to be fractured which increases the effective permeability of the formation. The competency of the local bedrock generally increases with depth.

## 5.2 GENERAL WASTE CHARACTERIZATION

The waste encountered was characterized during drilling. Sanitary and construction waste was found in Monitoring Well 1 and in Probes 4, 5, 7, 11, 12, and 13. This observed waste was dry to damp material consisting of wood, plastic, metal, ceramics, glass, cloth, paper, and miscellaneous household garbage. This waste was found to be placed directly on the silty clay layer at a depth of 2.6 to 4.0 m below grade. The thickness of the waste layer within the southwestern corner of the landfill varied with the thickest layer of waste in the centre and western portions of the landfill. The thicknesses ranged from 0.2 m to 2.5 m of waste across the corner section. The thickness of the waste layer may increase further into the landfills footprint.

## 5.3 GROUNDWATER MONITORING RESULTS

Groundwater was only observed in Monitoring Well 2. The groundwater table in the vicinity is about 6.5 to 7.0 m below grade which corresponds to an elevation of about 994 m for Monitoring Well 2. Flow of the groundwater is through the siltstone bedrock and will be dependent on fractures and fissures. Based on site observation and local experience, the groundwater flow on the site is expected to flow to the southwest towards Sylvan Lake. This groundwater elevation in Monitoring Well 2 was considered to be typical of the seasonal average for this area of the Sylvan Lake watershed. The local groundwater table will fluctuate higher during periods of snow melt and heavy or prolonged precipitation. The following table summarizes the observed groundwater conditions and elevations.

**TABLE 3**
**GROUNDWATER ELEVATIONS**

| Monitoring Well | Ground Elevation (m) | Groundwater Elevations (m) | | |
|---|---|---|---|---|
| | | Completion | Sept 22/08 | Oct 31/08 |
| MW1 | 1003.77 | - | - | - |
| MW2 | 1000.44 | - | 993.84 | 993.54 |
| MW3 | 997.39 | - | - | - |

## 5.4 GROUNDWATER WELLS

Based on water well drilling records, the depth of bedrock in the area is approximately 0.5 to 5 m below grade. A thin layer of medium plastic clay is typically found above the bedrock in this area. The bedrock is silt stone and shale with zones of sandstone at depth. The sandstone zones are typically aquifers and the shallowest aquifer is found at depths of approximately 21 to 35 m below grade, about 10 m below the top of the formation. The piezometric level of the local upper aquifer is expected to range between 17 and 25 m below grade. Water well records for this area are included in Appendix B.

## 5.5 GROUNDWATER CHEMISTRY RESULTS

The groundwater sample from Monitoring Well 2 was analysed for general water quality parameters, trace ions/metals, phenols, and oil and grease parameters. The groundwater was generally on the basic side of neutral (7.6 pH units) which is normal for this area. In summary, the test results did not indicate any evidence of leachate migration from the old landfill. The results for manganese, iron, lead, and total dissolved solids (TDS) slightly exceeded the Tier 1 and 2 criteria which is normal for the local groundwater.

Table C1 summarizes the results of groundwater chemistry testing and is included in Appendix C of this report. The red colour coding on the table represents parameters that are over the most stringent assessment criteria (ie. Alberta Tier 1 and 2). The guidelines used for this table are Tier 1 and Tier 2 Groundwater Remediation values.

### 5.6 MONITORING WELL HEADSPACE CHEMISTRY RESULTS

On October 1, 2008, VOC's concentrations were measured by ATH methods for the gas in the well casings at each gas monitoring well. Gas samples from the monitoring wells on October 15, 2008 were sent to the lab for compositional analysis. These samples were collected by pumping the gas into a Tedlar bag after releasing two volumes (two Tedlar Bag volumes) of air. The compositional analysis showed negligible concentrations of Methane and the results can be seen in Appendix C at the end of this report.

## 6.0 ASSESSMENT

### 6.1 PROXIMITY

The western edge and southwest corner of the landfill was delineated with a series of shallow probes. Upon the completion of the drilling, the probe locations and surrounding areas were surveyed. Based on the information collected, the northeast corner of the proposed Highland Park development is 250 m from the former County of Lacombe landfill. The location of the delineated landfill and its setback limit is presented in Figure 3, in Appendix A.

### 6.2 LANDFILL AREA

The former landfill area is located in the southwest corner of SW 21-39-1-W5M and is about 7 acres currently used as agricultural lands. The landfill consists of construction and household sanitary water materials. The waste in the landfill varies in depth ranging from 0.5 to 3.2 m below grade with a confirmed thickness of up to 2.5 m. A clay cap is in place over the landfill with the thinness portion confirmed at 0.3 m.

### 6.3 LANDFILL SETTING AND CONDITIONS

The local groundwater table within the siltstone bedrock in this area is recharged by direct infiltration of precipitation and movement of the groundwater from up-gradient areas of the watershed. The disposal area is located on the western side of a knoll. The ground surface of the waste disposal area slopes southwest with an elevation difference of 6.5 m between MW 1 and MW 3. A contour profile of the area is presented in Figure 8, in Appendix A. The precipitation falling on the disposal area is likely to flow down the knoll away from the disposal areas, however, some precipitation will infiltrate down into the landfill due to gravity. During the agricultural growing season, most of the landfill is vegetated with crops which require a significant volumes of water which further reduces the amount of infiltration into the landfill.

The landfill is understood to be in-filled natural or man-made depressions, although some excavation of lacustrine materials was probably undertaken to increase the volume of the landfill and to the provide cover fill. The base of the landfill is founded on the low permeable lacustrine clay layer and the waste is well above the water table at all locations. There appears to be an appreciable barrier to leachate seepage into the local water table in this section of the landfill. The direction of groundwater flow is most likely to the southwest across the site, discharging into Sylvan Lake.

From ParklandGEO's investigation it was found that the waste material and underlying base materials were noted to be damp to moist, suggesting that infiltration is probably moving down through the landfill into the silty clay base and then into the bedrock with movement towards Sylvan Lake. The refuse was typically found to be intact with limited decomposition. The local groundwater table is well below the landfill and buried debris layers.

## 6.4 LEACHATE QUALITY

The concentrations of indicator parameters (chloride, sodium and sulphates) in the groundwater from Monitoring Well 2 are within acceptable levels with the exception of chloride which is slightly elevated. The concentrations of soluble metals such as manganese, iron, and lead in the same area were elevated above parameter standards. The silty clay deposit over the bedrock under the waste material acts as a low permeable barrier so the speed of infiltration of the leachate downward into the deep groundwater table will be smaller than the velocity of groundwater flowing below the waste. The estimated hydraulic conductivity for the silty clay is about $1 \times 10^{-7}$ m/s. However, the investigation was limited to the southwest corner of the landfill and the natural clay linear cannot be confirmed for the entire landfill and there is the possibility that a portion of the waste debris has been placed directly onto the bedrock. In this situation, infiltration of the leachate into the groundwater table will be dependent on the condition of the bedrock. Fractures within the bedrock surface will facilitate a greater infiltration rate into the groundwater table. With surface runoff moving away from the landfill and a deep groundwater table the amount of water contributed to the water table by infiltration through the waste disposal areas will be smaller relative to the volume already moving below the site.

## 6.5 METHANE

Based on the test results the monitoring well within the landfill had a negligible concentration of methane. The concentration around the perimeter were also negligible. The cap materials are thin silty soils which are relatively permeable and may be reducing the methane spread by allowing some natural venting of the methane developed within the landfill areas. Traces of waste material from the landfill was observed throughout the field which would indicate that as the result of agricultural activities, the cap has been disturbed with areas of the landfill having been exposed which has lead to the easy escape of any methane that may have been produced by the landfill. It should be acknowledge that any changes to the landfills cap could have the impact of increasing methane and landfill gas concentration within the landfill basin. However the lateral extent of this methane spread from this small landfill with a proper new cap is expected to be less than 10 times the depth of the landfill basin of less than 25 m.

## 6.6 SUMMARY

The main screening parameter for assessing the risk associated with this old landfill relative to the proposed residential development in Lot 2, Block 1, Plan 062 0435 Lacombe County are summarized in the following table.

| Parameter | Condition |
|---|---|
| Sensitive Receptors | Residences |
| Non-Sensitive Receptors | Underground services, Parks |
| Proximity | 254 m from Property |
| Landfill Content | Construction and Sanitary Materials |
| Liner/Cap Design | Natural Liner (Clay), Thin Natural Cap |
| Age of Landfill | Closed in late 1980s |
| Size of Landfill | About 0.65 hectares |
| Hydrogeologic Setting | Moderately Favourable |
| Gas Management | None |
| Gradient Location | Site is down gradient |
| Servicing | Private Services |
| Information Level | Southwest corner of landfill has been delineated and tested |

Based on these factors, the risk associated with the site and the proposed project development based on natural conditions with no further protective measures was considered to be low. The leachate generation and landfill gas generation of the former landfill is low and will have negligible impact on the proposed development.

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

It was suspected that the 300 m regulatory setback required from the former County of Lacombe landfill in SW 21-39-1-W5M encroached on the proposed Highland Park rural residential subdivision located in NE 17-21-39-1-W5M. The western edge and southwest corner of the landfill were delineated and found to be 250 m from the closest part of the Highland Park development.
The easiest option for the proposed development would be to impose a no development zone in the northeast corner of the Highland Park subdivision quarter section. However, the former landfill is a significant distance from the proposed development and it is not having any impact of the development quarter-section in terms of either landfill gas or methane as confirmed by the information in this report and the potential for future impact is considered to be negligible. In summary:

1. The landfill was a very small 0.65 acre (est.) sanitary landfill that is 2 to 3 m deep and appears to be based on a thin layer of medium plastic clay overlying Paskapoo bedrock. The waste material was generally characterized as debris with some sanitary waste which was relatively dry. The waste did not appear to be subject to major decomposition. The local groundwater table appears to be about 6.5 to 7.0 m below grade, so it is not in direct contact with the waste material.

2. The landfill is poorly capped and the methane concentrations being generated by the landfill are very small. The methane concentrations at the perimeter of the former landfill were non-detectable. This will stay the same as long as there are no changes to the cap quality or thickness. In the event that the landfill was to be recapped with less permeable material it is unlikely that the lateral migration of methane gas would extend more than 30 to 40 m from the edge of the landfill.

3. This area is part of the Sylvan Lake watershed. The site slopes southwest towards the lake with an elevation ranging from 1004.5 m within the landfills footprint to 987 m in the northeast corner of the proposed development. The flow of groundwater in this area is expected to be downward to the top of the bedrock formation and then laterally towards the lake following the local topography. The local formation is very low permeable silt stone and shale which is likely fractured resulting in preferential pathways for groundwater flow in this direction. The degree of fractures and fissures within the bedrock will influence the flow velocity of groundwater, but any migration of groundwater through the site is expected to be slow.

4. The downward flow of the groundwater is expected to be restricted near the top of the bedrock formation. The shallowest aquifers in the areas are about 21 to 35 m below grade, or 4 to 20 m below the top of the formation. The siltstone and shale in the upper zone of the formation will provide a aquitard layer to protect the local potable groundwater supply.

5. The pH of the groundwater at the well location immediately down-gradient of the landfill was 7.6 and the concentrations of manganese, iron, lead, and total dissolved solids (TDS) were elevated, but within the normal range for the static water table. Overall the test results indicated that there was no evidence of leachate migration from the former County landfill.

This Phase 2 ESA has been undertaken to a level sufficient to support a possible application to Lacombe County for a development regulation waiver for set-back from a closed landfill (and the associated AENV review). The level of investigation performed for this Phase 2 ESA is considered to be sufficient to characterize the environmental risks the former County of Lacombe Landfill at SW 21-39-1-W5M on the proposed Highland Park development in NE 17-39-1-W5M. The closest approaches of the landfill footprint to the development have been delineated; and the methane gas and leachate generation from the landfill have been assessed. Based on the assessment performed, the environmental risk to the proposed development associated with the former landfill is considered to be very low.

# 8.0 CLOSURE

The American Society for Testing and Materials Standard of Practice notes that no environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions in connection with a property. Performance of a standardized environmental site assessment protocol is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions in connection with the subject properties, given reasonable limits of time and cost. This report has been prepared for the exclusive use of the **ISL Engineering and Land Services Ltd.** and their approved agents for the specified application to the Highland Park development. No other warranty, expressed or implied is made. The general terms and conditions of this report are specified in Appendix D and should be considered part of this report.

Respectfully submitted,
**PARKLAND GEOTECHNICAL CONSULTING LTD.**
A.P.P.E.G.A. Permit #07312

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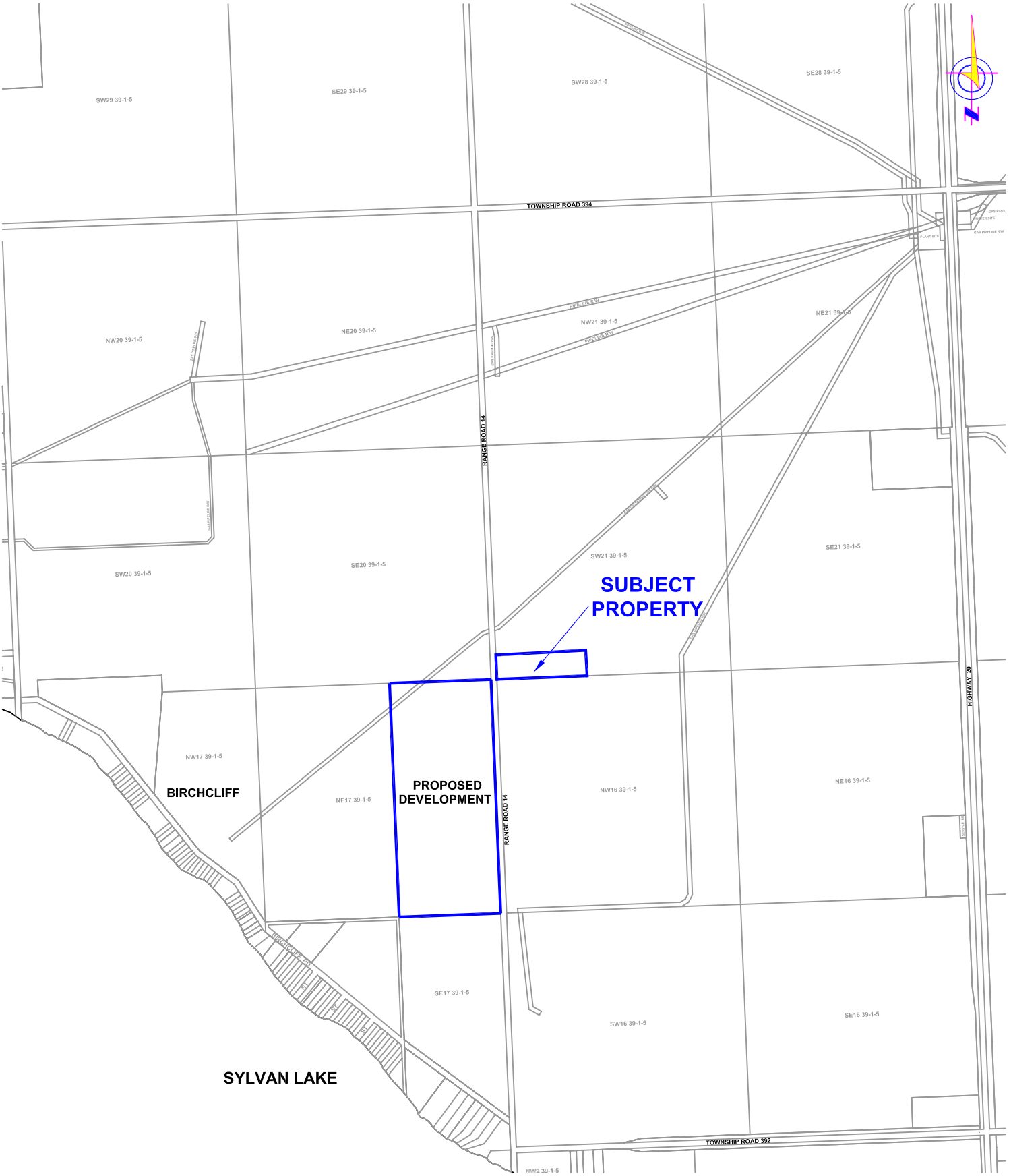
# APPENDIX A

FIGURE 1 - KEY PLAN
FIGURE 2 - SITE PLAN
FIGURE 3 - LANDFILL SETBACK
FIGURE 4 - 1978 AERIAL PHOTOGRAPH
FIGURE 5 - 1982 AERIAL PHOTOGRAPH
FIGURE 6 - 1987 AERIAL PHOTOGRAPH
FIGURE 7 - 2002 AERIAL PHOTOGRAPH
FIGURE 8 - CONTOUR PROFILE




Parkland GEO

CLIENT:

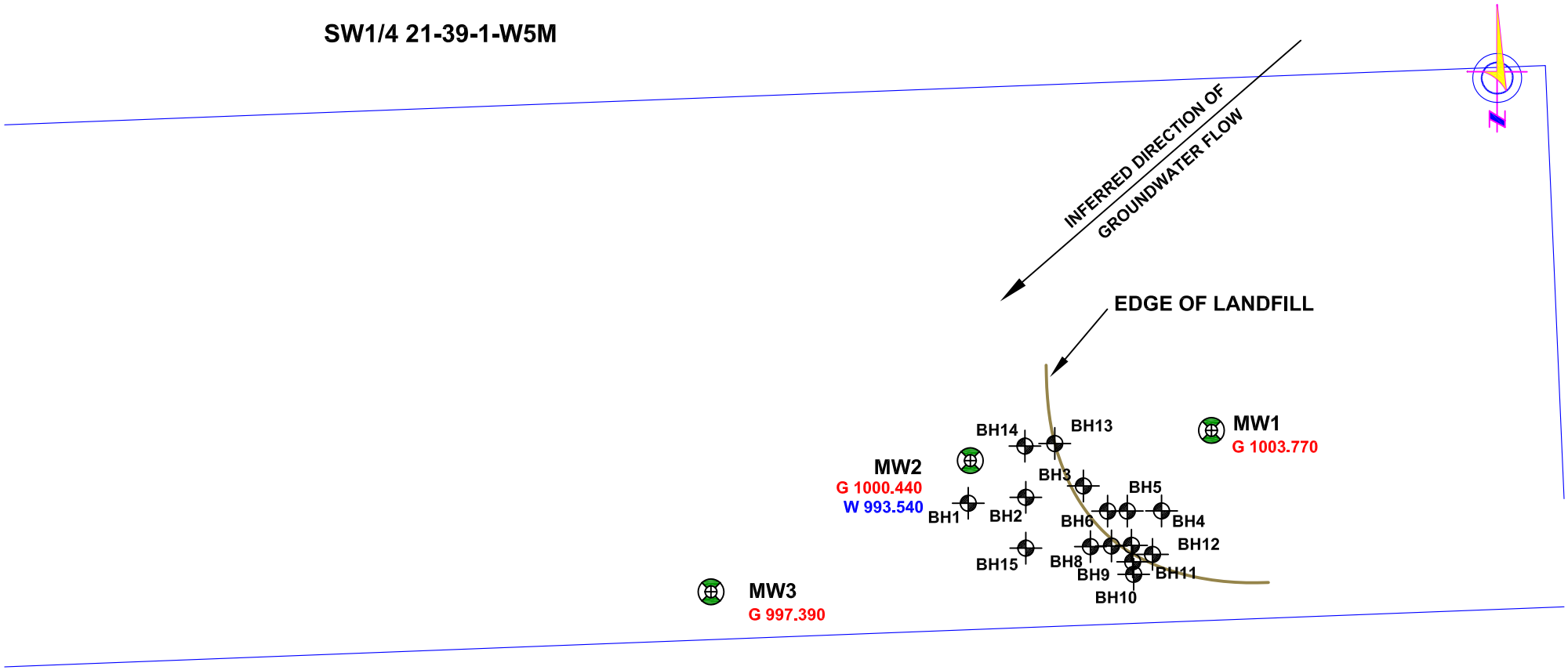
ISL Engineering and Land Services

# KEY PLAN

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| NTS | RD3026 | FIGURE 1 |




ParklandGEO

CLIENT:

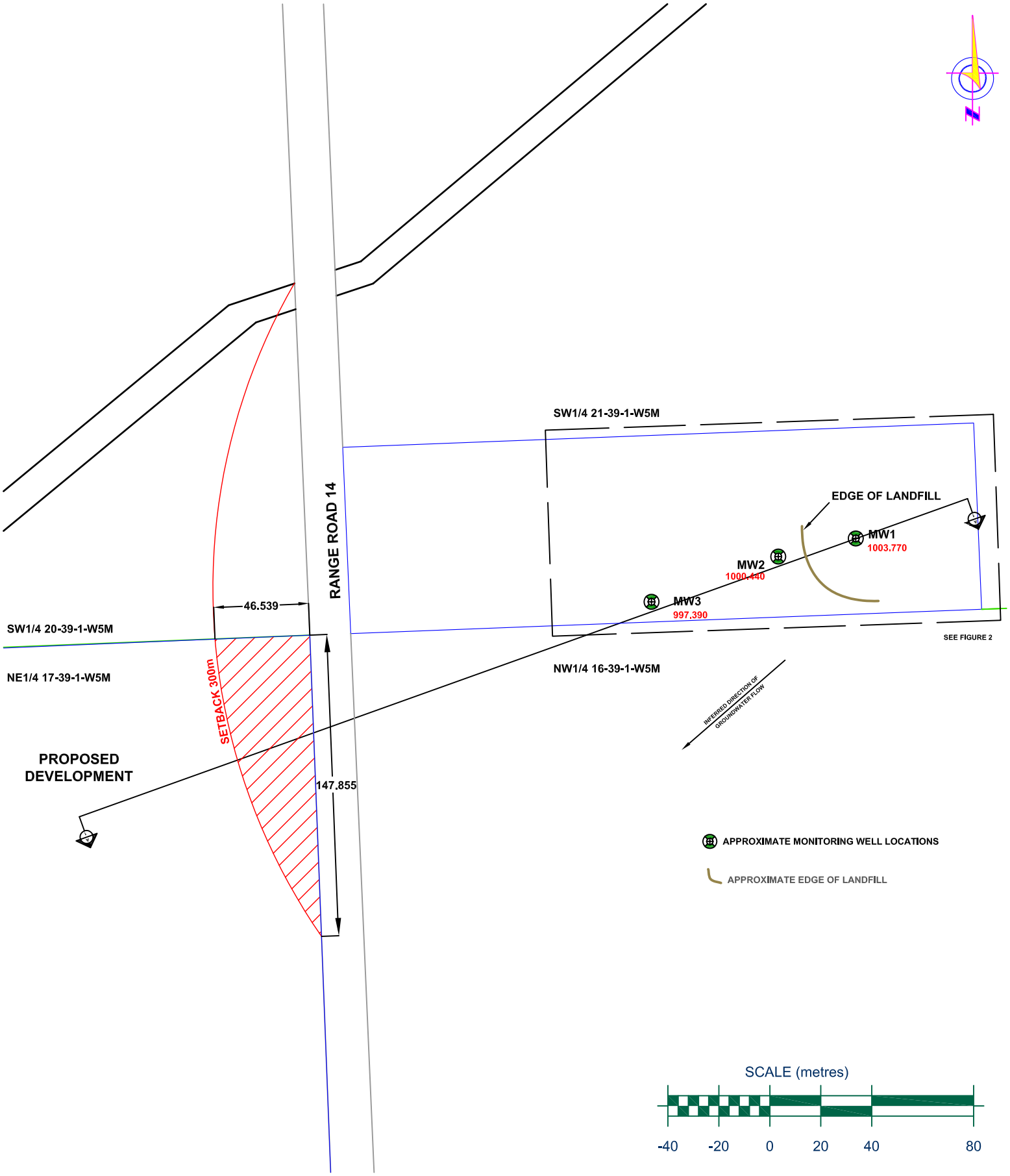
ISL Engineering and Land Services

# SITE PLAN

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:1000 | RD3026 | FIGURE 2 |




ParklandGEO

CLIENT:

ISL Engineering and Land Services

# LANDFILL SETBACK

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:2500 | RD3026 | FIGURE 3 |


ParklandGEO

CLIENT:

ISL Engineering and Land Services

# 1978 AERIAL PHOTOGRAPH

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:10000 | RD3026 | FIGURE 4 |


ParklandGEO

CLIENT:

ISL Engineering and Land Services

# 1982 AERIAL PHOTOGRAPH

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:10000 | RD3026 | FIGURE 5 |


Parkland GEO

CLIENT:

ISL Engineering and Land Services

# 1987 AERIAL PHOTOGRAPH

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:10000 | RD3026 | FIGURE 6 |


ParklandGEO

CLIENT:

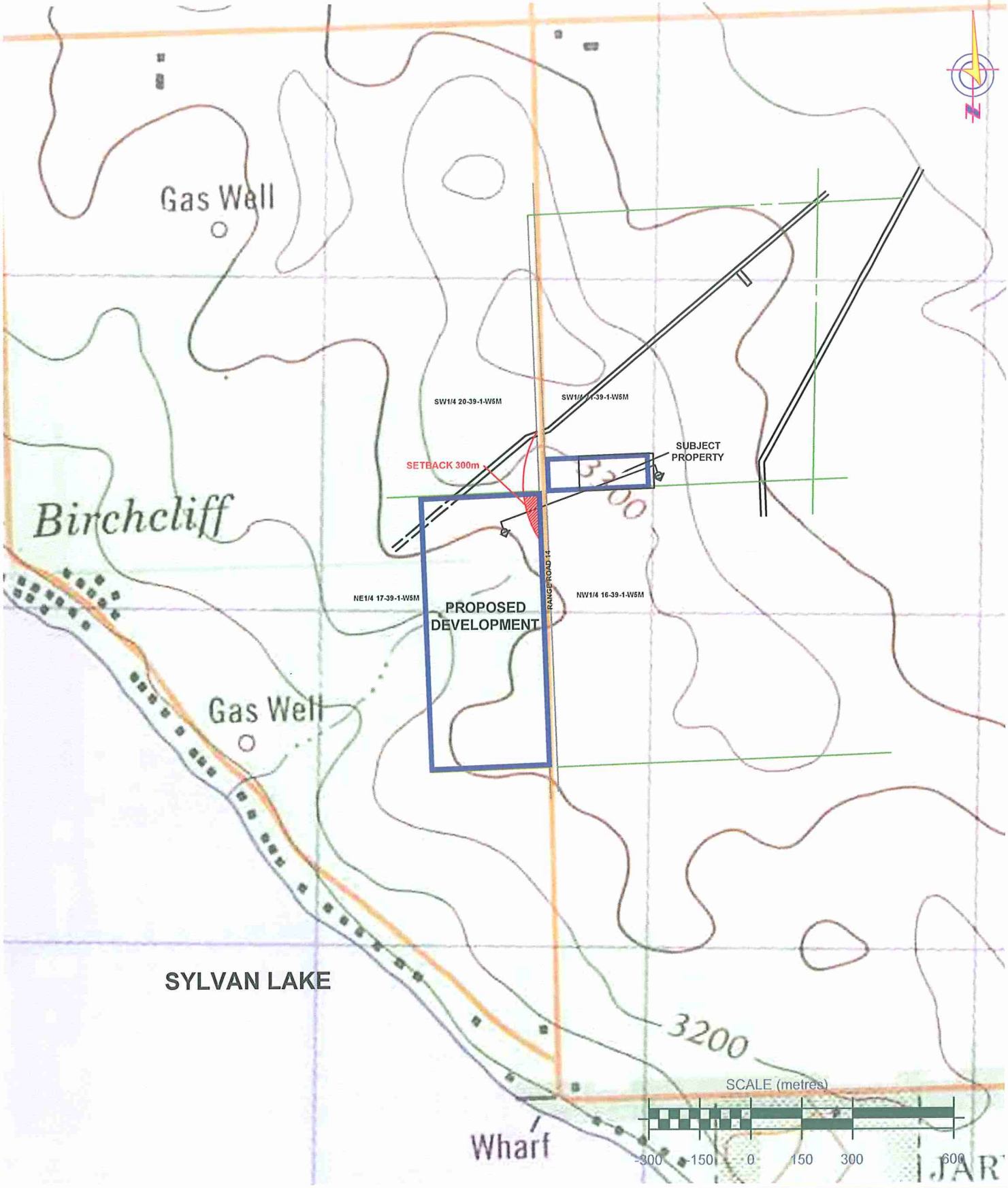
ISL Engineering and Land Services

# 2002 AERIAL PHOTOGRAPH

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:10000 | RD3026 | FIGURE 7 |




Parkland GEO

CLIENT:

ISL Engineering and Land Services

# CONTOUR PROFILE

HIGHLANDS PARK LANDFILL - PHASE 2 ASSESSMENT
SW1/4 21-39-1-W5M, LACOMBE COUNTY, ALBERTA

| DRAWN: | CHK'D.: | REV #: | DATE: |
|---|---|---|---|
| LDL | MDB | 1 | DECEMBER 2008 |

| SCALE: | JOB NO. | DRAWING NO. |
|---|---|---|
| 1:15000 | RD3026 | FIGURE 8 |

# APPENDIX B

MONITORING WELLS ( 1 THROUGH 3)
PROBE LOGS ( 1 THROUGH 15)
WATER WELL RECORDS
EXPLANATION OF TERMS AND SYMBOLS
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

**BOREHOLE NO.: MW1**

CLIENT: ISL Engineering and Land Services, Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Soil Vapour PPMV | Type | Sample No | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | 1003.77 |
| 0 | ***Topsoil*** Moderately organic, brown, dry. | | | | | | | 1003.57 |
| 0 | ***Clay*** Silty, some sand, soft to firm, medium plastic, brown, dry. | | | | | | | 1003.27 |
| 1 | ***Debris*** Wood, organics, plastic, metal, ceramics, glass, cloth, brown, damp. | | 25 | | | | | |
| 2 | | | 15 | | | | | |
| 3 | ***Clay*** Silty, some sand, little gravel, firm, medium plastic, brown, damp. | | 0 | | | | | 1000.77 |
| 4 | ***Weathered Bedrock*** Siltstone, hard, dry. | | 0 | | | | | 999.57 |
| 5 | | | 0 | | | | | |
| 6 | End of monitoring well at 6.0m. Slough to 5.0m. Backfilled with sand to 1.5m. Sealed with bentonite to surface. Locking well protector installed. Dry upon completion. Dry on September 22, 2008. Dry on October 31, 2008. | | 15 | | | | | 997.77 |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | 993.77 |

PPMV: 0 25 50 75 100

Well Completion Details: 50mm SOLID PVC PIPE; BENTONITE; 50mm SLOTTED PVC PIPE; SAND; SLOUGH

LOGGED BY: PA

CONTRACTOR: All Services Drilling Inc.

RIG/METHOD: Truck Mounted Auger / Solid Stem Auger

DATE: September 12, 2008

GROUND ELEVATION: 1003.772m

NORTHING: 5805444.006

EASTING: 697870.243

**BOREHOLE NO.: MW2**

CLIENT: ISL Engineering and Land Services, Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Soil Vapour PPMV | Type | Sample No | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | 1000.44 |
| 0 | ***Topsoil*** Moderately organic, brown, dry. | | | | | | | 1000.24 |
| 1 | ***Clay*** Silty, some sand, firm to stiff, medium plastic, brown, dry. | | 0 | | | | | |
| 2 | ***Weathered Bedrock*** Siltstone, hard, dry. | | 15 | | | | | 998.64 |
| 3 | | | 5 | | | | | |
| 4 | | | 5 | | | | | |
| 5 | | | 10 | | | | | |
| 6 | | | 0 | | | | | |
| 7 | End of monitoring well at 7.5m. 50mm standpipe installed. Backfilled wtih sand to 3.5m. Sealed with bentonite to surface. Locking well protector installed. Slough to 7.2m. Dry upon completion. Water at 6.6m on September 22, 2008. Water at 6.9m on October 31, 2008. | | | | | | | 992.94 |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | 990.44 |

PPMV scale: 0 25 50 75 100

Well Completion Details: 50mm SOLID PVC PIPE; BENTONITE; 50mm SLOTTED PVC PIPE; SAND; SLOUGH

LOGGED BY: PA

CONTRACTOR: All Services Drilling Inc.

RIG/METHOD: Truck Mounted Auger / Solid Stem Auger

DATE: September 12, 2008

GROUND ELEVATION: 1000.443m

NORTHING: 5805438.909

EASTING: 697829.547

**BOREHOLE NO.: MW3**

CLIENT: ISL Engineering and Land Services, Ltd.

SITE: SW 21-39-1-W5M — PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta — BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Soil Vapour PPMV | Type | Sample No | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | 997.39 |
| | ***Topsoil*** Moderately organic, brown, dry. | | | | | | | 997.09 |
| 1 | ***Weathered Bedrock*** Siltstone, hard, dry. | | 0 | | | | | |
| 2 | -damp at 2.0m. | | 10 | | | | | 995.49 |
| 3 | | | 0 | | | | | |
| | -moist at 3.8m. | | | | | | | 993.69 |
| 4 | | | 0 | | | | | |
| | -dry at 4.3m. | | | | | | | 993.19 |
| 5 | | | 10 | | | | | |
| 6 | End of monitoring well at 6.0m. 50mm standpipe installed. Backfilled with sand to 2.5m. Sealed with bentonite to surface. Locking well protector installed. Dry upon completion. Dry on September 22, 2008. Dry on October 31, 2008. | | 5 | | | | | 991.39 |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | 987.39 |

PPMV: 0 25 50 75 100

Well Completion Details: 50mm SOLID PVC PIPE; BENTONITE; 50mm SLOTTED PVC PIPE; SAND

LOGGED BY: PA

CONTRACTOR: All Services Drilling Inc.

RIG/METHOD: Truck Mounted Auger / Solid Stem Auger

DATE: September 12, 2008

GROUND ELEVATION: 997.390m

NORTHING: 5805416.758

EASTING: 697785.795

**BOREHOLE NO.: P1**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1000.03 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 999.83 |
| | ***Clay*** Silty, some sand, firm to stiff, medium plastic, brown, dry. | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| | | | | | | | | | 997.23 |
| | ***Weathered Bedrock*** Siltstone, hard, dry. | | | | | | | | 997.03 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 995.03 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1000.032m

NORTHING: 5805431.713

EASTING: 697829.208

**BOREHOLE NO.: P2**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1001.05 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1000.85 |
| | ***Clay*** Silty, trace sand, little gravel, firm, medium plastic, brown to grey, moist. -trace wood chips and plastic at 0.5m. | | | | | | | | 1000.55 |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| | | | | | | | | | 998.35 |
| | ***Till*** Clayey, silty, little gravel, firm to stiff, medium plastic, brown to grey, occasional coal inclusions, damp. -trace wood chips at 2.7m. | | | | | | | | 998.05 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 996.05 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1001.051m

NORTHING: 5805432.703

EASTING: 697838.915

**BOREHOLE NO.: P3**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1001.96 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1001.76 |
| | ***Clay*** Silty, some sand, little gravel, soft to firm, low to medium plastic, brown to grey, damp. -trace wood chips at 1.3m. | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | -dry at 2.3m. | | | | | | | | 999.76 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 998.96 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 996.96 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1001.963m

NORTHING: 5805434.625

EASTING: 697848.619

**BOREHOLE NO.: P4**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M — PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta — BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1003.01 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.81 |
| | ***Clay*** Silty, some sand, little gravel, soft to firm, low to medium plastic, brown, dry. | | | | | | | | |
| | -little sand at 0.9m. | | | | | | | | 1002.21 |
| 1 | -shale nodules, stiff to very stiff at 1.2m. | | | | | | | | 1001.91 |
| | ***Debris*** Plastic, metal, wood, organics, cloth, brown, moist. | | | | | | | | 1001.41 |
| 2 | | | | | | | | | |
| 3 | Enf of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 1000.01 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 998.01 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1003.007m

NORTHING: 5805430.411

EASTING: 697861.821

**BOREHOLE NO.: P5**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1002.55 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.34 |
| | ***Clay*** Silty, some sand, trace gravel, firm to stiff, medium plastic, brown, damp to moist. | | | | | | | | |
| 1 | -organics and trace wood chips at 1.4m. | | | | | | | | 1001.25 |
| | ***Debris*** Plastic, cloth, metal, brown, damp. | | | | | | | | 1000.95 |
| 2 | | | | | | | | | 999.95 |
| | ***Clay*** Silty, little sand, trace gravel, stiff, medium plastic, brown, damp. | | | | | | | | |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 999.55 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.55 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1002.545m

NORTHING: 5805430.392

EASTING: 697856.028

**BOREHOLE NO.: P6**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1002.29 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.09 |
| | ***Clay*** Silty, some sand, firm, low to medium plastic, brown, dry to moist. | | | | | | | | |
| | -little sand at 0.9m. | | | | | | | | 1001.49 |
| 1 | | | | | | | | | |
| | -stiff at 1.5m. | | | | | | | | 1000.89 |
| 2 | | | | | | | | | |
| | -dry at 2.5m. | | | | | | | | 999.89 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 999.29 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.29 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1002.287m

NORTHING: 5805430.380

EASTING: 697852.720

**BOREHOLE NO.: P7**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M

PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta

BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1002.51 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.31 |
| | ***Clay*** Silty, some sand, firm, medium plastic, brown, dry. | | | | | | | | 1001.81 |
| 1 | ***Debris*** Plastic, metal, cloth, paper, grey, moist. | | | | | | | | 1001.01 |
| | End of probe at 1.5m. Backfilled with cuttings. Dry upon completionl. | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.51 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1002.510m

NORTHING: 5805424.607

EASTING: 697856.740

**BOREHOLE NO.: P8**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1001.88 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1001.68 |
| | ***Clay*** Silty, some sand, firm, medium plastic, brown, dry to moist. | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | -dry at 2.2m. | | | | | | | | 999.78 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 998.88 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 996.88 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1001.882m

NORTHING: 5805424.391

EASTING: 697849.822

**BOREHOLE NO.: P9**

CLIENT: ISL Engineering and Land Services Ltd.
SITE: SW 21-39-1-W5M
NOTES: Lacombe County, Alberta

PROJECT NO.: RD3026
BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | 1002.24 |
| 0 | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.04 |
| | ***Clay*** Silty, some sand, trace gravel, firm, medium plastic, brown, dry. | | | | | | | | |
| | -moist at 0.8m. | | | | | | | | 1001.54 |
| 1 | -grey at 1.2m. | | | | | | | | 1001.14 |
| | -debris: two metal lids at 1.7m. | | | | | | | | 1000.64 |
| 2 | -dry at 2.2m. | | | | | | | | 1000.14 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 999.24 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.24 |

LOGGED BY: PA
CONTRACTOR: All Service Drilling Inc.
RIG/METHOD: Truck Mounted Rig / Solid Stem Auger
DATE: September 12, 2008
CALIBRATION:

GROUND ELEVATION: 1002.242m
NORTHING: 5805424.500
EASTING: 697853.360

**BOREHOLE NO.: P10**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1002.49 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.29 |
| | ***Clay*** Silty, some sand, firm, medium plastic, brown to dark brown, dry. | | | | | | | | |
| 1 | | | | | | | | | |
| | -stiff at 1.5m. | | | | | | | | 1001.09 |
| 2 | | | | | | | | | |
| | -grey at 2.8m. | | | | | | | | 999.79 |
| 3 | End of hole at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 999.49 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.49 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1002.486m

NORTHING: 5805419.712

EASTING: 697857.113

**BOREHOLE NO.: P11**

CLIENT: ISL Engineering and Land Services Ltd.
SITE: SW 21-39-1-W5M
NOTES: Lacombe County, Alberta

PROJECT NO.: RD3026
BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | 1002.55 |
| 0 | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.35 |
| | ***Clay*** Silty, some sand, firm, medium plastic, brown, dry. | | | | | | | | |
| | -trace wood chips and plastic at 0.6 - 0.8m. | | | | | | | | 1001.95 |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| | -grey at 2.7m. | | | | | | | | 999.95 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 999.55 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.55 |

LOGGED BY: PA
CONTRACTOR: All Service Drilling Inc.
RIG/METHOD: Truck Mounted Rig / Solid Stem Auger
DATE: September 12, 2008
CALIBRATION:

GROUND ELEVATION: 1002.548m
NORTHING: 5805421.828
EASTING: 697856.943

**BOREHOLE NO.: P12**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1002.76 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1002.56 |
| 1 | ***Clay*** Silty, some sand, firm, medium plastic, brown, dry to moist. | | | | | | | | 1001.56 |
| | ***Debris*** Plastic, metal, wood, grey, damp. | | | | | | | | 1001.26 |
| 2 | End of probe at 1.5m. Backfilled with cuttings. Dry upon completion. | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 997.76 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1002.764m

NORTHING: 5805423.077

EASTING: 697860.282

**BOREHOLE NO.: P13**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1001.59 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1001.39 |
| | ***Clay*** Silty, some sand, firm to stiff, low to medium plastic, brown to dark brown, occasional rust stains, moist. | | | | | | | | |
| 1 | | | | | | | | | |
| | | | | | | | | | 999.79 |
| | -trace fabric from 1.9 - 2.3m. | | | | | | | | |
| 2 | | | | | | | | | |
| | | | | | | | | | 999.19 |
| | -trace gravel and discoloration at 2.5m. (blue, brown, yellow) | | | | | | | | |
| 3 | | | | | | | | | |
| | | | | | | | | | 998.39 |
| | ***Debris*** Metal, plastic, brown, damp. | | | | | | | | |
| 4 | | | | | | | | | 997.59 |
| | ***Clay*** Silty, some sand, stiff, medium plastic, brown, occasional rust stains, dry to damp. | | | | | | | | |
| | | | | | | | | | 997.09 |
| | End of probe at 4.5m. Backfilled with cuttings. Dry upon completion. | | | | | | | | |
| 5 | | | | | | | | | 996.59 |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1001.587m

NORTHING: 5805441.797

EASTING: 697843.798

**BOREHOLE NO.: P14**

CLIENT: ISL Engineering and Land Services Ltd.

SITE: SW 21-39-1-W5M | PROJECT NO.: RD3026

NOTES: Lacombe County, Alberta | BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1001.26 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1001.06 |
| | ***Clay*** Silty, some sand, firm to stiff, medium plastic, brown to dark brown, dry. | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | 997.96 |
| | ***Weathered Bedrock*** Siltstone, hard, dry. | | | | | | | | |
| 4 | | | | | | | | | 996.76 |
| | End of probe at 4.5m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 996.26 |
| 5 | | | | | | | | | |

LOGGED BY: PA

CONTRACTOR: All Service Drilling Inc.

RIG/METHOD: Truck Mounted Rig / Solid Stem Auger

DATE: September 12, 2008

CALIBRATION:

GROUND ELEVATION: 1001.258m

NORTHING: 5805441.357

EASTING: 697838.767

**BOREHOLE NO.: P15**

CLIENT: ISL Engineering and Land Services Ltd.
SITE: SW 21-39-1-W5M
NOTES: Lacombe County, Alberta

PROJECT NO.: RD3026
BH LOCATION:

## SUBSURFACE PROFILE

| Depth (m) | Description | Symbol | Moisture (Wp \|-----X-----\| Wl) 25 50 75 | Type | Sample No | SPT (N) | Comments | Well Completion Details | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GROUND SURFACE | | | | | | | | 1000.77 |
| | ***Topsoil*** Organic, brown, dry. | | | | | | | | 1000.57 |
| | ***Clay*** Silty, some sand, firm to stiff, low to medium plastic, brown, damp. -shoelace at 0.7m. | | | | | | | | 1000.17 |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| | ***Weathered Bedrock*** Siltstone, hard, dry. | | | | | | | | 998.07 |
| 3 | End of probe at 3.0m. Backfilled with cuttings. Dry upon completion. | | | | | | | | 997.77 |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | 995.77 |

LOGGED BY: PA
CONTRACTOR: All Service Drilling Inc.
RIG/METHOD: Truck Mounted Rig / Solid Stem Auger
DATE: September 12, 2008
CALIBRATION:

GROUND ELEVATION: 1000.772m
NORTHING: 5805424.127
EASTING: 697838.919

# Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

| | |
|---|---|
| Well I.D.: | 0361927 |
| Map Verified: | Not Verified |
| Date Report Received: | 1984/12/20 |
| Measurements: | Metric |

## 1. Contractor & Well Owner Information

| | | |
|---|---|---|
| Company Name: ALBERTA EAGLE DRILLING LTD. | | Drilling Company Approval No.: 117793 |
| Mailing Address: BOX 9036 | City or Town: SYLVAN LAKE AB CA | Postal Code: T4S 1S6 |
| WellOwner's Name: BLUE RANGE RES | Well Location Identifier: | |
| P.O. Box Number: | Mailing Address: 905 706 7 AVE SW, CALGARY | Postal Code: T2P 0Z1 |
| City: | Province: | Country: |

## 2. Well Location

| 1/4 or LSD | Sec | Twp | Rge | Westof M |
|---|---|---|---|---|
| 06 | 21 | 039 | 01 | 5 |

Location in Quarter
0 M from Boundary
0 M from Boundary

Lot | Block | Plan

Well Elev: 1005.84 M
How Obtain: Estimated

## 3. Drilling Information

Type of Work: Old Well-Abandoned Reclaimed Well
Proposed well use: Industrial
Date Reclaimed: 1984/12/06
Materials Used: Cement
Anticipated Water Requirements/day 0 Liters
Method of Drilling: Rotary
Flowing Well: No
Rate: Liters
Gas Present:
Oil Present:

## 4. Formation Log

| Depth from ground level (meters) | Lithology Description |
|---|---|
| 1.83 | Clay |
| 16.76 | Brown Sandstone |
| 24.38 | Shale |
| 25.6 | Sandstone |
| 39.62 | Shale |
| 42.67 | Sandstone |
| 71.63 | Shale & Sandstone Ledges |
| 106.68 | Sandstone |

## 5. Well Completion

Date Started(yyyy/mm/dd): 1984/11/24
Date Completed(yyyy/mm/dd): 1984/12/06
Well Depth: 106.68 M
Borehole Diameter: 0 CM
Casing Type: Steel
Liner Type:
Size OD: 14.12 CM
Size OD: 0 CM
Wall Thickness: 0.48 CM
Wall Thickness: 0 CM
Bottom at: 5.49 M
Top: 0 M Bottom: 0 M
Perforations
from: 0 M to: 0 M
from: 0 M to: 0 M
from: 0 M to: 0 M
Perforations Size:
0 CM x 0 CM
0 CM x 0 CM
0 CM x 0 CM
Perforated by:
Seal: Driven
from: 0 M to: 0 M
Seal:
from: 0 M to: 0 M
Seal:
from: 0 M to: 0 M
Screen Type:
from: 0 M to: 0 M
Screen ID: 0 CM
Slot Size: 0 CM
Screen Type:
from: 0 M to: 0 M
Screen ID: 0 CM
Slot Size: 0 CM
Screen Installation Method:
Fittings
Top:
Bottom:
Pack:
Grain Size:
Amount: 0
Geophysical Log Taken:
Retained on Files:
Additional Test and/or Pump Data
Chemistries taken By Driller: Yes
Held: 0
Documents Held: 2
Pitless Adapter Type:
Drop Pipe Type:
Length: M
Diameter: CM
Comments:
MEDIUM HARD WATER.

## 6. Well Yield

Test Date (yyyy/mm/dd): 1984/11/24
Start Time: 11:00 AM
Test Method: Pump
Non pumping static level: 25.91 M
Rate of water removal: 113.65 Liters/Min
Depth of pump intake: 51.21 M
Water level at end of pumping: 51.21 M
Distance from top of casing to ground level: CM
Depth To water level (meters)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: 20.73 M
If water removal was less than 2 hr duration, reason why:
Recommended pumping rate: 0 Liters/Min
Recommended pump intake: 51.82 M
Type Pump Installed
Pump Type: SUB
Pump Model:
H.P.:
Any further pumptest information?

## 7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.:
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

# Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

| | |
|---|---|
| Well I.D.: | 0495651 |
| Map Verified: | Map |
| Date Report Received: | 2000/02/04 |
| Measurements: | Metric |

## 1. Contractor & Well Owner Information

| | | |
|---|---|---|
| Company Name: ALBERTA EAGLE DRILLING LTD. | | Drilling Company Approval No.: 117793 |
| Mailing Address: BOX 9036 | City or Town: SYLVAN LAKE AB CA | Postal Code: T4S 1S6 |
| WellOwner's Name: SCOTT, ROB | Well Location Identifier: | |
| P.O. Box Number: 481 | Mailing Address: HIGH LEVEL | Postal Code: T0H 1Z0 |
| City: | Province: | Country: |

## 2. Well Location

| 1/4 or LSD | Sec | Twp | Rge | Westof M |
|---|---|---|---|---|
| NW | 21 | 039 | 01 | 5 |

Location in Quarter
0 M from Boundary
0 M from Boundary

Lot | Block | Plan

Well Elev: M | How Obtain: Not Obtain

## 3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed: | Materials Used:

Proposed well use: Domestic & Stock
Anticipated Water Requirements/day 2273 Liters

Method of Drilling: Combination

Flowing Well: No | Rate: Liters
Gas Present: No | Oil Present: No

## 4. Formation Log

| Depth from ground level (meters) | Lithology Description |
|---|---|
| 2.44 | Brown Till |
| 5.18 | Brown Sandstone |
| 5.49 | Gray Sandstone |
| 7.01 | Brown Sandstone |
| 7.32 | Coal |
| 9.14 | Brown Fine Grained Sandstone |
| 10.67 | Gray Fine Grained Sandstone |
| 11.58 | Gray Shale |
| 16.15 | Gray Fine Grained Sandstone |
| 21.34 | Gray Silty Shale |
| 23.77 | Gray Medium Grained Sandstone |
| 24.38 | Gray Shale |
| 27.43 | Gray Fine Grained Sandstone |
| 30.48 | Gray Silty Shale |

## 5. Well Completion

| | |
|---|---|
| Date Started(yyyy/mm/dd): 1999/06/21 | Date Completed(yyyy/mm/dd): 1999/06/21 |
| Well Depth: 30.48 M | Borehole Diameter: 0 CM |
| Casing Type: Plastic | Liner Type: Plastic |
| Size OD: 14.12 CM | Size OD: 11.43 CM |
| Wall Thickness: 0.95 CM | Wall Thickness: 0.59 CM |
| Bottom at: 15.54 M | Top: 12.19 M Bottom: 30.48 M |
| Perforations from: 21.34 M to: 27.43 M<br>from: 0 M to: 0 M<br>from: 0 M to: 0 M | Perforations Size:<br>0 CM x 1.59 CM<br>0 CM x 0 CM<br>0 CM x 0 CM |
| Perforated by: Hand Drill | |
| Seal: Other from: 14.63 M | to: 15.54 M |
| Seal: from: 0 M | to: 0 M |
| Seal: from: 0 M | to: 0 M |
| Screen Type: from: 0 M to: 0 M | Screen ID: 0 CM Slot Size: 0 CM |
| Screen Type: from: 0 M to: 0 M | Screen ID: 0 CM Slot Size: 0 CM |
| Screen Installation Method: | |
| Fittings Top: | Bottom: |
| Pack: Grain Size: | Amount: |
| Geophysical Log Taken: Retained on Files: | |
| Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0 | Documents Held: 1 |
| Pitless Adapter Type: Drop Pipe Type: Length: M | Diameter: CM |

Comments:
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: .8 M. 4 HARD, PH 8.5, FE .5. DEPTH PUMP INTAKE, WATER LEVEL END TO TEST 32M 105', 5' DEEPER THAN WELL DEPTH, TOTAL DRAWDOWN 14.67M 48'. PROPER NOT AVAILABLE FROM THE DRILLER.

## 6. Well Yield

Test Date (yyyy/mm/dd): 1999/06/21 | Start Time: 11:00 AM
Test Method: Air

Non pumping static level: 17.31 M

Rate of water removal: 34.1 Liters/Min

Depth of pump intake: 0 M

Water level at end of pumping: M

Distance from top of casing to ground level: CM

| Depth To water level (meters) Elapsed Time Drawdown | Minutes:Sec | Recovery |
|---|---|---|
| | 5:00 | 24.1 |
| | 6:00 | 22.97 |
| | 7:00 | 21.62 |
| | 8:00 | 20.8 |
| | 9:00 | 20.08 |
| | 10:00 | 19.55 |
| | 12:00 | 18.76 |
| | 14:00 | 18.3 |
| | 16:00 | 17.91 |
| | 20:00 | 17.61 |
| | 25:00 | 17.44 |
| | 30:00 | 17.33 |

Total Drawdown: 14.63 M

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 22.73 Liters/Min

Recommended pump intake: 27.43 M

Type Pump Installed
Pump Type: SUB
Pump Model:
H.P.:
Any further pumptest information?

## 7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
Certification No.: 27275A

This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.

Signature Yr Mo Day

# Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

| | |
|---|---|
| Well I.D.: | 1045092 |
| Map Verified: | Not Verified |
| Date Report Received: | 2005/07/13 |
| Measurements: | Metric |

## 1. Contractor & Well Owner Information

| | | |
|---|---|---|
| Company Name: ALBERTA EAGLE DRILLING LTD. | | Drilling Company Approval No.: 117793 |
| Mailing Address: BOX 9036 | City or Town: SYLVAN LAKE AB CA | Postal Code: T4S 1S6 |
| WellOwner's Name: RADOMSKI | Well Location Identifier: | |
| P.O. Box Number: | Mailing Address: 7 - 4608 - 62 ST | Postal Code: T4N 6T3 |
| City: RED DEER | Province: AB | Country: CA |

## 2. Well Location

| 1/4 or LSD | Sec | Twp | Rge | Westof M |
|---|---|---|---|---|
| SE | 21 | 039 | 01 | 5 |

Location in Quarter
M from N Boundary
M from E Boundary

Lot Block Plan

Well Elev: M
How Obtain: Not Obtain

## 3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed:
Materials Used: Unknown
Proposed well use: Domestic
Anticipated Water Requirements/day Liters
Method of Drilling: Combination
Flowing Well: No
Gas Present: No
Rate: Liters
Oil Present: No

## 4. Formation Log

| Depth from ground level (meters) | Lithology Description |
|---|---|
| 2.74 | Till & Clay |
| 8.23 | Brown Sandy Shale |
| 12.8 | Brown Medium Grained Sandstone |
| 17.37 | Gray Shale |
| 34.14 | Brownish Gray Sandstone |
| 35.05 | Gray Shale |

## 5. Well Completion

| | |
|---|---|
| Date Started(yyyy/mm/dd): 2004/03/18 | Date Completed(yyyy/mm/dd): 2004/03/18 |
| Well Depth: 35.05 M | Borehole Diameter: 13.02 CM |
| Casing Type: Plastic | Liner Type: Plastic |
| Size OD: 15.24 CM | Size OD: 11.43 CM |
| Wall Thickness: 1.1 CM | Wall Thickness: 0.54 CM |
| Bottom at: 23.77 M | Top: 22.86 M Bottom: 35.05 M |
| Perforations from: 28.96 M to: 35.05 M<br>from: M to: M<br>from: M to: M | Perforations Size: 1.59 CM x CM<br>CM x CM<br>CM x CM |
| Perforated by: Hand Drill | |
| Seal: Driven & Bentonite from: 0 M<br>Seal: Unknown from: M<br>Seal: Unknown from: M | to: 23.77 M<br>to: M<br>to: M |
| Screen Type: Unknown from: M to: M | Screen ID: CM Slot Size: CM |
| Screen Type: Unknown from: M to: M | Screen ID: CM Slot Size: CM |
| Screen Installation Method: Unknown | |
| Fittings Top: Unknown | Bottom: Unknown |
| Pack: Unknown Grain Size: | Amount: Unknown |
| Geophysical Log Taken:<br>Retained on Files: | |
| Additional Test and/or Pump Data<br>Chemistries taken By Driller: No<br>Held: | Documents Held: |
| Pitless Adapter Type:<br>Drop Pipe Type:<br>Length: M | Diameter: CM |

Comments:
SUBMERSIBLE PUMP INSTALLED AT 90'.

## 6. Well Yield

Test Date (yyyy/mm/dd): 2004/03/18
Start Time: 11:00 AM
Test Method: Unknown

Non pumping static level: 20.15 M

Rate of water removal: 90.92 Liters/Min

Depth of pump intake: 34.99 M

Water level at end of pumping: M

Distance from top of casing to ground level: 70 CM

Depth To water level (meters)
Elapsed Time

| Drawdown | Minutes:Sec | Recovery |
|---|---|---|
| | 1:00 | 27.45 |
| | 2:00 | 22.17 |
| | 3:00 | 21.4 |
| | 4:00 | 21.02 |
| | 5:00 | 20.74 |
| | 6:00 | 20.56 |
| | 7:00 | 20.48 |
| | 8:00 | 20.45 |
| | 9:00 | 20.41 |
| | 10:00 | 20.39 |

Total Drawdown: M

If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 45.46 Liters/Min

Recommended pump intake: 27.43 M

Type Pump Installed
Pump Type: SUB
Pump Model:
H.P.:
Any further pumptest information? No

## 7. Contractor Certification

Driller's Name: JACK WHITEHEAD
Certification No.: VA7724

This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.

Signature Yr Mo Day

# EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of the field investigation and subsequent laboratory testing are described on the following two pages.

The borehole logs are a graphical representation summarizing the soil profile as determined during site specific field investigation. The borehole logs may include test data from laboratory soil testing, if applicable. The materials, boundaries and conditions have been established only at the borehole locations at the time of drilling. The soil conditions shown on the borehole logs are not necessarily representative of the subsurface conditions elsewhere across the site. The transitions in soil profile usually have gradual rather than distinct unit boundaries as shown on this graphical representation.

**1. PRINCIPAL SOIL TYPE** - The major soil type by weight of material or by behavior.

| Material | Grain Size |
|---|---|
| Boulders | Larger than 300 mm |
| Cobbles | 75 mm to 300 mm |
| Coarse Gravel | 19 mm to 75 mm |
| Fine Gravel | 5 mm to 19 mm |
| Coarse Sand | 2 mm to 5 mm |
| Medium Sand | 0.425 mm to 2 mm |
| Fine Sand | 0.75 mm to 0.425 mm |
| Silt & Clay | Smaller than 0.075 mm |

**2. DESCRIPTION OF MINOR SOIL TYPE** - Minor soil types are identified by weight of minor component.

| Percent | Descriptor |
|---|---|
| 35 to 50 | and |
| 20 to 35 | some |
| 10 to 20 | little |
| 1 to 10 | trace |

**3. RELATIVE STRENGTH OF COARSE GRAINED SOIL** - The following terms are used relative to Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

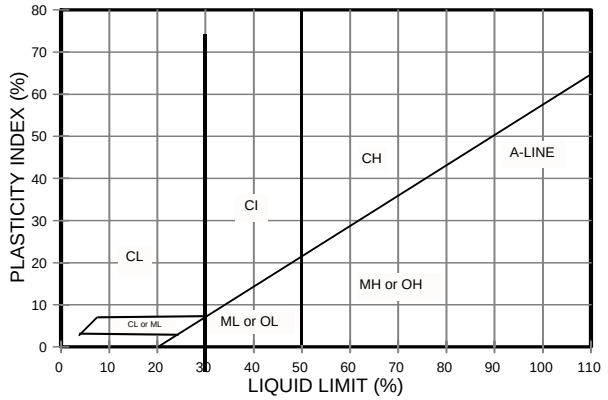
| Description | N Value |
|---|---|
| Very Loose | Less than 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | Over 50 |

**4. CONSISTENCY OF FINED GRAINED SOIL** - The following terms are used relative to unconfined strength in kPa and Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

| Description | Unconfined Compressive Strength (kPa) | N Value |
|---|---|---|
| Very Soft | less than 25 | Less than 2 |
| Soft | 25 to 50 | 2 to 4 |
| Firm | 50 to 100 | 4 to 8 |
| Stiff | 100 to 200 | 8 to 15 |
| Very Stiff | 200 to 380 | 15 to 30 |
| Hard | Over 380 | Over 30 |

## MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

| MAJOR DIVISION | | | GROUP SYMBOL | GRAPH SYMBOL | TYPICAL DESCRIPTION | LABORATORY CLASSIFICATION CRITERIA | |
|---|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE) | GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE | CLEAN GRAVELS (LITTLE OR NO FINES) | GW | | WELL GRADED GRAVELS, LITTLE OR NO FINES | $C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$ | |
| | | | GP | | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO | NOT MEETING ALL OF THE ABOVE REQUIREMENTS | |
| | | DIRTY GRAVELS (WITH SOME FINES) | GM | | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES | CONTENT OF FINES EXCEEDS 12 % | ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4 |
| | | | GC | | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES | | ATTERBERG LIMITS ABOVE "A" LINE OR P.I. MORE THAN |
| | SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE | CLEAN SANDS (LITTLE OR NO FINES) | SW | | WELL GRADED SANDS, GRAVELLY SANDS WITH LITTLE OR NO FINES | $C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$ | |
| | | | SP | | POORLY GRADED SANDS, LITTLE OR NO FINES | NOT MEETING ALL OF THE ABOVE REQUIREMENTS | |
| | | DIRTY SANDS (WITH SOME FINES) | SM | | SILTY SANDS, SAND-SILT MIXTURES | CONTENT OF FINES EXCEEDS 12 % | ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4 |
| | | | SC | | CLAYEY SANDS, SAND-CLAY MIXTURES | | ATTERBERG LIMITS ABOVE "A" LINE OR P.I. MORE THAN |
| FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE) | SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT | $W_L < 50\%$ | ML | | INORGANIC SILTS & VERY FINE SANDS, ROCK FLUOR, SILTY SANDS OF SLIGHT | CLASSIFICATION IS BASED ON THE PLASTICITY CHART BELOW | |
| | | $W_L > 50\%$ | MH | | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY | | |
| | CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT | $W_L < 30\%$ | CL | | INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR | | |
| | | $30\% < W_L < 50\%$ | CI | | INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS | | |
| | | $W_L > 50\%$ | CH | | INORGANIC CLAYS OF HIGH PLASTICITY | | |
| | ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART | $W_L < 50\%$ | OL | | ORGANIC SILT, AND ORGANIC SILTY CLAYS OF LOW PLASTICITY | | |
| | | $W_L > 50\%$ | OH | | ORGANIC CLAYS OF HIGH PLASTICITY | | |
| HIGHLY ORGANIC SOILS | | | Pt | | PEAT AND OTHER HIGHLY ORGANIC SOILS | STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE | |




**NOTES ON SOIL CLASSIFICATION AND DESCRIPTION**:

5. Soils are classified and described according to their engineering properties and behaviour.
6. Boundary classifications for soils with characteristics of two groups are given combined group symbols, eg. GW-GC is a well graded gravel-sand mixture with clay binder between 5 and 12 %.
7. Soil classification is in accordance with the Unified Soil Classification System, with the exception that an inorganic clay of medium plasticity (CI) is recognized.
8. The use of modifying adjectives may be employed to define the estimated percentage range by weight of minor components.



Parkland GEO

# APPENDIX C

TABLE C1 - GROUNDWATER CHEMISTRY RESULTS
CERTIFICATES OF ANALYSIS - GROUNDWATER
CERTIFICATES OF ANALYSIS - GAS COMPOSITION
PREPARATION AND QUANTIFICATION METHODS

# TABLE C1
# GROUNDWATER CHEMISTRY RESULTS

| | Tier 1 Guidelines | Tier 2 Calculated Guidelines[1] | MW#2 |
|---|---|---|---|
| | | | 2008 |
| **Landfill Code of Practice Criteria** | | | |
| pH | 6.5-8.5 | 6.5-9.0 | 7.6 |
| Sodium | 200 | | 30.3 |
| Chloride | 100 | | 408 |
| Sulfate | 500 | | 138 |
| **Routine Water** | | | |
| EC | | | 2150 |
| Calcium | | | 247 |
| Magnesium | | | 87.1 |
| Phenols | | 0.004 | <0.002 |
| Potassium | | | |
| Iron | 0.3 | 0.3 | 0.003 |
| Manganese | 0.05 | | 0.602 |
| Nitrate-N | | | 1.91 |
| Nitrite-N | | 0.06 | <0.009 |
| Nitrate+Nitrite-N | | | 1.94 |
| Hydroxide | | | <5 |
| Carbonate | | | <5 |
| Bicarbonate | | | 415 |
| Flouride | | | 0.07 |
| P-Alkalinity | | | <5 |
| T-alkalinity | | | 415 |
| TDS | 500 | | 1180 |
| Hardness | | | 975 |
| Ionic Balance | | | 0.984 |
| **Metals** | | | |
| Aluminum | | | 7.89 |
| Antinomy | 0.006 | | <0.001 |
| Arsenic | 0.005 | 0.005 | 0.008 |
| Barium | 1 | | 0.449 |
| Boron | 0.5 | | 0.05 |
| Cadmium | 0.005 | 0.005 | 0.00174 |
| Chromium | 0.05 | 0.05 | 0.014 |
| Copper | 0.2 | 0.2 | 0.039 |
| Iron | 0.3 | 0.3 | 12.6 |
| Lead | 0.01 | 0.01 | 0.016 |
| manganese | | | 2.07 |
| Mercury | 0.001 | 0.001 | <0.000025 |
| Nickel | 0.2 | 0.2 | 0.07 |
| Selenium | 0.001 | 0.01 | 0.01 |
| Silver | 0.002 | 0.02 | 0.00007 |
| Uranium | | | 0.002 |
| Zinc | 0.03 | 1 | 0.168 |
| **Hydrocarbons** | | | |
| Oil & Grease | | | <0.2 |

Note : Highlighted red values are referenced to the most stringent guideline values

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# Certificate of Analysis

**AGAT WORK ORDER: 08R296549**

**PROJECT NO: RD3026**

**CLIENT NAME: PARKLAND GEOTECHNICAL**

**ATTENTION TO: Danny Yost**

## Routine Chemistry Water Analysis

**DATE SAMPLED: Sep 30, 2008** | **DATE RECEIVED: Oct 02, 2008** | **DATE REPORTED: Oct 06, 2008** | **SAMPLE TYPE: Water**

| | Unit | G / S | RDL | MW2 1099561 |
|---|---|---|---|---|
| pH | | 6.5-8.5 | NA | 7.6 |
| p - Alkalinity (as CaCO3) | mg/L | | 5 | <5 |
| T - Alkalinity (as CaCO3) | mg/L | | 5 | 415 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 415 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 |
| Electrical Conductivity | uS/cm | | 1 | 2150 |
| Chloride | mg/L | 250 | 0.60 | **408** |
| Fluoride | mg/L | 1.5 | 0.01 | 0.07 |
| Nitrate | mg/L | 45 | 0.08 | 8.44 |
| Nitrite | mg/L | 3.2 | 0.03 | <0.03 |
| Sulfate | mg/L | 500 | 0.03 | 138 |
| Dissolved Calcium | mg/L | | 0.3 | 247 |
| Dissolved Magnesium | mg/L | | 0.2 | 87.1 |
| Dissolved Sodium | mg/L | 200 | 0.6 | 30.3 |
| Dissolved Potassium | mg/L | | 0.6 | 7.2 |
| Dissolved Iron | mg/L | | 0.001 | 0.003 |
| Dissolved Manganese | mg/L | 0.05 | 0.001 | **0.602** |
| % Difference Cation/Anion | % | | | 0.785 |
| Anion Sum (Water) | meq/L | | | 21.3 |
| Calculated Electrical Conductivity | uS/cm | | | 2390 |
| Calculated TDS | mg/L | | | 1180 |
| Cation Sum (Water) | meq/L | | | 21.0 |
| Ion Balance | | | | 0.984 |
| Nitrate + Nitrite (as Nitrogen) | mg/L | | | 1.91 |
| Nitrate-N | mg/L | | | 1.91 |
| Nitrite-N | mg/L | | | <0.009 |
| Total Hardness | mg CaCO3/L | | | 975 |

**Comments:** RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME 2007 (D Water)

**1099561** < - Values refer to Method Detection Limits.

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# Quality Assurance

**CLIENT NAME: PARKLAND GEOTECHNICAL**

**AGAT WORK ORDER: 08R296549**

**PROJECT NO: RD3026**

**ATTENTION TO: Danny Yost**

## Water Analysis

| RPT Date: Oct 06, 2008 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **Routine Chemistry Water Analysis** | | | | | | | | | | | | | | | |
| pH | 1214 | | 8.7 | 8.7 | 8.7% | | 100% | 90% | 110% | | | | | | |
| T - Alkalinity (as CaCO3) (mg/L) | 1214 | | 607 | 618 | 1.8% | < 5 | 99% | 90% | 110% | | | | | | |
| Electrical Conductivity (uS/cm) | 1214 | | 1250 | 1230 | 1.6% | < 1 | 103% | 90% | 110% | | | | | | |
| Chloride (mg/L) | 552 | | 3.74 | 3.73 | 0.3% | < 0.03 | 96% | 90% | 110% | | | | 97% | 90% | 110% |
| Fluoride (mg/L) | 552 | | 0.49 | 0.49 | 0.0% | < 0.01 | 96% | 90% | 110% | | | | 97% | 90% | 110% |
| Nitrate (mg/L) | 552 | | 4.56 | 4.42 | 3.1% | < 0.08 | 98% | 90% | 110% | | | | 99% | 90% | 110% |
| Nitrite (mg/L) | 552 | | 3.74 | 3.72 | 0.5% | < 0.03 | 98% | 90% | 110% | | | | 98% | 90% | 110% |
| Sulfate (mg/L) | 552 | | 5.01 | 4.98 | 0.6% | < 0.03 | 97% | 90% | 110% | | | | 98% | 90% | 110% |
| Dissolved Calcium (mg/L) | 644 | | | | 0.5% | < 0.3 | 96% | 90% | 110% | | | | 102% | 90% | 110% |
| Dissolved Magnesium (mg/L) | 644 | | | | 0.6% | < 0.2 | 95% | 90% | 110% | | | | 100% | 90% | 110% |
| Dissolved Sodium (mg/L) | 644 | | | | 1.4% | < 0.6 | 93% | 90% | 110% | | | | 99% | 90% | 110% |
| Dissolved Potassium (mg/L) | 644 | | | | 1.4% | < 0.6 | 94% | 90% | 110% | | | | 100% | 90% | 110% |
| Dissolved Iron (mg/L) | 644 | | | | 0.0% | < 0.001 | 98% | 90% | 110% | | | | 99% | 90% | 110% |
| Dissolved Manganese (mg/L) | 644 | | | | 0.0% | < 0.001 | 97% | 90% | 110% | | | | 98% | 90% | 110% |

Comments: N/A - Not Available.

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# Method Summary

**CLIENT NAME: PARKLAND GEOTECHNICAL**

**AGAT WORK ORDER: 08R296549**

**PROJECT NO: RD3026**

**ATTENTION TO: Danny Yost**

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| **Trace Organics Analysis** | | | |
| Helium (He) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hydrogen (H2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Oxygen (O2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Nitrogen (N2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Carbon Dioxide (CO2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hydrogen Sulphide (H2S) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Methane (C1) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Ethane (C2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Propane (C3) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| I-Butane (IC4) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| N-Butane (NC4) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| I-Pentane (IC5) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| N-Pentane (NC5) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hexanes (C6) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Heptanes (C7) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Octanes (C8) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Nonanes (C9) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Decanes+ (C10+) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| **Water Analysis** | | | |
| pH | WAT 0400 | SM4500H+B | pH METER |
| p - Alkalinity (as CaCO3) | WAT 0300 | SM 2320 | TITRATION |
| T - Alkalinity (as CaCO3) | WAT 0300 | SM 2320 | TITRATION |
| Bicarbonate (as CaCO3) | WAT 0310 | SM 2320 B | TITRATION |
| Carbonate (as CaCO3) | WAT 0310 | SM 2320 B | TITRATION |
| Hydroxide (as CaCO3) | WAT 0310 | SM 2320 B | TITRATION |
| Electrical Conductivity | WAT 0700 | SM 2510 B | CONDUCTIVITY METER |
| Chloride | INS 0200 | SM 4110 B | IC |
| Fluoride | INS 0204 | SM4500-F-G | IC |
| Nitrate | INS 0200 | SM 4110 B | IC |
| Nitrite | INS 0200 | SM 4110 B | IC |
| Sulfate | INS 0200 | SM 4110 B | IC |
| Dissolved Calcium | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Magnesium | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Sodium | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Potassium | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Iron | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Manganese | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |

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# Certificate of Analysis

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R302061

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Oil and Grease in Water (FTIR)

SAMPLE TYPE: water | SAMPLE ID: 1133553 | DATE RECEIVED: Nov 01, 2008

DATE SAMPLED: Oct 31, 2008 | DATE REPORTED: Nov 10, 2008

SAMPLE DESCRIPTION: MW2

| PARAMETER | RESULT | G / S | UNIT | RDL | DATE ANALYZED | INITIAL | DATE PREPARED |
|---|---|---|---|---|---|---|---|
| Oil Content, Infrared | <0.2 | | mg/L | 0.2 | Nov 04, 2008 | NV | Nov 04, 2008 |

COMMENTS:

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

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# Certificate of Analysis

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R302061

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Water Analysis - Phenols

SAMPLE TYPE: water | SAMPLE ID: 1133568 | DATE RECEIVED: Nov 01, 2008

DATE SAMPLED: Oct 31, 2008 | DATE REPORTED: Nov 10, 2008

SAMPLE DESCRIPTION: MW2

| PARAMETER | RESULT | G / S | UNIT | RDL | DATE ANALYZED | INITIAL | DATE PREPARED |
|---|---|---|---|---|---|---|---|
| Phenols | <0.002 | | mg/L | 0.002 | Nov 06, 2008 | ST | Nov 06, 2008 |

COMMENTS:

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

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# Quality Assurance

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R302061

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Trace Organics Analysis

| RPT Date: Nov 10, 2008 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Oil and Grease in Water (FTIR) | | | | | | | | | | | | | | | |
| Oil Content, Infrared (mg/L) | 2803 | | | | 5.0% | < 0.2 | 101% | 70% | 130% | 113% | 70% | 130% | 117% | 70% | 130% |

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# Quality Assurance

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R302061

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Water Analysis

| RPT Date: Nov 10, 2008 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Water Analysis - Phenols | | | | | | | | | | | | | | | |
| Phenols (mg/L) | 116 | | 20.7 | 20.7 | 0.0% | < 0.002 | 94% | 90% | 110% | 101% | 90% | 110% | | 90% | 110% |

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# Method Summary

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R302061

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| Trace Organics Analysis | | | |
| Oil Content, Infrared | | | FTIR |
| Water Analysis | | | |
| Phenols | TEC 0105 | ENVIRODAT VMV 06537 689 METHOD 154 | TECHNICON |

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# Certificate of Analysis

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R298926

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Alberta Tier 1 - Groundwater Metals (Dissolved)

SAMPLE TYPE: Water | SAMPLE ID: 1110663 | DATE RECEIVED: Oct 16, 2008

DATE SAMPLED: Oct 15, 2008 | DATE REPORTED: Oct 27, 2008

SAMPLE DESCRIPTION: Monitoring Well 2

| PARAMETER | RESULT | G / S | UNIT | RDL | DATE ANALYZED | INITIAL | DATE PREPARED |
|---|---|---|---|---|---|---|---|
| Dissolved Aluminum | 7.89 | | mg/L | 0.002 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Antimony | <0.001 | 0.006 | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Arsenic | 0.008 | | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Barium | 0.449 | | mg/L | 0.001 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Boron | 0.05 | | mg/L | 0.01 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Cadmium | 0.00174 | | mg/L | 0.000025 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Chromium | 0.014 | | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Copper | 0.039 | | mg/L | 0.002 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Iron | 12.6 | | mg/L | 0.1 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Lead | 0.016 | | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Manganese | 2.07 | | mg/L | 0.010 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Mercury (Low Level) | <0.000025 | 0.001 | mg/L | 0.000025 | Oct 20, 2008 | AJ | Oct 20, 2008 |
| Dissolved Nickel | 0.07 | | mg/L | 0.01 | Oct 23, 2008 | DZ | Oct 20, 2008 |
| Dissolved Selenium | 0.010 | | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Silver | 0.00007 | | mg/L | 0.00005 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Uranium | 0.020 | | mg/L | 0.001 | Oct 21, 2008 | MG | Oct 20, 2008 |
| Dissolved Zinc | 0.168 | | mg/L | 0.001 | Oct 23, 2008 | DZ | Oct 20, 2008 |

COMMENTS:

RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ABTier1 GW (Ag,F)
< - Values refer to Method Detection Limit.

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# Quality Assurance

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R298926

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

## Water Analysis

| RPT Date: Oct 27, 2008 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Alberta Tier 1 - Groundwater Metals (Dissolved) | | | | | | | | | | | | | | | |
| Dissolved Aluminum (mg/L) | 659 | | | | 0.8% | < 0.002 | 100% | 90% | 110% | | | | 100% | 90% | 110% |
| Dissolved Antimony (mg/L) | 1020 | | | | 0.0% | < 0.001 | 116% | 80% | 120% | | | | 104% | 75% | 125% |
| Dissolved Arsenic (mg/L) | 1020 | | | | 1.7% | < 0.001 | 82% | 80% | 120% | | | | 102% | 75% | 125% |
| Dissolved Barium (mg/L) | 659 | | | | 0.9% | < 0.001 | 102% | 90% | 110% | | | | 101% | 90% | 110% |
| Dissolved Boron (mg/L) | 1020 | | | | 4.6% | < 0.01 | 91% | 80% | 120% | | | | 94% | 75% | 125% |
| Dissolved Cadmium (mg/L) | 1020 | | | | 0.0% | < | 82% | 80% | 120% | | | | 103% | 90% | 110% |
| Dissolved Chromium (mg/L) | 1020 | | | | 23.6% | < 0.001 | 83% | 80% | 120% | | | | 98% | 90% | 110% |
| Dissolved Copper (mg/L) | 659 | | | | 2.5% | < 0.002 | 101% | 90% | 110% | | | | 100% | 90% | 110% |
| Dissolved Iron (mg/L) | 659 | | | | 0.0% | < 0.1 | 102% | 80% | 120% | | | | 101% | 75% | 125% |
| Dissolved Lead (mg/L) | 1020 | | | | 0.0% | < 0.001 | 82% | 80% | 120% | | | | 104% | 75% | 125% |
| Dissolved Manganese (mg/L) | 659 | | | | 0.4% | < 0.001 | 100% | 90% | 110% | | | | 100% | 90% | 110% |
| Dissolved Mercury (Low Level) (mg/L) | 48 | | | | 0.0% | < | 100% | 90% | 110% | 103% | 90% | 110% | 98% | 85% | 115% |
| Dissolved Nickel (mg/L) | 659 | | | | 1.5% | < 0.01 | 99% | 90% | 110% | | | | 92% | 90% | 110% |
| Dissolved Selenium (mg/L) | 1020 | | | | 0.0% | < 0.001 | 104% | 80% | 120% | | | | 112% | 75% | 125% |
| Dissolved Silver (mg/L) | 1020 | | | | 0.0% | < 0.00005 | 100% | 80% | 120% | | | | 98% | 75% | 125% |
| Dissolved Uranium (mg/L) | 1020 | | | | 0.7% | < 0.001 | 97% | 80% | 120% | | | | 103% | 75% | 125% |
| Dissolved Zinc (mg/L) | 659 | | | | 1.2% | < 0.001 | 101% | 90% | 110% | | | | 98% | 90% | 110% |

Certified By:

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7


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# Method Summary

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R298926

PROJECT NO: RD3026

ATTENTION TO: Phillip Auclair

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| Water Analysis | | | |
| Dissolved Aluminum | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Antimony | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Arsenic | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Barium | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Boron | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/MS |
| Dissolved Cadmium | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Chromium | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Copper | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Iron | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Lead | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Manganese | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Mercury (Low Level) | INS 0400 | SM 3112 B | CV/AA |
| Dissolved Nickel | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |
| Dissolved Selenium | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Silver | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Uranium | INS 0104 | SM 3125 | ICP/MS |
| Dissolved Zinc | INS 0103 | EPA SW 846-6010B, SM 3030B | ICP/OES |

AGAT Laboratories

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# Certificate of Analysis

AGAT WORK ORDER: 08R296549
PROJECT NO: RD3026

CLIENT NAME: PARKLAND GEOTECHNICAL

ATTENTION TO: Danny Yost

## C10+ Gas (Including O2)

DATE SAMPLED: Sep 30, 2008 | DATE RECEIVED: Oct 02, 2008 | DATE REPORTED: Oct 06, 2008 | SAMPLE TYPE: Gas

| | Unit | G / S | RDL | MW1 TB1A | MW2 TB2B | MW3 TB3C |
|---|---|---|---|---|---|---|
| Helium (He) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Hydrogen (H2) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Oxygen (O2) | % | | 0.001 | 1.718 | 15.411 | 18.076 |
| Nitrogen (N2) | % | | 0.001 | 84.991 | 78.676 | 79.221 |
| Carbon Dioxide (CO2) | % | | 0.001 | 13.291 | 5.913 | 2.703 |
| Hydrogen Sulphide (H2S) | % | | 0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Methane (C1) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Ethane (C2) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Propane (C3) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| I-Butane (IC4) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| N-Butane (NC4) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| I-Pentane (IC5) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| N-Pentane (NC5) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Hexanes (C6) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Heptanes (C7) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Octanes (C8) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Nonanes (C9) | % | | 0.001 | <0.001 | <0.001 | <0.001 |
| Decanes+ (C10+) | % | | 0.001 | <0.001 | <0.001 | <0.001 |

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
TB1A-TB3C Analysis Conducted Using GPA 2286-95 (Modified)

Certified By:

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# Method Summary

CLIENT NAME: PARKLAND GEOTECHNICAL

AGAT WORK ORDER: 08R296549

PROJECT NO: RD3026

ATTENTION TO: Danny Yost

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| Trace Organics Analysis | | | |
| Helium (He) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hydrogen (H2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Oxygen (O2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Nitrogen (N2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Carbon Dioxide (CO2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hydrogen Sulphide (H2S) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Methane (C1) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Ethane (C2) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Propane (C3) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| I-Butane (IC4) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| N-Butane (NC4) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| I-Pentane (IC5) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| N-Pentane (NC5) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Hexanes (C6) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Heptanes (C7) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Octanes (C8) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Nonanes (C9) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |
| Decanes+ (C10+) | HC-0160.013 | GPA 2286-95 | GC/TCD/FID |

# GENERAL TERMS AND CONDITIONS

The use of this attached report is subject to acceptance of the following general terms and conditions.

1. STANDARD OF CARE - In the performance of professional services, ParklandGEO will use that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession practicing in the same or similar localities. No other warranty expressed or implied is made or intended by this agreement or by furnishing oral or written reports of the findings made. ParklandGEO is to be liable only for damage directly caused by the negligence of ParklandGEO.

2. INTERPRETATION OF THE REPORT - The CLIENT recognizes that subsurface conditions will vary from those encountered at the location where borings, surveys, or explorations are made and that the data, interpretations and recommendation of ParklandGEO are based solely on the information available to him. Classification and identification of soils, rocks, geological units, contaminated materials and contaminant quantities will be based on commonly accepted practices in geotechnical consulting practice in this area. ParklandGEO will not be responsible for the interpretation by others of the information developed.

3. SITE INFORMATION - The CLIENT agrees to fully cooperate with ParklandGEO and provide all information with respect to the past, present and proposed conditions and use of the Site whether specifically requested or not. The CLIENT acknowledges that in order for ParklandGEO to properly advise and assist the CLIENT in respect of the investigation of the Site, ParklandGEO is relying upon full disclosure by the CLIENT of all matters pertinent to an investigation of the Site.

   Where specifically stated in the scope of work, ParklandGEO will perform a review of the historical information obtained or provided by the Client to assist in the investigation of the Site unless and except to the extent that such a review is limited or excluded from the scope of work.

4. RIGHT OF ENTRY - The CLIENT is responsible for ensuring that ParklandGEO is provided unencumbered access to the property to the extent necessary for ParklandGEO to complete the scope of work to ParklandGEO's satisfaction. The CLIENT is solely responsible for obtaining permission and permits for ParklandGEO to enter onto the subject site, including informing tenants. The CLIENT shall also provide ParklandGEO with the location of all underground utilities and structures on the subject site, unless otherwise agreed to in writing. While ParklandGEO will take all reasonable precautions to avoid and minimize any damage to any sub-terrain utilities or structures, the CLIENT agrees to hold ParklandGEO harmless for any damage to any sub-terrain utilities or structures or any damage occasioned in gaining access to the subject site.

5. COMPLETE REPORT - The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to ParklandGEO by the CLIENT, communications between ParklandGEO and the CLIENT, and to any other reports, writings or documents prepared by ParklandGEO for the CLIENT relative to the specific Site, all of which constitute the Report. The word "Report" shall refer to any and all of the documents referred to herein. In order to properly understand the suggestions, recommendations and opinions expressed by ParklandGEO, reference must be made to the whole of the Report. ParklandGEO cannot be responsible for use of any part or portions of the report without reference to the whole report. The CLIENT agrees that any and all reports prepared by ParklandGEO shall contain the following statement:

   > "This report has been prepared for the exclusive use of the named CLIENT. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. PARKLAND GEOTECHNICAL CONSULTING LTD. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report."

   The CLIENT agrees that in the event that any such report is released to a third party, such disclaimer shall not be obliterated or altered in any manner. The CLIENT further agrees that all such reports shall be used solely for the purposes of the CLIENT and shall not be released or used by others without the prior written permission of ParklandGEO.

6. LIMITATIONS ON SCOPE OF INVESTIGATION AND WARRANTY DISCLAIMER

There is no warranty, expressed or implied, by ParklandGEO that:

a) the investigation shall uncover all potential contaminants or environmental liabilities on the Site; or

b) the Site will be entirely free of all contaminants as a result of any investigation or cleanup work undertaken on the Site, since it is not possible, even with exhaustive sampling, testing and analysis, to document all potential contaminants on the Site.

The CLIENT acknowledges that:

a) the investigation findings are based solely on the information generated as a result of the specific scope of the investigation authorized by the CLIENT;

b) any assessment regarding geological conditions on the Site is based on the interpretation of conditions determined at specific sampling locations and depths and that conditions may vary between sampling locations, hence there can be no assurance that undetected geological conditions, including soils or groundwater are not located on the Site;

c) any assessment is also dependent on and limited by the accuracy of the analytical data generated by the sample analyses;

d) any assessment is also limited by the scientific possibility of determining the presence of unsuitable geological conditions for which scientific analyses have been conducted; and

e) the analytical parameters selected are limited to those outlined in the CLIENT's authorized scope of investigation; and

f) there are risks associated with the discovery of hazardous materials in and upon the lands and premises which may inadvertently discovered as part of this investigation. The CLIENT acknowledges that it may have a responsibility in law to inform the owner of any affected property of the existence or suspected existence of hazardous materials. The CLIENT further acknowledges that any such discovery may result in the fair market value of the lands and premises and of any other lands and premises adjacent thereto to be adversely affected in a material respect.

7. CONTROL OF WORK SITE AND JOBSITE SAFETY - ParklandGEO is only responsible for the activities of its employees on the jobsite. The presence of ParklandGEO personnel on the Site shall not be construed in any way to relieve the CLIENT or any contractors on Site from their responsibilities for Site safety. The CLIENT undertakes to inform ParklandGEO of all hazardous conditions, or possible hazardous conditions which are known to him. The CLIENT also recognizes that the activities of ParklandGEO may uncover previously unknown hazardous materials and that such a discovery may result in the necessity to undertake emergency procedures to protect ParklandGEO employees as well as the public at large and the environment in general. The CLIENT also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the CLIENT agrees that notification to such bodies by ParklandGEO will not be a cause of action or dispute.