Geotechnical, Environmental and Materials Engineering

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GEOTECHNICAL INVESTIGATION

BURBANK SUBDIVISION
PORTION OF SW 24-39-27-W4M
LACOMBE COUNTY, ALBERTA

PREPARED FOR

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ParklandGEO

PROJECT NO. RD5566
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1.0 INTRODUCTION

1.1 GENERAL

18442107 Alberta Ltd. is proposing new residential subdivision in Lacombe County, Alberta. Parkland Geotechnical Consulting Ltd. (ParklandGEO) was commissioned to conduct a geotechnical assessment and percolation test for the site. The scope was outlined in the ParklandGEO proposal dated November 19, 2015 (File # PRO4629). Authorization to proceed with this assessment was given by Mr. Bard Buchiski. The site location is shown on Figure 1.

1.2 SCOPE OF WORK

This assessment was based on a review of existing publically available site investigation information and recent site investigation. This report summarizes results of historical field and laboratory testing programs for the site and presents geotechnical recommendations for the proposed development. Geotechnical recommendations are provided with respect to design and installation of underground services, residential foundations, roadway subgrades and flexible pavement design for light residential and collector roads.

2.0 SITE AND PROJECT DESCRIPTION

The proposed residential subdivision is located about 2 km southwest of Blackfalds, Alberta. The legal address of the site is SW 24-39-27-W4M in Lacombe County, Alberta. Access to the site is from the south of Township Road 393A. The surface coverage and site development is shown on the 2010 Aerial Photograph (Figure 3). The site was surrounded by the residential acreage to the north and the Blindman River and CN Rail line to the south. A Canadian National Railway storage yard was located east of the development.

The property has a rolling topography. The overall relief at the site was about 8 m between boreholes with elevations that range from 859 m to 868 m. The high areas were at the center of the development sloping down to the east and the west. The 8 m high slope was gradual at an typical angle up to 10 percent (ie 11H:1V). The center portion and southwest portion of the development was tree covered.

The Owner is proposing to subdivide this 18 acre parcel into 14 individual lots ranging in size from 1.25 to 1.50 acres. A private sewage disposal system (PSDS) will be required for the proposed lots. A site plan illustrating the proposed subdivision and lot layout is provided on Figure 2. Stormwater will be managed by over land drainage through roadway ditches. The lots will be accessed by paved access roadway (cul-de-sacs) and will be constructed as part of this development.

3.0 FIELD AND LABORATORY PROGRAMS

On December 3, 2015, one deep boreholes and five shallow boreholes were drilled at the site. Boreholes 1 to 5 were drilled to a depth of 4.5 or 5.0 m below grade. Borehole 6 was drilled to a depth of 13 m. The following sampling and testing procedures were followed during the field program:

1. Prior to mobilizing the drilling rig, ParklandGEO personnel completed an Alberta One Call to verify the drill site was clear of underground utilities.

2. The boreholes were drilled using a truck mounted power auger drilling rig with 150 mm diameter solid stem augers. The drill rig was owned and operated by Darkhorse Drilling of Lacombe, Alberta.

3. Drilling operations were monitored by members of ParklandGEO's geotechnical staff. The soil encountered was visually examined during drilling and logged according to the Modified Unified Soil Classification System.

4. Soil samples were collected from auger cuttings at 1.0 m intervals in order to determine the soil/moisture profile and from other selected depths for other testing. Disturbed soil samples were also obtained from Standard Penetrations Tests (SPTs), which were performed at selected depth intervals.

5. At the completion of drilling, a 25 mm hand-slotted PVC standpipes was installed in Boreholes 1 to 6 and backfilled with auger cuttings. Excess auger cuttings were spread at the respective borehole locations. Groundwater levels and depths where seepage zones were encountered were noted during drilling. Groundwater measurements were recorded on January 14, 2016, about 42 days after drilling.

6. All soil samples were returned to ParklandGEO's Red Deer laboratories for possible further testing. The results of all laboratory testing are shown on the borehole logs in Appendix A and individual test results presented in Appendix B. The laboratory program consisted of moisture contents, Atterberg Limits, sieve and hydrometer particle size analysis and water soluble sulphates.

7. The location of the boreholes were surveyed by ParklandGEO using a Trimble GeoXH 2008 Series GPS receiver and a Trimble Zephyr GPS antenna. The estimated post data correction vertical accuracy of this equipment is ±10 cm. UTM coordinates and geodetic elevations are provided in the boreholes logs in Appendix A.

4.0 SUBSURFACE CONDITIONS

The general soil profile at the site consisted of, in descending order: topsoil, sand and gravel, clay and clay till. Bedrock was not encountered during this investigation. Detailed descriptions of the soil conditions encountered at the borehole locations are provided in the logs in Appendix A. Individual soil test results and definitions of the terminology and symbols used on the borehole logs are provided on the explanation sheets in Appendix A. The following is a brief description of the typical soil types encountered.

4.1 TOPSOIL

A layer of topsoil was encountered at the surface in all boreholes. The topsoil at this site ranged from 100 to 600 mm thick at the borehole locations. Thicker depths of topsoil may be encountered between borehole sites. This moderately organic, black and moist topsoil layer was considered to be weak and compressible under load.

4.2 SAND

A layer of sand was encountered below the topsoil in all boreholes and extended to depths up to 8 m below grade. The sand was fine grained and poorly graded with mixture of little to some silt. The Standard Penetration test "N" value ranged from of 8 to 13 blows over 300 mm of penetration indicating that the sand was compact. The moisture content of the sand was 3 to 11 percent with typical values of 5 percent which is considered to be below Optimum Moisture Content (OMC).

4.3 SAND AND GRAVEL

A layer of sand and gravel up to 0.9 m thick was encountered below the sand in Boreholes 2, 3, 5 and 6. The sand and gravel was well graded and dense relative density. The moisture content of the sand and gravel was 7 to 9 percent which is considered to be near to OMC.

4.4 CLAY

Clay was encountered in all boreholes, except Boreholes 4 and 5, at a depth between 1.6 and 8.5 m below grade. The clay extended to depths between 3.6 m and 10.5 m below grade. The clay contained some silt, little to some sand, traces of gravel and inclusion of coal. The clay was low to medium plastic and stiff; with a SPT "N" value between 8 and 9 blows over 300 mm penetration. The moisture content of the clay ranged from 18 to 26 percent.

4.5 SILT

A silt layer was noted below the clay at depth of 10.5 m in Borehole 6. The silt extended to a depth of 11.8 m below grade. The silt was stiff and contained some sand and little clay.

4.6 CLAY TILL

Clay till was encountered below the clay and silt layers in Boreholes 2, 3, 5 and 6. The clay till extended beyond the drilled depth of 13 m below grade in Borehole 6. The clay till contained some silt, some sand, traces of gravel and inclusions of rust and coal. The clay till was medium plastic and characterized as stiff to very stiff. The moisture content of the clay till ranged from 13 to 18 percent.

4.7 WATER SOLUBLE SULPHATES

Soil samples were taken at a depth of 2.0 m in selected boreholes for water soluble concentration testing. The concentration is expressed as percent of the dry mass of soil. The concentration of water soluble sulphate was below 0.1 percent which is considered to be negligible.

4.8 SUMMARY OF SOIL TESTING

The following table provides a summary of laboratory classification testing undertaken for this investigation.

TABLE 1
LABORATORY CLASSIFICATION TEST SUMMARY

BH#	Depth (m)	Grain Size Distribution (%)				Plasticity (%)			Soil Classification
		Gravel	Sand	Silt	Clay	PL	LL	PI	
1	4.5	0.0	1.8	58.0	40.2	19	40	21	Lean clay (Cl)
2	1.5	26.4	58.6	15.0		--	--	--	Poorly graded sand (SP)
2	3.0	0.0	2.8	52.6	44.6	18	41	23	Lean clay (Cl)
5	1.5	0.0	86.6	13.4		---	---	---	Poorly graded sand (SP)

5.0 GROUNDWATER LEVELS

Groundwater seepage was observed in Borehole 6 during drilling. The groundwater levels measured on January 14, 2016 are summarized in the following table.

TABLE 2
GROUNDWATER MEASUREMENTS

Borehole	Ground Elevation (m)	Upon Completion	December 22, 2015	
		Groundwater Level (mbg)	Groundwater Level (mbg)	Groundwater Elevation (m)
1	861.75	Dry	4.31	857.44
2	861.33	Dry	1.71	859.62
3	861.31	Dry	1.77	859.54
4	864.40	Dry	Dry	<859.40
5	859.86	Dry	4.75	855.11
6	868.06	Wet	8.46	859.60

A shallow groundwater condition is considered to be typical for this area. Groundwater levels are expected to be dependent on infiltration for recharge. Groundwater elevations are expected to fluctuate on a seasonal basis and will be highest after periods of heavy or prolonged precipitation and snow-melt. Groundwater seepage should be expected for shallow excavations and deeper excavations especially where excavations in the sand layer. The volumes of groundwater encountered will be dependent on seasonal conditions and the permeability of the soils within the profile.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 GEOTECHNICAL EVALUATION

The proposed development is a 14 lot residential subdivision. The development will include paved cul-de-sacs and associated systems for water supply and private sewage disposal. The subsurface conditions at this site are considered to be suitable for residential development. Bearing pressures for shallow residential foundations on native soil or properly engineered fill will be suitable for lightly loaded houses. The main geotechnical concerns regarding soil conditions and foundations at the site include:

1. It is expected that the development will be country residential style subdivision, so minimal pre-grading of the site will not be undertaken except as required for road construction. If any pre-grading is undertaken in topographical low areas and grades are raised more than 1.0 m, there may be potential for fill below proposed residential houses. If proposed, placement of fill below footing elevation will need to be carefully addressed and monitored to minimize the potential for foundation problems due to settlement. Good documentation and inspection of deep fills are highly recommended.

2. The surficial sand subgrade is considered to be low frost susceptible. However, the lower silty clay are considered to be highly frost susceptible if given access to free water or groundwater within the zone of seasonal frost (estimated to an average depth of 2.5 m). In general, the depth to the local water table for much of this site is relatively shallow and within the potential depth of frost influence.

3. Groundwater seepage is expected for shallow excavations at this site. Utility excavations in shallow groundwater areas may require relatively flat cut slopes.

4. The use of a permanent drainage system is recommended for all basements. In areas with less than 1.0 m of separation below the high groundwater level and proposed basement floor slab elevations, the use of lateral drainage pipes below the floor slab areas is recommended. Consideration should be given to raising floor slab elevations (underside of slabs) to at least 0.5 m above the seasonal high groundwater table.

5. The individual lot layouts have not been finalized, however the water wells and septic fields will need minimum separation distances. Private sewage disposal system locations will also need to be located in areas that do not impact houses and other structures. In general, most of the property was not suitable for conventional treatment field systems due to relatively permeable sandy soil conditions. A more feasible option would be the use of treatment mounds for this site.

6.2 RESIDENTIAL DEVELOPMENT

6.2.1 Site Preparation

It is anticipated that only minor cuts or fills (i.e. less than 1.0 m) are proposed for most building sites. It is recommended that all vegetation and topsoil be stripped from areas to be pre-graded or developed for roadway or building pad areas. Topsoil could be stockpiled for future use at the site. Ideally, fill used to bring the site up to grade should be: selected sand, well graded coarse gravel, or low to medium plastic inorganic clay. The surficial sand is considered to be a suitable fill material, however, moisture conditioning may be required prior to use in order to achieve specified densities.

The engineered fill placed during site grading should be compacted to at least 95 percent of SPMDD. Uniformity of compaction is most important. The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. Maximum lift thicknesses of 200 mm for granular fill and 150 mm for clay fill are recommended. Granular fill is best compacted with large smooth drum vibratory rollers while clay fill is best compacted with large vibratory "padfoot" or "sheepsfoot" rollers. In areas which require higher compaction, it is recommended that granular fill be placed at moisture contents 0 to 2 percent below the OMC and that clay fill be placed at moisture contents about 0 to 2 percent above the OMC. This will help reduce compactive effort and potential risk of subgrade disturbance needed to achieve maximum density.

Special consideration must be given to deep fill areas at the proposed building sites. The engineered fill placed below structures should be uniformly compacted to at least 98 percent of SPMDD at moisture content within 2 percent of OMC for fills up to 1.0 m deep. For deeper fill, the compaction standards should be increased to 100 percent of SPMDD. If these density levels cannot be achieved using common fill during site grading, the footing bearing surfaces should be subcut and underlain with select granular fills compacted to at least 99 percent. The depth of subcut should be determined at the time of construction and will depend on factors such as: age of fill, initial compaction, depth of fill, water table, footing configuration and loads. To reduce settlement potential and the compactive efforts to achieve maximum density, it is recommended that granular fill be placed at moisture contents 0 to 2 percent below the OMC. Full time density testing during placement and compaction and post construction settlement monitoring are strongly recommended for fill depths exceeding 1.5 in proposed building area footprints

6.2.2 Footings

Standard house basement foundations using strip and spread footings will generally be acceptable at this site. Footings based on native clay till, or engineered fill prepared as described in Section 6.2.1, may be designed based on a maximum allowable bearing pressure of 100 kPa for strip footings and 120 kPa for pad footing placed on undisturbed inorganic soil free from loosened material. The design and construction of residential foundations should conform to the Alberta Building Code. In general, excavations should be protected against surface water runoff and ingress of groundwater; footing bases should not be allowed to dry out excessively during construction; and the bearing soil should be protected against freezing during and after construction.

6.2.3 Grade Supported Slabs

Floor slabs should rest on at least 150 mm of well graded, free draining, granular base. Suitable materials would include coarse sand or crushed gravel with less than 10 percent passing the 0.080 mm sieve. The drainage layer below the slab should be compacted uniformly to at least 95 percent of SPMDD.

Small vertical subgrade movements may be experienced, therefore provisions should be made for movements between partitions and adjoining columns or load bearing walls. In addition, where partitions are placed under structural members a space should be left at the top of the partition to allow vertical movement (at least 25 mm). Columns in basements which support floor joists should be adjustable. Water lines should be installed carefully to minimize the potential for breakage and leaks below slabs. Heating ducts below grade should be insulated to prevent drying of the subgrade soils.

6.2.4 Basement Subdrainage System

A permanent subdrainage system (weeping tile drain) is recommended around the outside perimeter of basements. Lateral drains below the house are recommended in areas where the average groundwater table is within 1 m of the underside of slabs. The lateral drains should be spaced 5 m apart at most. If the seasonal high groundwater level is within 0.5 m of the underside of a slab, the basement foundation and a slab should be also provided with water stops to prevent potential seepage. The weeping drain should be surrounded with granular material to prevent the fine grained native soil from being washed into the drain. The granular filter may consist of free draining crushed rock or washed rock placed around the perforated drain pipe and wrapped with a coarse concrete sand or suitable geotextile.

Infiltration flows into most weeping tile drains are expected to be moderate because the native soil, is relatively low permeable. The largest flows will occur during periods of heavy precipitation and will be greatest for basements excavated into very sandy soils which are perched on lower permeable clays within the till deposits. Groundwater infiltration flows can be

significantly increased by poor site drainage around houses, improperly directed roof leaders and poorly graded or compacted backfill.

6.2.5 Basement Excavations

Basement excavations in the native soils are not expected to be able to stand near vertical even for relatively short periods of time. Excavation side slopes should be cut back to 1H:1V from the toe of the excavation. Flatter side-slopes may be required for excavations if the groundwater table is encountered. If space does not permit the slopes to be cut back, some form of temporary shoring must be installed to protect workers in the excavation.

All excavation work must comply with the requirements of the Alberta Occupational Health and Safety Act (OHS Act, 2002), OHS Regulation (2003) and OHS Code (2009). The OHS Code contains the technical requirements that support the Act and Regulation. All temporary surcharge loads should be kept back from the excavated faces a distance of at least one-half the depth of the excavation. All vehicles delivering materials to the site should be kept back from excavated faces a distance equal to half the excavated height or at least 1.5 m.

For proposed basements excavated during wet weather or with elevations close to the groundwater table elevation, construction traffic from tractor dozer equipment could cause the disturbance of the subgrade resulting in a significant weakening of the subgrade. In this case, excavation is best carried out with backhoe or "Gradall" equipment.

6.2.6 Backfill for House Structures

Backfill soils are capable of exerting significant horizontal pressures onto a basement wall. It is recommended the backfilling be delayed until the concrete has gained enough strength to support the horizontal loads. The top and bottom of the wall should be braced prior to backfilling. Therefore, it is recommended to place the basement floor slab and floor joists prior to backfilling around walls. Backfill should be brought up evenly around the building perimeter to minimize differential horizontal pressures on the basement walls.

Rather than heavily compacting the backfill around the basements, it is recommended to nominally compact the backfill (90 - 95 percent of SPMDD) recognizing that settlement of the backfill will occur, particularly after the first freeze/thaw and moisture infiltration cycle. Backfill around basement walls should be sloped to shed water away from the structure with a recommended slope of at least 5 percent. The slope of the backfill should be checked periodically to maintain the slope of the ground surface away from the wall. If possible, the upper 500 mm of backfill should be low to medium plastic clay, to reduce potential surface water infiltration against the foundation walls. Roof leaders from houses and garages may be discharged onto the ground surface well clear of the foundation walls to help reduce wet weather infiltration of water into the subdrainage weeping tile system.

6.2.7 Foundation Concrete

Water soluble sulphate concentrations of soil samples from the site ranged from 0.04 to 0.05 percent, which indicate a negligible potential for chemical attack of subsurface concrete. Therefore, General Use (GU) hydraulic cement is recommended for use in all subsurface concrete in contact with native soil at the site in accordance with CSA Standard CAN3-A23.1-14. The recommended minimum 28 day compressive strength is 25 MPa with a water cement ratio of 0.5. Air entrainment is recommended for all concrete exposed to freezing and thawing to further enhance durability. Calcium chloride or any admixture formulation containing chloride should not be used in the subsurface concrete. Calcium salts used as accelerating admixture should be avoided, since they may increase the severity of sulphate attack.

6.3 SERVICE TRENCH INSTALLATION

6.3.1 Service Trench Excavation

Excavations will be required for foundations and underground utility installations. All excavation work must comply with the requirements of the Alberta Occupational Health and Safety Act (OHS Act, 2002), OHS Regulation (2003) and OHS Code (2009). The OHS Code contains the technical requirements that support the Act and Regulation. Excavation side slopes are not expected to be able to stand near vertical for extended periods of time. For all excavations deeper than 1.5 m in the native clay, side slopes should be cut back to 1H:1V. If space does not permit the slopes to be cut back, some form of temporary shoring must be installed to protect workers in the trench.

The degree of stability of excavated trench walls directly decreases with time and therefore, construction should be directed at minimizing the length of time service trenches are left open. Due to the generally shallow water table, some groundwater seepage is expected during excavation. If groundwater is encountered, base heave and/or boiling of the trench bottom could occur where a significant differential hydrostatic head exists at the bottom of the excavation and soils are not cohesive (e.g. if sand layers are encountered within the clay till). Dewatering and other pressure relief measures are available to minimize problems with the stability of the trench bottom.

Surface grading should be undertaken so that surface water is not allowed to pond adjacent to service trenches. Surcharge loads, including excavation spoil, should be kept back from the crest of the excavation a minimum distance equal to the excavation depth. Monitoring and maintenance of the slopes should be carried out on a regular basis.

Installation of underground services and utilities require an observational approach to be adopted, which should combine past local experience, contractor's experience, and geotechnical input. It would be desirable for the selected excavation contractor to be experienced in similar conditions and/or, alternatively, to excavate test pits in advance of

construction to familiarize field personnel with subsurface conditions. Quality workmanship is essential.

6.3.2 Pipe Bedding

Ideally, granular pipe bedding should be relatively well graded sand or sand gravel mixture which can be readily compacted around the pipe to achieve a high frictional strength. Bedding soils must have an appropriate gradation so that migration of natural soils into the granular system is minimized. Uniform or gap-graded sands and gravels should not be used as bedding materials unless adequate provision is made to surround such soils with a filter fabric or graded granular filter compatible with the existing subsoils. Select native materials such as fine sand may be proposed for bedding. However, the use of these materials may require a higher level of compaction in order to satisfy the pipe manufacturer's requirements for adequate pipe support. Native materials consisting of high plastic clay or wet, silty clay that cannot be adequately compacted should not be used for pipe bedding. If granular bedding material is proposed, the following gradation specifications are recommended.

TABLE 3
GRADATION SPECIFICATIONS - GRANULAR BEDDING MATERIAL

Sieve Size (mm)	Percent Passing By Weight		
	Native Sand	**Clean Sand**	**Drain Rock**
50	-	-	100
40	-	-	95 - 100
20	-	-	5 -10
10	-	100	0 - 5
5	100	90 -100	0 - 5
2.5	-	80 - 95	-
1.25	66 - 100	55 - 85	-
0.63	52 - 100	30 - 65	-
0.315	35 - 78	10 - 35	-
0.160	18 - 43	2 - 10	-
0.080	2 - 12	0 - 8	-

Minor deflections of the trench bedding are expected. Underground utility pipes should be of a type which will maintain watertight joints (i.e. rubber gasket) after minor shifting has occurred. Bedding requirements are a function of the class of pipe and trench configuration, as well as site specific geotechnical considerations.

In the event of significant groundwater seepage or wet base conditions, additional pipe foundation measures may be required. Typically these measures include placement of a working mat of free draining gravel and filter cloth after lowering of the water table and removal of disturbed soils. This layer of gravel is intended to be a safe working base and the thickness required will be based on keeping groundwater below the working surface. The function of the geotextile in pipe bedding applications is to act as a separation barrier between the coarse

bedding materials and the native fine grained soils, therefore it needs to be strong enough to withstand construction activity.

6.3.3 Trench Backfill

It is assumed that trench backfill will consist of excavated sand or silty clay materials. The native sand is considered to be suitable for backfill, but may require removal adjustment of the natural moisture content to achieve proper compaction. Soil used for trench backfill should be free of frozen material, organics, and any other undesirable debris. To minimize fill settlement under self-weight, it is not recommended to allow the use of excavated soil for fill where the water content exceeds the OMC of the soil by more than 5 percent. If excavated soils are excessively wet, the material should be dried or blended with dry soil prior to use.

Trench backfill in building areas should conform with the recommendations given under the site preparation discussion. In other developed areas, trench backfill should be placed in maximum 150 mm thick lifts compacted to 95 percent of the SPMDD to within 1.5 m of the finished ground surface and to a minimum 98 percent of the SPMDD from 1.5 m below ground surface to grade. The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. It is recommended to use lifts with a maximum compacted thickness of 150 mm for clay soils.

Some settlement of the compacted backfill in trenches under self-weight is expected to occur. The magnitude and rate of settlement would be dependent on the backfill soil type, the moisture condition of the backfill at the time of placement, the depth of the service trench, drainage conditions and the initial density achieved during compaction. For the compaction recommendations given above it is expected that total settlement in the order of 0.5 to 1.0 percent of the trench depth will occur. For properly moisture conditioned sand backfill the majority of the settlement is expected to occur with 2 to 4 months of backfill. Silty soils will take slightly longer to consolidate. Density monitoring of backfill placement is recommended to encourage better attention to quality workmanship in placement. Fill materials with variable moisture contents recompacted as trench backfill will not provide uniform roadway subgrades for the support of pavement sections. To minimize the effects of potential settlements on completed roadway surfaces, it is recommended that staged asphalt pavement construction be adopted and that placement of final asphalt concrete surfacing materials be delayed as long as possible, subsequent to completion of trench backfilling.

6.4 ROADS

6.4.1 Road Subgrade Preparation

The native surficial soils were estimated to have CBR values in the order of 3 to 8 depending on the type of subgrade soil with a typical value of at least 4 for the most common silt or sand subgrade soil. These estimated CBR values are indicative of a low to moderate level of subgrade support.

The exposed subgrade surface should be proof-rolled to identify soft areas. Soft areas should be sub-cut and replaced with suitable fill compacted to 95 percent of SPMDD. The depth of excavation should be sufficient to remove the soft material or to bridge over the soft material. The excavation of sensitive soils should be performed by a tracked backhoe rather than dozer equipment to minimize disturbance to the subgrade. The recommended type of subgrade fill would be medium plastic clay or select granular fill such as relatively clean coarse graded gravel with a maximum aggregate size of 150 mm. If coarse gravel is selected, a proposed gradation specification is provided below in Table 4:

TABLE 4
150mm COARSE GRADED GRAVEL

Sieve Size (mm)	Percent Passing By Weight	
150	---	100
75	100	75 – 100
50	85 – 100	---
25	60 – 85	60 – 85
5.0	20 – 50	20 – 50
0.080	0 – 10	0 – 10

Fill material in the road bed should be placed to a density of at least 98 percent of SPMDD. Uniformity of compaction is most important. The uniformity of compaction can be checked periodically by proofrolling the fill, in conjunction with a regular in-situ density testing program. The lift thicknesses will be governed by the ability of the compaction equipment to achieve the recommended density. It would be suggested to use lifts with a maximum thickness of 200 mm, although initial lifts may have to be thicker to protect the subgrade.

6.4.2 Soft Subgrade Conditions

If soft subgrade conditions are encountered, the site preparation procedures should be reviewed based on the actual subgrade conditions and final road grades. Subgrade problems are most often encountered during periods of snowmelt or heavy precipitation when the groundwater table is shallowest and when surface water does not evaporate or infiltrate into the subgrade. In some cases, construction traffic on the fine grained subgrade may cause the shallow groundwater to "pump up" into the surface soils which substantially weakens the subgrade. Wetting of the exposed surface will substantially weaken the subgrade.

Other methods to avoid subgrade failure may include: limiting construction traffic, modification of site preparation procedures (scarification, recompaction, etc.) and sub-cut and replacement with a suitable engineered fill material. In the most severe cases backhoe excavation equipment should be used for the sub-cut and gravel should be placed over the area in a single lift by end dumping and spreading with wide pad crawler equipment to protect the subgrade from further disturbance. The gravel should be placed on top of a filter fabric to keep the subgrade fines from migrating up into the gravel. The initial lift of gravel should be nominally compacted in a manner to minimize disturbance to the soft subgrade. In pavement areas this extra "subgrade improvement" gravel can be incorporated into the pavement sub-base. For subgrade improvement fill, it is recommended to use a select coarse gravel with a maximum aggregate size of 150 mm. A suggested gradation specification is given in Table 4 in Subsection 6.4.1.

6.4.3 Minimum Fill Thickness over Unsuitable Materials

Although not encountered during this investigation, buried organic layers have been encountered constructing in similar rural areas in the past. Unsuitable materials are considered to be organic soils (organic contents over 10 percent); debris; and weak, wet inorganic soils.

It is recommended that the minimum requirement for these roads is to remove all organics, if encountered, within 1.5 m of final grade. Any areas of existing roadway which show signs of subgrade distress during construction should be investigated to determine the presence and influence of shallow buried organic or unsuitable soils.

Where road bed fills are less than 0.5 m thick, the exposed surface should be inspected during initial site stripping to identify soft and/or weak. Any soft areas encountered during site stripping or initial construction activity should be sub-excavated and recompacted or replaced with a selected fill material as recommended above. The depth of excavation should be sufficient to remove the soft material or to bridge over the material to give proper support to construction and post-construction traffic.

6.4.4 Sideslopes and Cutslopes

If shallow embankments or roadside ditches are proposed, embankment sideslopes no steeper than 3H:1V should be used for preliminary design purposes. If granular embankment fills are used, it may be possible to slightly steepen the embankments provided the slopes are well vegetated to protect against erosion. The comments above are based on local experience. These preliminary recommendations should be reviewed before finalizing designs. The appropriate time for this review is after the grade line, right-of-way restrictions and possible fill materials have been determined.

6.4.5 Flexible Pavement Design

One flexible pavement design is proposed for a light traffic section for the local residential streets using a Design Traffic of 9 x 104 ESAL's. The design traffic numbers are based on period of 20 years. The proposed pavement design sections for this subdivision are based on the assumption of a stable clay or sand subgrade which meets the criteria of CBR = 4 or a subgrade which has been improved to an equivalent level. The majority of surficial soils across this site are expected to meet this minimum subgrade support condition. Based on these assumptions the following flexible pavement sections are proposed:

TABLE 5
FLEXIBLE PAVEMENT DESIGN

Pavement Sections	Local Residential	
Design traffic (ESAL's)	9×10^4	
Asphalt Concrete 20 mm Crushed Base Gravel Sub-base Gravel (minimum)	75 mm 100 mm 250 mm	100 mm 150mm -

The native surficial soils were estimated to have CBR values in the order of 5 to 10 in a soaked condition which is representative of spring thaw when the subgrade will exist in a weakened condition. This range of CBR values is indicative of a moderate level of subgrade support.

The majority of surficial soils across the site are expected to meet this minimum subgrade support condition, but there is potential for some localized soft areas. In localized areas of weaker subgrade it is expected the subgrade will be improved to an equivalent level of support as discussed in Sub-Section 6.4.1.

6.4.6 Pavement Materials

The performance of the proposed pavement sections will be, in part, dependent on achieving an adequate level of compaction in subgrade and pavement materials. The recommended levels of compaction for the granular pavement section should be a minimum of 98 percent of SPMDD. The asphalt concrete should be compacted to a minimum of 97 percent of Marshall Density based on a 50 blow laboratory Marshall Test. It is recommended to use pavement materials conforming to the following specifications.

TABLE 6
ASPHALT CONCRETE

Parameter	Specification
Stability (kN minimum)	8.5
Flow (mm)	2 – 4
Air Voids (percent)	3 – 5
VMA (minimum percent)	14.5
Asphalt Cement (penetration grade)	150-200 (A)

Aggregate materials for base and sub-base gravel should be composed of sound, hard, durable particles free from organics and other foreign material. It is recommended to use aggregates conforming to the following Alberta Transportation specifications.

TABLE 7
GRANULAR PAVEMENT DESIGN FOR ACCESS ROADS

	Alberta Transportation
Asphalt Concrete Pavement	Designation 1, Class 16
Crushed Base Gravel	Designation 2, Class 20 or 25
Subbase Gravel	Designation 2, Class 40

A copy of the Alberta Transportation aggregate specification are provide in Appendix A. Based on availability of local materials at the time of tendering or construction, alternate materials could be considered upon review by the geotechnical engineer.

6.4.7 Surface Drainage

Site grading during and after construction is an important consideration. The pavement and road bed area should be sloped and graded to effectively and rapidly remove all surface water during and after construction. To minimize the occurrence of surface water ponding on the roadway, surface grades of at least 2 percent are recommended. Water should not be allowed to pond on the exposed subgrade or sub-base. Allowing water to pond on the sub-base, base, or pavement surface will lead to infiltration of water into the subgrade which could result in weakening of the subgrade soils and may lead to distress/failure of the overlying pavement. The pavement grades should be set as high as possible to minimize sub-cutting and provide greater separation between the surface and the groundwater table.

As a general guideline, the road side ditches should be designed to maintain groundwater levels at least 1.0 m below the top of subgrade along the road alignment. In areas of very shallow groundwater table and low road elevation, the use of subdrains may be required if road side ditches cannot maintain groundwater out of the road embankment.

6.4.8 Geosynthetic Filter Fabric

As a general rule, if the subgrade is too soft to undertake a conventional subgrade preparation, the use of a geosynthetic filter fabric should be considered. The filter fabric is placed below the coarse granular materials so as to provide a separation barrier to keep subgrade fines from rising up into the gravel. The fabric will also help to protect the subgrade from disturbance (gravel pushing into the subgrade). If a fabric is not placed, more gravel will be needed to achieve the same performance. The filter fabric must be strong enough to withstand construction activities. If a geotextile is required to act as a separation barrier between the subgrade and subgrade improvement gravel, it is recommended to place the geotextile in accordance with the manufacturer's recommendations, and to use a woven filter fabric with the following characteristics:

TABLE 8
MINIMUM FILTER CLOTH SPECIFICATION

Test Parameter	Specification	Test Method
Minimum Grab Tensile Strength	1100 N	ASTM D4632
Maximum Elongation at Break	25 percent	ASTM D4632
Minimum Puncture Strength	400 N	ASTM D4833
Minimum Sewn Seam Strength	990 N	ASTM D3786
Minimum Tear Strength	400 N	ASTM D4533
Maximum Apparent Opening Size	0.6 mm	ASTM D4751

Woven fabrics typically have more favourable stress/strain characteristics (30 percent elongation at failure) than non-woven filter fabrics (100 percent elongation at failure). Therefore, the woven fabric will mobilize more strength as the subgrade deflects under construction traffic loads. Non-woven fabrics would be suitable for use as a separation barrier in subdrainage trenches. If sand fill is used on top of the native subgrade, a filter fabric is not required because there is limited potential for upward migration of fines and no need for a separation barrier. Proposed geotextiles should be reviewed based on the proposed end use.

6.5 PRIVATE SEWAGE DISPOSAL

Given that the final layout and location of each proposed treatment area are not yet determined, a detailed lot specific sewage treatment assessment will need to be carried out once the locations of the proposed PSDS are determined. The following comments are intended to provide an overview of suitability for the general area, and soil design parameters for preliminary sizing only. A detailed assessment for each individual PSDS is not within the scope of this assessment.

6.5.1 Site Description

As discussed in Section 2.0, the property area was elevated in the center and sloped to the east and west. The proposed development will have slopes of less than 10 percent in the general area proposed for PSTS at the site. Rock outcrops were not observed within the vicinity of the site. No other natural features were identified that could impact the application and/or design of a treatment system. Clearing of trees and vegetation may be required for the installation of on-site wastewater treatment systems.

6.5.2 Soil Classification

To make effective use of the Standard, the description of the soil must use terms that are set out in the Canadian System of Soil Classification as effluent loading rates and available vertical separations is determined by these characteristics. The soils encountered were categorized by the Safety Codes Council (SCC) soil texture classification system, in accordance with the standard. The SCC soil texture classification system is summarized on the Soil Triangle, Figure 4 in Appendix A. The following table summarizes the classification of the site soils based on the laboratory testing.

TABLE 9
SOIL CLASSIFCATION FOR PSDS

Sample ID	Depth (m)	Sand Content (% by wt.)	Clay Content (% by wt.)	SSC Soil Texture Classification	Structure Shape*	Structure Grade*
2G1	1.5	58.6	<15.0	Sandy Loam (FSL)	Blocky (BK)	Weak (1) to Moderate (2)
5D1	1.5	86.4	<13.4	Fine Sand (FS)	Blocky (BK)	Weak (1) to Moderate (2)
2D1	3.0	2.8	44.6	Silty Clay (SIC)	Massive (M)	Moderate (2) to Strong (3)

*The structure of the soil is assumed and should be verified prior to construction of the PSDS.

Additional testing will be required once the proposed PSDS sites are located on the proposed lots.

6.5.3 Soil Suitability

As discussed in the Section 3.0, six boreholes were drilled at the site to a depths from 4.5 to 13 m below grade. The upper 3 m of the subsoil profile consisted of Fine Sandy Loam / Fine Sand with an assumed blocky, weak to moderate structure and/or Silty Clay (SIC) with an assumed massive, moderate to strong structure. These silty clay soil deposits having massive structure are not generally considered suitable for treatment fields. A treatment mound will likely be required for economic reasons if the proposed PSDS is constructed in the area. Fine Sandy Loam / Fine Sand soils are generally considered suitable for treatment fields. The typical sand subgrade at this site is not suitable for this application. Material for mounds would need to be imported to site.

6.5.4 Private Sewage Disposal System Requirements

The mean daily wastewater volume for single family residence is 228 L per person. The peak expected daily wastewater volume for a dwelling with 2 bedrooms or less is 340 L per person (assuming 2 people per bedroom). For dwellings with 3 bedrooms or more, the peak expected daily wastewater volume is 340 L per person (assuming 1.5 people per bedroom). When the combined total of fixture units exceeds 20, add 50 L for each fixture (Table 2.2.2.2.A of the Standard of Practice).

The working capacity for primary treatment (septic tanks) is required to include an additional capacity of 400 L per expected occupant to accommodate sludge and scum accumulation. Septic tank access openings should not be buried and should be located at a height above the surrounding landscape that ensures surface water will drain away from the access opening. Access openings should be equipped with a secure, air-tight lid or cover. A secondary treatment component shall include sampling ports or a suitable location to obtain wastewater and effluent samples to confirm treatment performance and assess operation of the component.

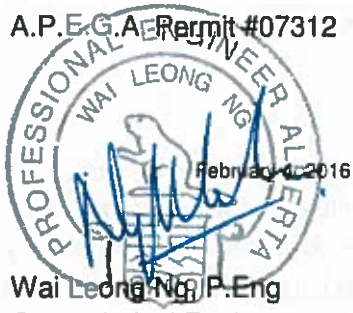
6.6 INSPECTION

It is recommended that on-site inspection and testing be performed to verify that actual site conditions are consistent with assumed conditions which meet or exceed design criteria. Based on the Alberta Building Code, adequate levels of inspection include: testing of engineered fill, review of all completed bearing surfaces for footings and full time inspection during construction of deep foundations.

7.0 CLOSURE

This report is based on the findings at the 6 boreholes at the site. If new information or different subsoil/groundwater conditions are encountered, this office must be notified and recommendations submitted herein will be reviewed and revised as required. This report has been prepared for the exclusive use of **1842107 Alberta Ltd.** and their approved agents for the specified application to the proposed residential subdivision within portion of SW 24-39-27-W4M in Lacombe County, Alberta. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made. The limitations of this report are specified in the General Terms and Conditions section and should be considered part of this report.

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



Wai Leong Ng, P.Eng
Geotechnical Engineer

Reviewed By:
Mark Brotherton, P. Eng.

Any soil-based treatment requires a minimum vertical separation of 0.9 m between the groundwater table and any limiting soils conditions and the point at which the effluent infiltrates into the soil. The Standard of Practices sets an effluent loading rate of 19.6 L/day/m^2 when using soil-based treatment in fine sand and 8.8 L/day/m^2 in fine sand loam, with a specified effluent quality of 30 – 150 mg/L. Silty Clay soils of massive and strong structure is considered a limiting layer and therefore is set an effluent rate of 0.0 L/day/m^2. For a more detailed outline of all the effluent loading rates and separation distances required by each of the treatment systems mentioned in this report, please refer to the Alberta Private Sewage System Standards of Practice.

Additional requirements for private sewage disposal systems:

1. Septic tanks need to have adequate earth cover or other means to protect it from freezing while in operation and during periods of non-use. A septic tank that has less than 1.2 m of earth cover to protect it from freezing conditions need to be insulated to provide the equivalent of an R-8 insulation value over the top and sides of the tank to a minimum depth of 1.2 m below grade or insulated in some other acceptable manner to achieve a level of protection from freezing that equivalent to tank that has a minimum 1.2 m cover of the in situ soil.

2. The PSDS shall be designed to meet the separation requirements and to not exceed the effluent loading rate. The treatment system should be constructed in accordance with applicable regulations and should be properly sized and installed by a licensed contractor based on normal testing and verification of actual field conditions.

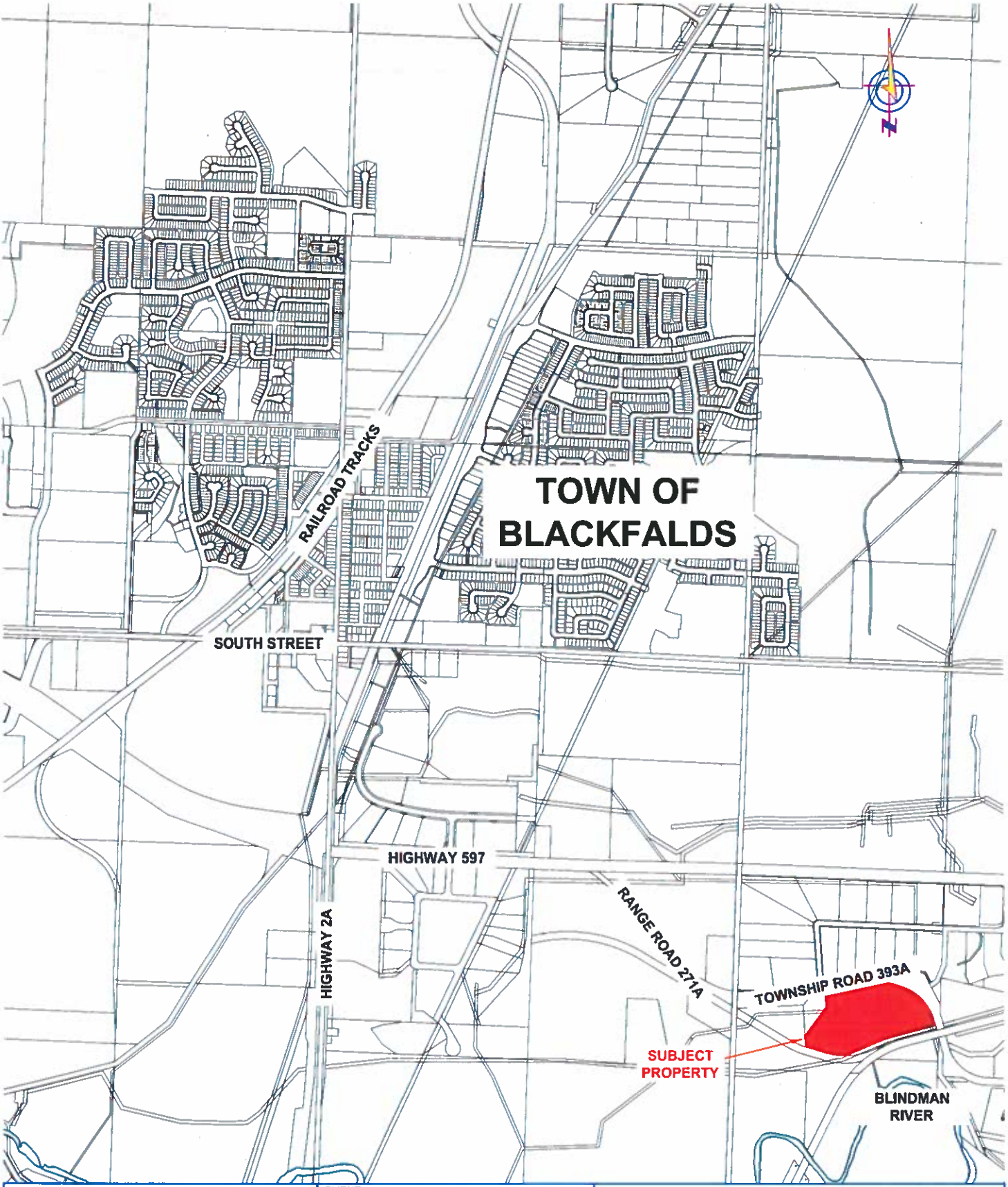
6.5.5 Treatment Mound

For the proposed PSDS areas of the lot investigated, a septic tank and conventional treatment field system were not suitable for private sewage disposal due to limiting conditions imposed by the soil conditions. A more feasible option would be a treatment mound receiving secondary treated effluent. Mounds will need to be constructed with imported materials that meet the required infiltration rate requirements. In addition, treatment mounds are required to meet the following setback requirements:

- 15 from a water source;
- 15 m from a water course;
- 3 m from a property line;
- 3 m from septic tank;
- 10 m from a building without a basement, cellar or crawl space; and
- 10 m from a basement, cellar or crawl space.

Additional details and recommendations can be provided when the detail PSDS assessment is undertaken.

FIGURES



ParklandGEO

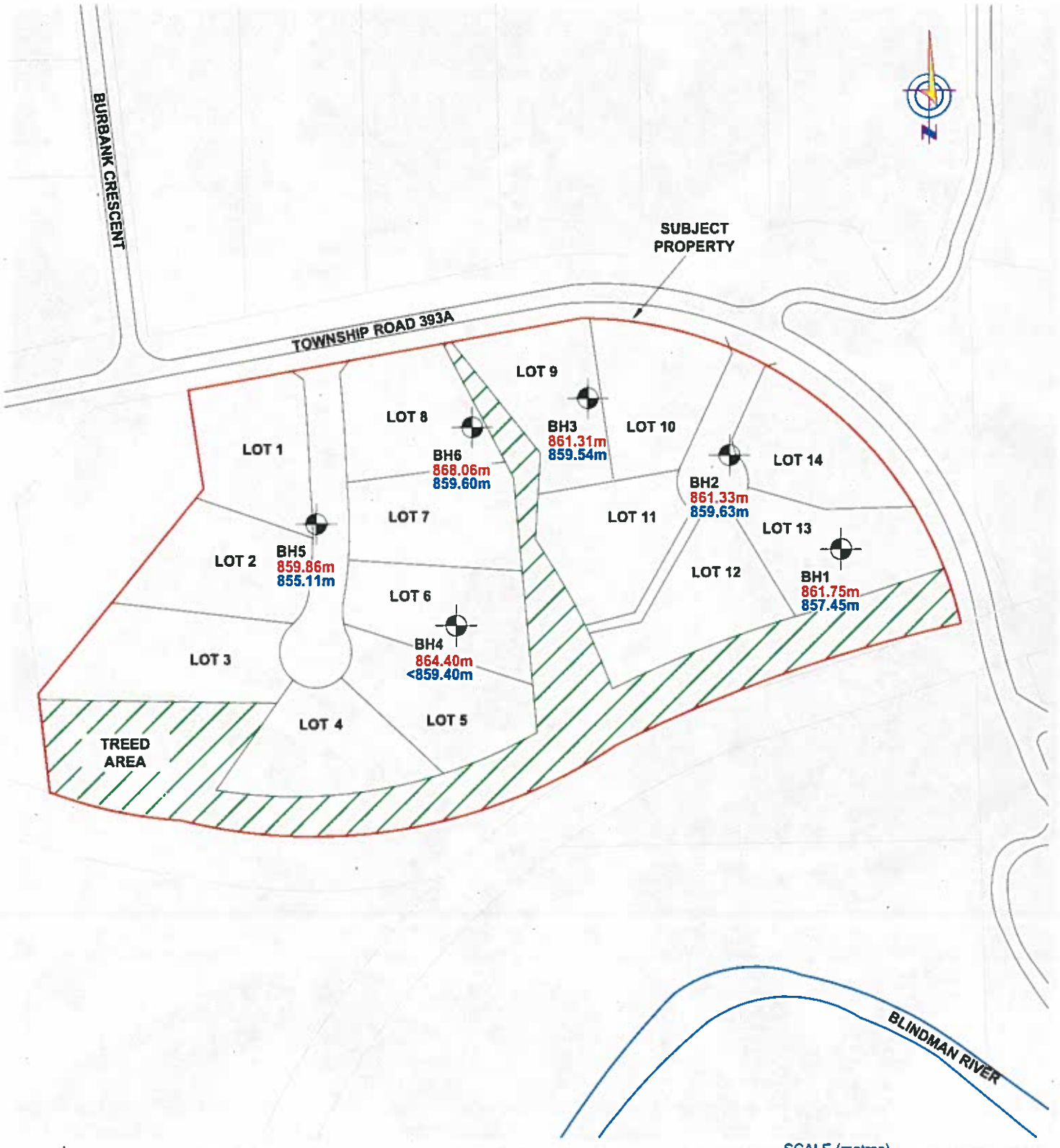
CLIENT:

1842107
ALBERTA LTD.

KEY PLAN

BURBANK SUBDIVISION
SW 24-39-27 W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
NC	NN	1	JANUARY 2016
SCALE:	JOB NO.		DRAWING NO.
1:20,000	RD5566		FIGURE 1



ALL BOREHOLE LOCATIONS ARE APPROXIMATE.

861.75m SURFACE ELEVATION

857.45m GROUNDWATER ELEVATION (JANUARY 14, 2016)

SCALE (metres)

-60 -30 0 30 60 120

ParklandGEO

CLIENT:

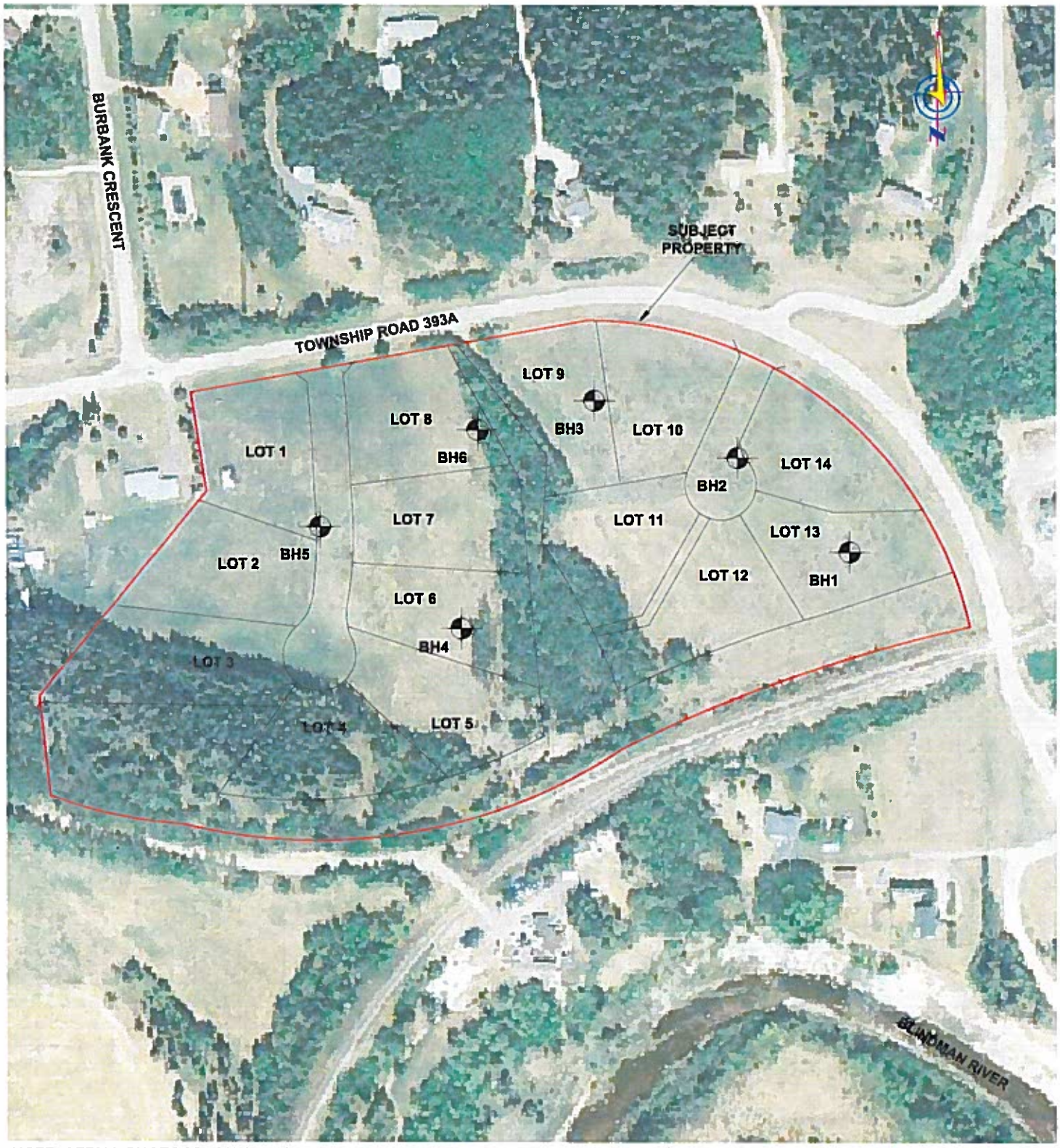
1842107
ALBERTA LTD.

SITE PLAN

BURBANK SUBDIVISION
SW 24-39-27 W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
NC	NN	1	JANUARY 2016

SCALE:	JOB NO.	DRAWING NO.
1:3000	RD5566	FIGURE 2



NOTE: AERIAL PHOTOGRAPH OBTAINED FROM ABACUS DATAGRAPHICS LTD., DATED MAY 9, 2013 TO JULY 3, 2013.

ALL BOREHOLE LOCATIONS ARE APPROXIMATE.

SCALE (metres)

-60 -30 0 30 60 120

Parkland GEO

CLIENT:

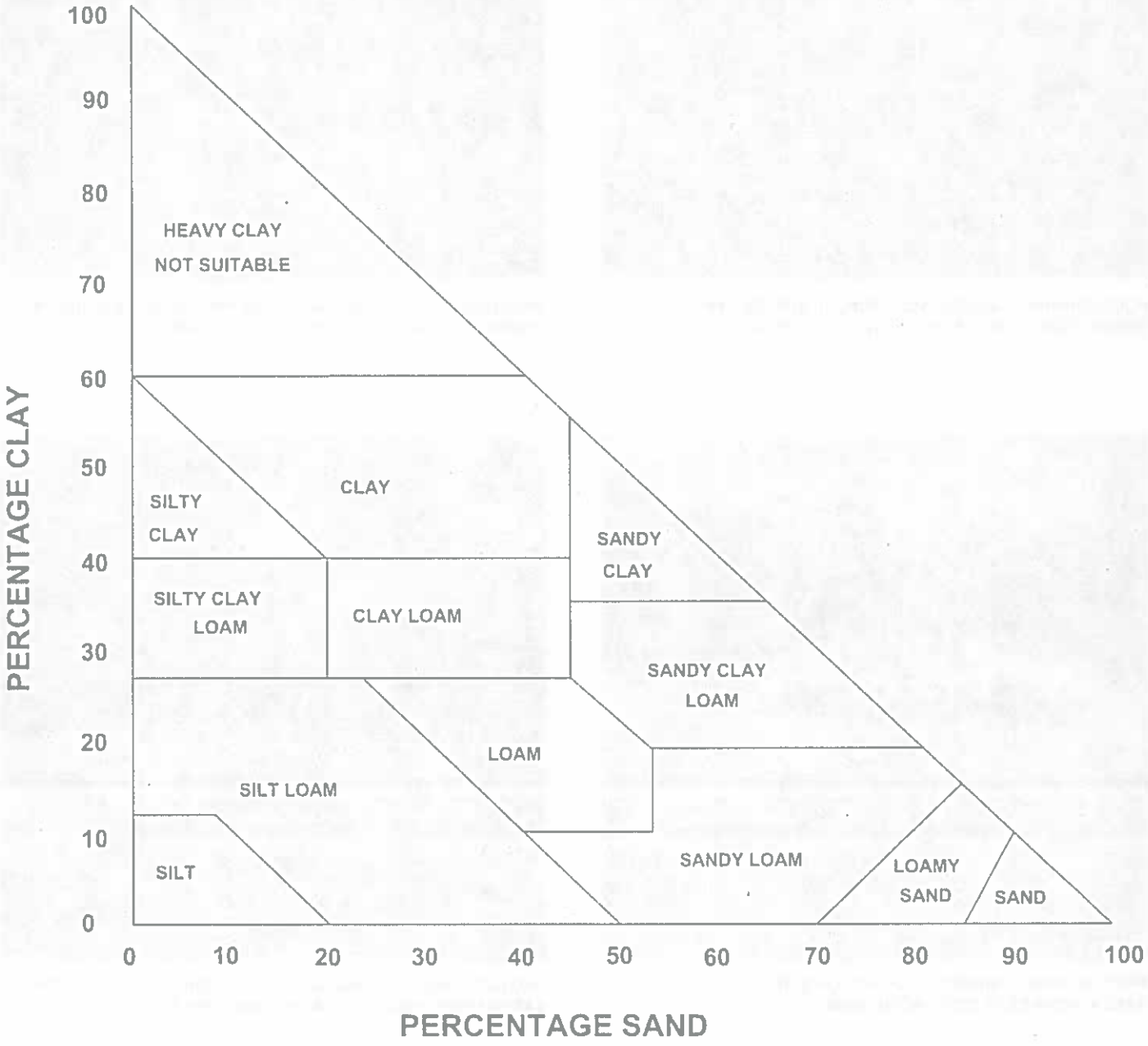
1842107 ALBERTA LTD.

AERIAL PLAN

BURBANK SUBDIVISION
SW 24-39-27 W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
NC	NN	1	JANUARY 2016

SCALE:	JOB NO.	DRAWING NO.
1:3000	RD5566	FIGURE 3



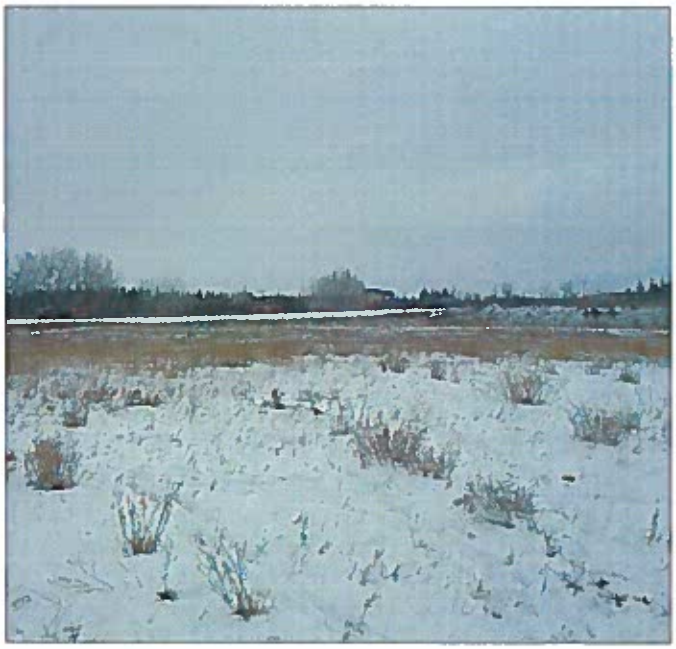
ParklandGEO	CLIENT: 1842107 ALBERTA LTD.	**SOIL TEXTURE CLASSIFICATION** BURBANK SUBDIVISION SW 24-39-27 W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D.:	REV #:	DATE:
NC	NN	1	JANUARY 2016
SCALE: NTS	JOB NO. RD5566		DRAWING NO. FIGURE 4

PHOTOGRAPH 1: SHOWS WEST SIDE OF SUBJECT PROPERTY, TAKEN FROM SOUTH SIDE, FACING NORTHWEST

PHOTOGRAPH 2: SHOWS WEST SIDE OF SUBJECT PROPERTY, TAKEN FROM WEST SIDE FACING NORTHEAST

PHOTOGRAPH 3: SHOWS EAST SIDE OF SUBJECT PROPERTY, TAKEN FROM EAST SIDE FACING WEST



PHOTOGRAPH 4: SHOWS EAST SIDE OF SUBJECT PROPERTY, TAKEN FROM EAST SIDE FACING SOUTHEAST

Parkland GEO	CLIENT: 1842107 ALBERTA LTD.	**SITE PHOTOGRAPHS** BURBANK SUBDIVISION SW 24-39-27 W4M, LACOMBE COUNTY, ALBERTA

DRAWN:	CHK'D:	REV #:	DATE:
NC	NN	1	JANUARY 2016
SCALE: NTS	JOB NO. RD5566		DRAWING NO. FIGURE 5

APPENDIX A

Borehole Logs (6)
Soil Test Results
AT Specifications
Explanation Sheets

Parkland GEO

CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

BOREHOLE NO.: 01

PROJECT NO.: RD5566
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								861.75
0	***Topsoil*** Black, organic, moist.								
1	***Sand*** little to some silt, loose to compact, poorly graded, brown, damp.		3						
2	-trace organics from 1.9 to 2.0 m.		7		1D1	11	SO_4 = 0.04%		
3			4	G	1G1				858.45
4	***Clay*** Some silt, trace to little sand, trace gravel, firm, rust, coal inclusions, low to medium plastic, brown, moist.		26 26						
5					1D2	8	**Grain Size Analysis:** Sand - 1.8% Silt - 58.0% Clay - 40.2%		856.75
5	End of hole at 5.0 m. 25 mm standpipe installed. Backfilled with auger cuttings. Dry upon completion. Water at 4.3 m on January 14, 2016.							SLOTTED PVC PIPE BACKFILLED WITH AUGER CUTTINGS	

LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

GROUND ELEVATION: 861.75 m
NORTHING: 5804998.44
EASTING: 312050.25

Parkland GEO

BOREHOLE NO.: 02

CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

PROJECT NO.: RD5566
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								861.33
	Topsoil Black, organic, moist.		7						860.83
1	***Sand*** Some gravel, little silt, loose to compact, fine grained, brown, damp.								860.53
	Sand and Gravel Little silt, little clay, dense, well graded, brown moist.		23		2G1		**Grain Size Analysis:** Gravel - 26.4% Sand - 58.6% Silt & Clay - 15.0% SO_4 = 0.04%		859.63
2									
	Clay Some silt, trace to little sand, trace gravel, firm, rust, coal inclusions, low to medium plastic, brown, moist.		22		2S1				
3					2D1	9	**Grain Size Analysis:** Sand - 2.8% Silt - 52.6% Clay - 44.6%		857.63
	Till Clay, some silt, some sand, trace gravel, stiff, low plastic, grey, occasional coal, damp.		15						
4					2G2				856.83
5	End of hole at 4.5 m. 25 mm standpipe installed. Backfilled with auger cuttings. Dry upon completion. Water at 1.7 m on January 14, 2016.							SLOTTED PVC PIPE BACKFILLED WITH AUGER CUTTINGS	
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

GROUND ELEVATION: 861.33 m
NORTHING: 5805052.06
EASTING: 311986.34

Parkland GEO

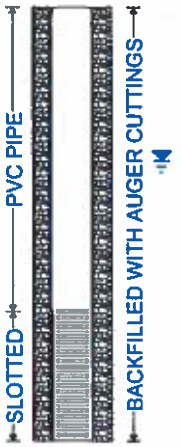
CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

BOREHOLE NO.: 03

PROJECT NO.: RD5566
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								861.31
	Topsoil Black, organic, moist.								860.71
1	***Sand*** Some silt, loose, fine grained, brown, damp.		10						860.31
2	***Sand and Gravel*** Little silt, little clay, dense, well graded, brown, moist.		23		3D1	6	SO_4 = 0.04%		859.66
3	***Clay*** Some silt, trace sand, firm, low to medium plastic, brown, moist.		26						857.71
4	***Till*** Clay, some silt, some sand, trace gravel, stiff to very stiff, low plastic, coal inclusions, damp.		15		3D2	15			856.31
5	End of hole at 5.0 m. 25 mm standpipe installed. Backfilled with auger cuttings. Dry upon completion. Water at 1.77 m on January 14, 2016.								
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									



LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

GROUND ELEVATION: 861.31 m
NORTHING: 5805074.52
EASTING: 311904.95

Parkland GEO

CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

BOREHOLE NO.: 04

PROJECT NO.: RD5566
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								864.40
	Topsoil Black, organic, moist.		4	G	4G1			PVC PIPE	
1	***Sand*** Little silt, loose, well graded, brown, moist.								
2			4		4D1	8	SO_4 = 0.04%		
3			4						
4			5					SLOTTED	
5	End of hole at 5.0 m. 25 mm standpipe installed. Backfilled with auger cuttings. Dry upon completion. Dry on January 14, 2016.				4D2	3		BACKFILLED WITH AUGER CUTTINGS	859.40
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

GROUND ELEVATION: 864.40 m
NORTHING: 5804954.73
EASTING: 311829.35

Parkland GEO

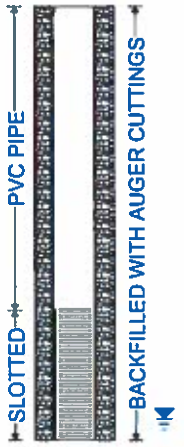
CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

BOREHOLE NO.: 05

PROJECT NO.: RD5566
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								859.86
0	***Topsoil*** Black, organic, moist.								
1	***Sand*** Little silt, loose, fine grained, brown.		4						
2			6		5D1	8	**Grain Size Analysis:** Sand - 86.4% Silt & Clay - 13.4% SO_4 = 0.05%		
3			11		5D2	8			
4	***Sand and Gravel*** Little silt, little clay, dense, well graded, brown, moist.		9						856.26
5	***Till*** Clay, some silt, some sand, trace gravel, stiff, low plastic, brown, coal inclusions, damp.		12						855.46
5									854.86
6	End of hole at 5.0 m. 25 mm standpipe installed. Backfilled with auger cuttings. Dry upon completion. Water at 4.75 m on January 14, 2016.								
7									
8									
9									
10									
11									
12									
13									
14									
15									



LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

GROUND ELEVATION: 859.86 m
NORTHING: 5805012.37
EASTING: 311748.97

Parkland GEO

CLIENT: 1842107 Alberta Ltd.
SITE: Burbank Subdivision
NOTES:

BOREHOLE NO.: 06

PROJECT NO.: RD5566
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								868.06
0	***Topsoil*** Black, organic, moist.								
1	***Sand*** Little silt, loose, brown,moist, well graded.		4						
2			5						
3			5		6D1	10			
4			4						
5			4						
6			3	G	6G1				
7			5						
8			7		6D2	13			860.06
8	***Sand and Gravel*** Little silt, little clay, compact to dense, well graded, brown, moist.								859.56
9			18						
9	***Clay*** Some silt, some sand, stiff, low plastic, grey, moist.								
10			20						
10	- sand lense from 10.4 to 10.5 m.								857.56
11	***Silt*** Some sand, little clay, stiff, non to low plastic, grey, wet.		22		6D3	13			
12			18						856.26
12	***Till*** Clay, some silt, some sand, trace gravel, stiff to very stiff, low plastic, brown, coal inclusions, damp.								
13			13						855.06
13	End of hole at 13.0 m. 25 mm standpipe installed. Backfilled with auger cuttings. Wet upon completion. Water at 8.46 m in January 14, 2016.								
14									
15									

SOLID PVC PIPE
BACKFILLED WITH AUGER CUTTINGS
SLOTTED PVC PIPE

LOGGED BY: BL
CONTRACTOR: Darkhorse Drilling Ltd.
RIG/METHOD: Solid Stem/Geoprobe
DATE: December 3, 2015
CALIBRATION:

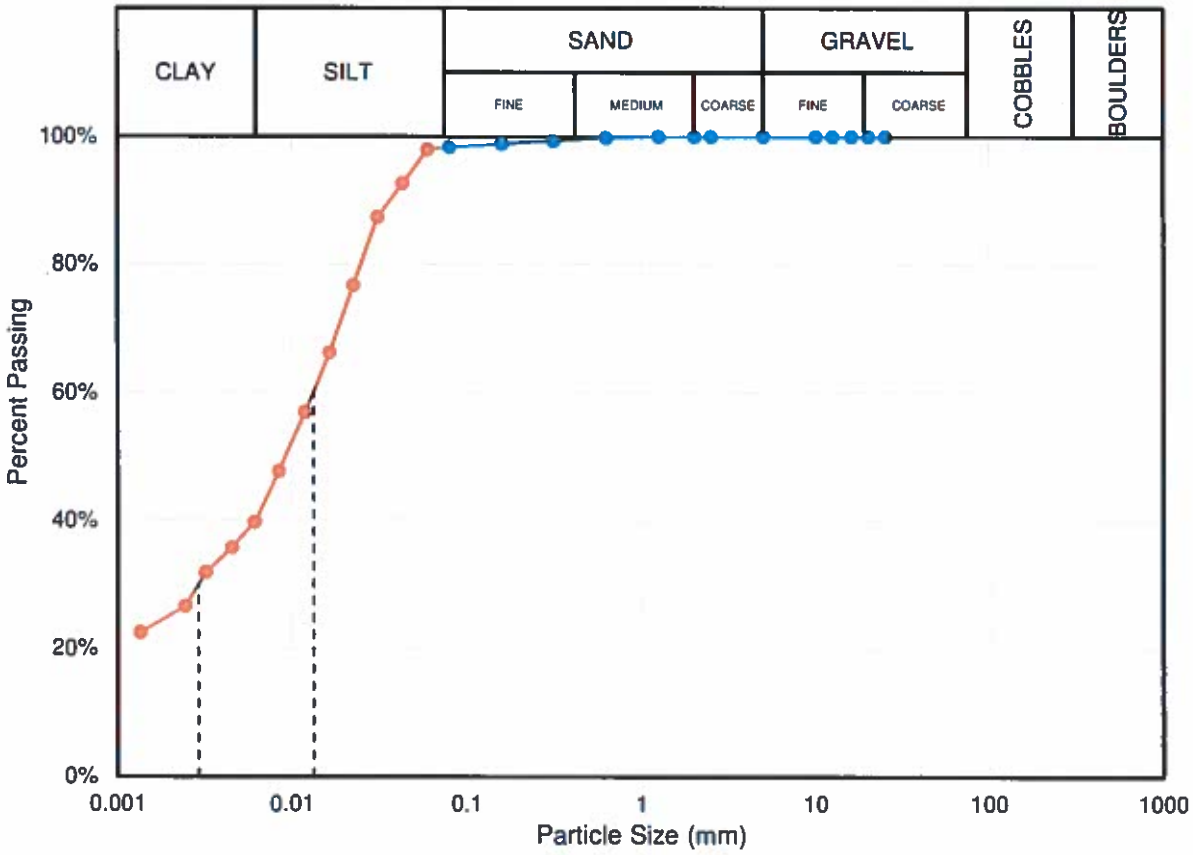
GROUND ELEVATION: 868.06
NORTHING: 5805067.85
EASTING: 3611838.59

PARTICLE-SIZE ANALYSIS, LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY

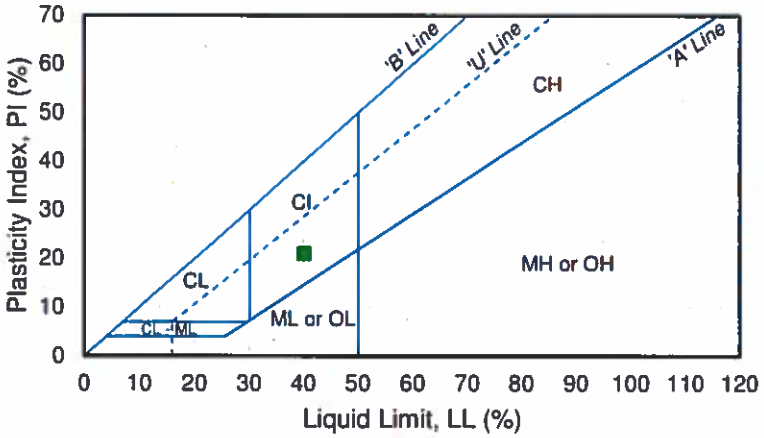
ASTM D422 & ASTM D4318

PROJECT: Burbank Subdivision
PROJECT#: RD5566
CLIENT: 1842107 Alberta Ltd.
SOIL DESCRIPTION: silt, and clay, trace sand

SAMPLE DATE: December 3, 2015
TEST DATE: January 6, 2016
SAMPLE ID: 1D2
DEPTH: 4.5m



PARTICLE-SIZE ANALYSIS	Gravel	0.0%
	Sand	1.8%
	Silt	58.0%
	Clay	40.2%
	D_{10}	---
	D_{30}	0.0029 mm
	D_{60}	0.0132 mm
	C_U	---
	C_C	---
LIMITS	PL	19
	LL	40
	PI	21



Modified Unified Soil Classification	Group Symbol
Lean clay	CI

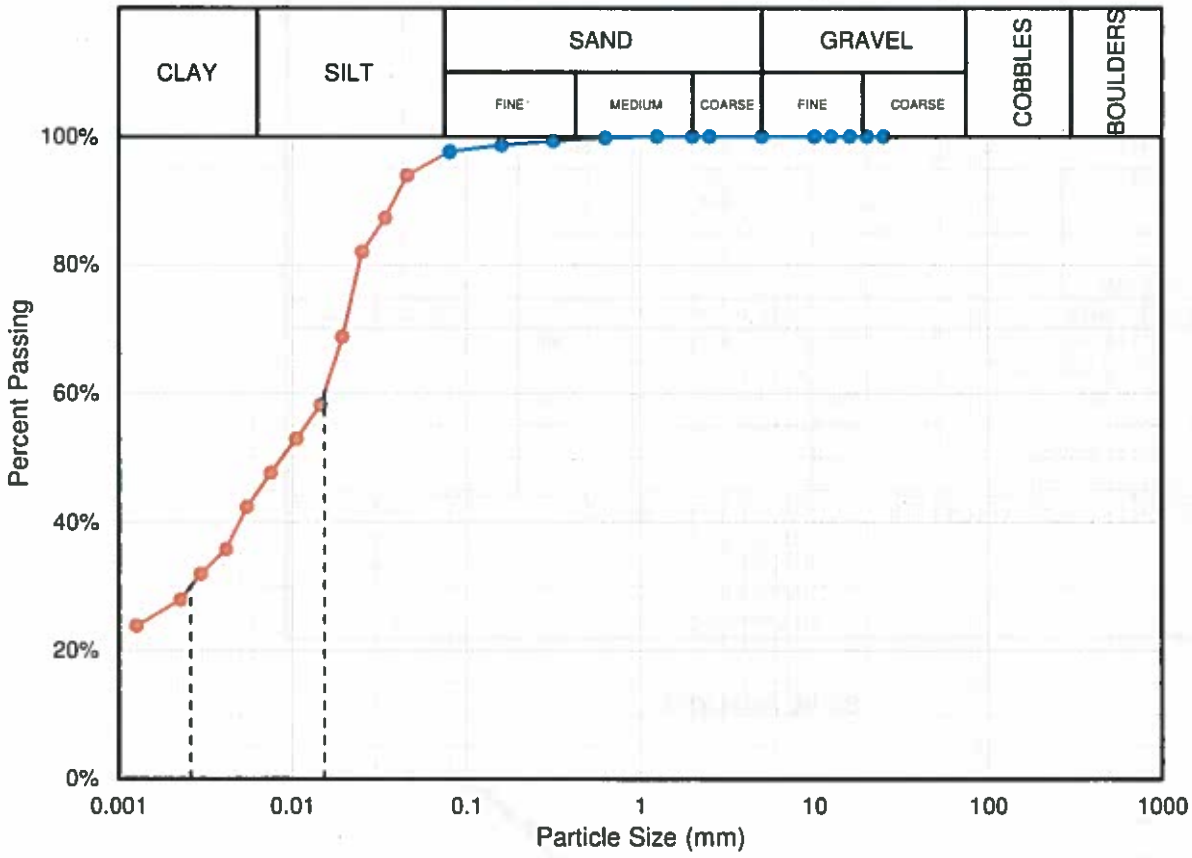
TECH: AB
CHECKED: NN
1 of 1

PARTICLE-SIZE ANALYSIS, LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY

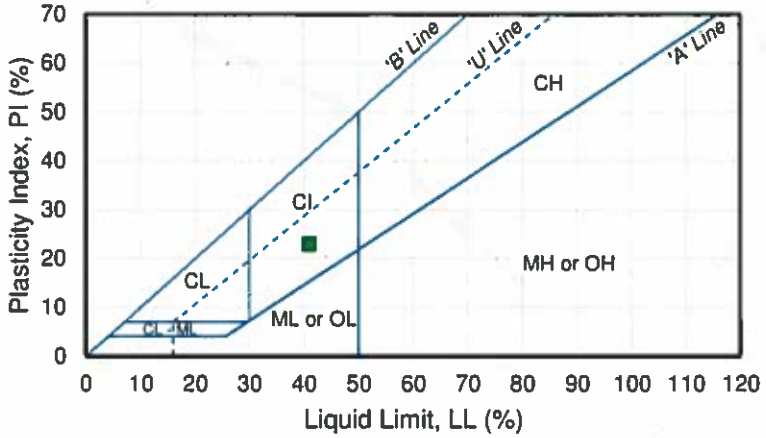
ASTM D422 & ASTM D4318

PROJECT: Burbank Subdivision
PROJECT#: RD5566
CLIENT: 1842107 Alberta Ltd.
SOIL DESCRIPTION: silt, and clay, trace sand

SAMPLE DATE: December 3, 2015
TEST DATE: January 6, 2016
SAMPLE ID: 2D1
DEPTH: 3.0m



PARTICLE-SIZE ANALYSIS	Gravel	0.0%
	Sand	2.8%
	Silt	52.6%
	Clay	44.6%
	D_{10}	---
	D_{30}	0.0026 mm
	D_{60}	0.0151 mm
	C_U	---
	C_C	---
LIMITS	PL	18
	LL	41
	PI	23



Modified Unified Soil Classification	Group Symbol
Lean clay	CI

TECH: AB
CHECKED: NN
1 of 1

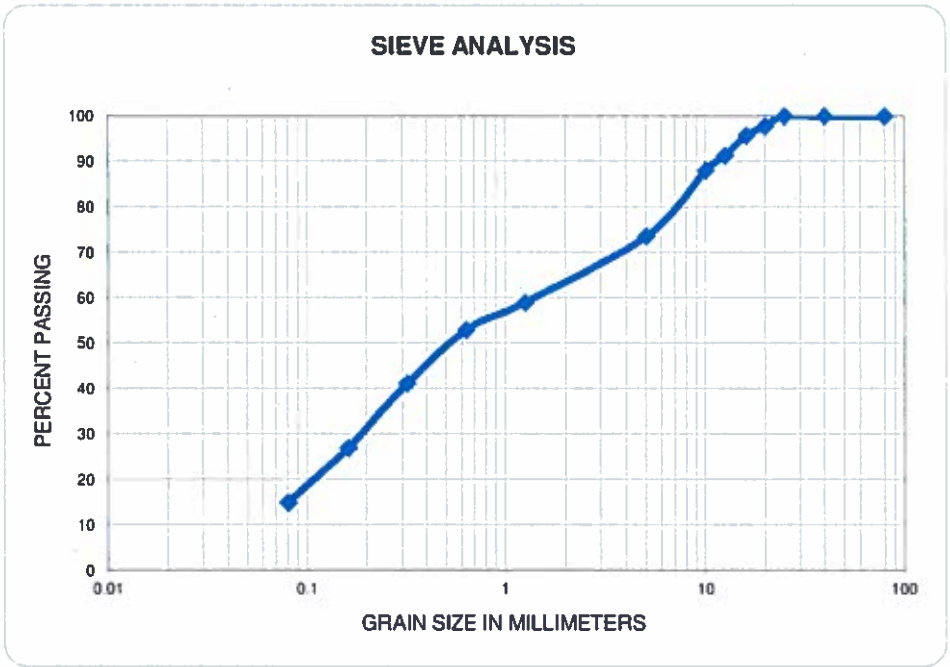
Parkland GEO

PROJECT - Burbank Subdivision
PROJECT # RD5566 **DATE -** January 4/16
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - AB **SIEVE #** 1

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		885.4	100.0		
40000	40		885.4	100.0		
25000	25		885.4	100.0		
20000	20	19.5	865.9	97.8		
16000	16	18.1	847.8	95.8		
12500	12.5	39.1	808.7	91.3		
10000	10	29.1	779.6	88.1		
5000	5	128.2	651.4	73.6		
1250	1.25	129	522.4	59.0		
630	0.63	53.4	469	53.0		
315	0.315	105.2	363.8	41.1		
160	0.16	125.4	238.4	26.9		
80	0.08	105.9	132.5	15.0		
SIEVE PAN		15.4				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	1658.9	G-WT OF DRY SAMPLE	885.4	
B-WT. DRY SAMPLE + PAN	1589.3	H- WASHED DRY +PAN	1472.2	
C-WT. OF WATER	69.6	I- WT OF WASHED DRY SA	768.3	
D-WT. OF PAN	703.9	J- WT WASHED FINES	117.1	
E-WT. OF DRY SAMPLE	885.4			
F-MOISTURE CONTENT	7.9			

DESCRIPTION OF SAMPLE/COMMENTS	METHOD OF PREPARATION	WASHED
BH2	TOTAL WEIGHT	885.4
2G1	DRY WT.	885.4
1.2m	DIFFERENCE	0
	% DIFFERENCE	0



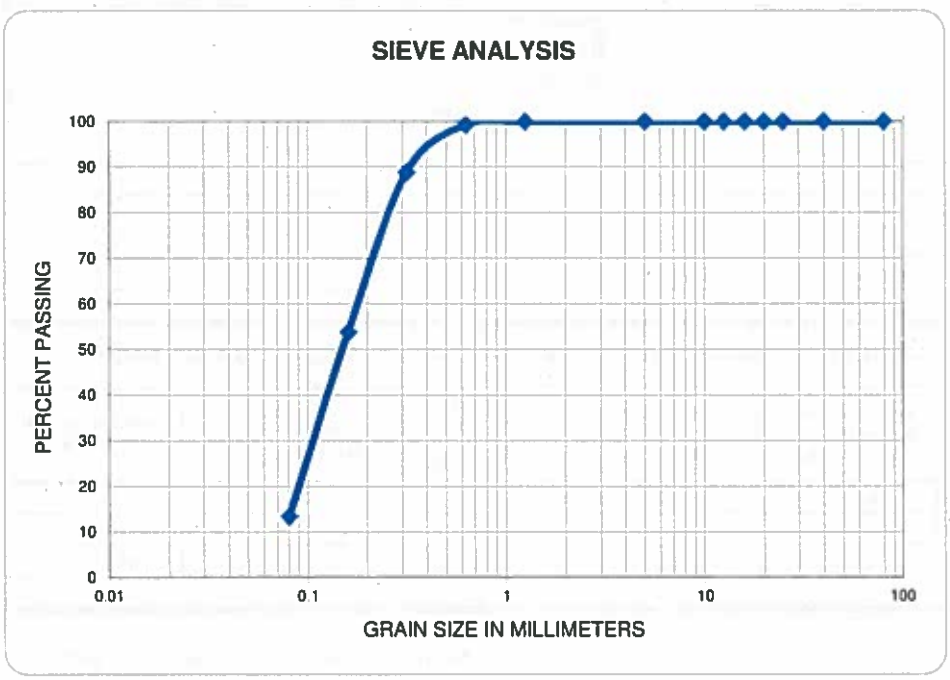
ParklandGEO

PROJECT - Burbank Subdivision
PROJECT # RD5566 **DATE -** January 4/16
SAMPLE SOURCE -
PIT NAME -
TECHNICIAN - AB **SIEVE #** 2

SIEVE NO.	OPENING SIZE (mm)	WEIGHT RETAINED (g)	TOTAL WT. FINER (gms)	PERCENT PASSING	SPECIFICATION Min.	SPECIFICATION Max.
80000	80		775.9	100.0		
40000	40		775.9	100.0		
25000	25		775.9	100.0		
20000	20		775.9	100.0		
16000	16		775.9	100.0		
12500	12.5		775.9	100.0		
10000	10		775.9	100.0		
5000	5		775.9	100.0		
1250	1.25	0.2	775.7	100.0		
630	0.63	5.5	770.2	99.3		
315	0.315	80.6	689.6	88.9		
160	0.16	271.8	417.8	53.8		
80	0.08	313.5	104.3	13.4		
SIEVE PAN		25.7				

MOISTURE CONTENT SAMPLE		SIEVE ANALYSIS SAMPLE		D.W.W.CALCULATIONS
A-WT. WET SAMPLE + PAN	1527	G-WT. OF DRY SAMPLE	775.9	
B-WT. DRY SAMPLE + PAN	1477.6	H- WASHED DRY +PAN	1399	
C-WT. OF WATER	49.4	I- WT OF WASHED DRY SA	697.3	
D-WT. OF PAN	701.7	J- WT WASHED FINES	78.6	
E-WT. OF DRY SAMPLE	775.9			
F-MOISTURE CONTENT	6.4			

DESCRIPTION OF SAMPLE/COMMENTS	METHOD OF PREPARATION	WASHED
BH5	TOTAL WEIGHT	775.9
5D1	DRY WT.	775.9
1.5m	DIFFERENCE	0
	% DIFFERENCE	0



Parkland GEO

Project: Burbank Subdivision
Subject: Geotechnical Testing - Soil Sulphate Test Results
Project #: RD5566 **Date:** December 24, 2015

Soil Sulphate Test Results

Laboratory: Parkland Geotechnical

Sample #: MC1-2 Borehole: 1 Depth: 2.0m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC2-2 Borehole: 2 Depth: 2.0m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC3-2 Borehole: 3 Depth: 2.0m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC4-2 Borehole: 4 Depth: 2.0m Result (% Sulphate): 0.04	Sample #: Borehole: Depth: Result (% Sulphate):
Sample #: MC5-2 Borehole: 5 Depth: 2.0m Result (% Sulphate): 0.05	Sample #: Borehole: Depth: Result (% Sulphate):

Comments:

REQUIREMENTS FOR CONCRETE SUBJECTED TO SULPHATE ATTACK (CAN/CSA-A231-M09)

EXPOSURE CLASSIFICATION	DEGREE OF EXPOSURE	WATER-SOLUBLE SULPHATE(SO4) IN SOIL SAMPLE, %	SULPHATE(SO4) IN GROUND WATER SAMPLES, mg/L	MINIMUM SPECIFIED 56-DAY COMPRESSIVE STRENGTH, MPa	MAXIMUM WATER/CEMENTING MATERIALS RATIO	PORTLAND CEMENT TO BE USED
S-1	Very Severe	over 2.0	over 10,000	35	0.4	HS
S-2	Severe	0.20 to 2.0	1 500 to 10 000	32	0.45	HS
S-3	Moderate	0.10 to 0.20	150 to 1 500	30	0.5	MS or HS

Tech: AB **Chkd:** NN

ALBERTA TRANSPORTATION - SPECIFICATIONS FOR AGGREGATE (TABLE 3.2.3.1, DECEMBER 2010)

DESIGNATION		1				2				3				4			5		6		7	8	9
Class (mm)		10	12.5	16	25	*16(N2)	20	25	40	12.5AW	12.5BW	12.5C	16	20	25	40	10A	10B	80	125	40	25	8
Percent Passing Metric Sieve (CGSB 8-GP-2M) µm	125 000																			100			
	80 000																		100				
	50 000																		55-100	55-100			
	40 000								100							100					100		
	25 000				100			100	70-94						100				38-100	38-100		100	
	20 000				85-95		100	82-97						100		55-90							
	16 000			100	75-87	100	84-94	70-94	55-85				100						32-85	32-85		90-100	
	12 500		100	80-92	65-80	89-100				100	100	100	72-95										
	10 000	100	83-92	70-84	58-72	78-94	63-86	52-79	44-74	35-65	55-75	70-93	53-82	35-77	30-77	25-72	100	100			85-100	45-75	
	8 000																						100
	5 000	60-75	55-70	50-65	40-58	55-70	40-67	35-64	33-62	0-15	0-15	30-60	27-54	15-55	15-55	8-55	70-90	45-70	20-65	20-65		0-15	85-100
	1250	26-45	26-45	26-45	25-44	26-45	20-43	18-43	17-43	0-3	0-3	9-28	9-28	0-30	0-30	0-30	20-45	20-45			40-100	0-5	45-75
	630	18-38	18-38	18-38	16-36	18-38	14-34	12-34	12-34														30-50
	315	12-30	12-30	12-30	10-28	12-30	9-26	8-26	8-26			0-15	0-15				9-22	9-22	6-30	6-30	17-100		18-30
	160	8-20	8-20	8-20	6-18	8-20	5-18	5-18	5-18			0-11	0-11				5-15	5-15					10-21
	80	4-10	4-10	4-10	4-10	4-10	2-10	2-10	2-10	0-0.3	0-0.3	0-8	0-8	0-12	0-12	0-12	0-10	0-10	2-10	2-15	6-30		5-15
%FRACTURE BY WEIGHT (2 FACES)	ALL +5000	* SEE NOTE (N1)				60+	60+	60+	50+	75+ (100% 1 face)	75+ (100% 1 face)	60+	60+	40+	40+	25+	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PLASTICITY INDEX (PI)		NP	NP	NP	NP	NP	NP-6	NP-6	NP-6	N/A	N/A	NP-4	NP-4	NP-8	NP-8	NP-8	NP-6	NP-6	NP-8	NP-8	NP-5	NP-5	NP
L.A. ABRASION LOSS PERCENT MAX.		40	40	40	40	50	50	50	50	35	35	35	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	35
FLAKINESS INDEX		N/A								MAX 15		N/A											
COEFFICIENT OF UNIFORMITY (C_u)		N/A																			3+	N/A	

Designations:

Designation 1 - Asphalt Concrete Pavement

Designation 2 - Base Course Aggregate

Designation 3 - Seal Coat Aggregate

Designation 4 - Gravel Surfacing Aggregate

Designation 5 - Sanding Material

Designation 6 - Gravel Fill

Designation 7 - Cement Stabilized Base Course Aggregate

Designation 8 - Granular Filter Aggregate

Designation 9 - Slurry Seal Aggregate

* Notes:

N1. According to Specification 3.50, Asphalt Concrete Pavement - EPS or 3.53, Apshalt Concrete Pavement - Superpave and Mix Type Specified.

N2. Designation 2 Class 16 Material is ASBC

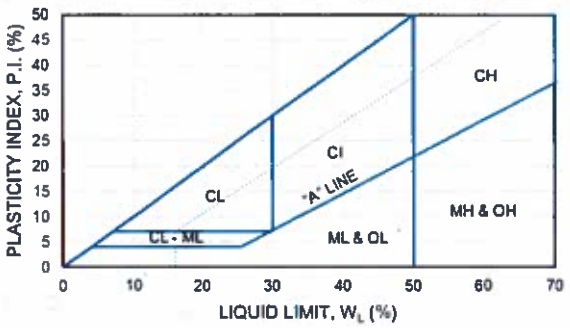
N3. For crushed aggregates other than all Designation 5 and Designation 9 materials, a tolerance of three percent in the amount passing the maximum size sieve will be permitted provided all oversize material passes the next larger standard sieve size.

N4. Unless otherwise specified, Pit-Run Aggregate will be defined as unprocessed granular material, with no specified gradation requirement, that is extracted from an aggregate deposit.

THE PARKLANDGEO CONSULTING GROUP
EXPLANATION OF TERMS AND SYMBOLS

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, GRAVEL-SAND MIXTURE, 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, LITTLE OR NO FINES	NOT MEETING 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. LESS THAN 7
	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, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING 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. LESS THAN 7
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 FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50\%$	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY SOILS		
		$30\% < W_L < 50\%$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS		
		$W_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$W_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY		
		$W_L > 50\%$	OH		ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS		
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	



NOTES ON SOIL CLASSIFICATION AND DESCRIPTION:

1. Soil are classified and described according to their engineering properties and behaviour.
2. Boundary classification for soil with characteristics of two groups are given combined group symbols (e.g. GW-GC is a well graded gravel sand mixture with clay binder between 5 and 12%).
3. Soil classification is in accordance with the Unified Soil Classification System (ASTM D2487) with the exception that an inorganic clay of medium plasticity (CI) is recognized.
4. The use of modifying adjectives may be employed to define the estimated percentage range by eight of minor components.

GEOTECHNICAL, ENVIRONMENTAL
AND MATERIALS ENGINEERING
www.parklandgeo.com

THE PARKLANDGEO CONSULTING GROUP
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 materials, boundaries, and conditions have been established only at the borehole location 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 the borehole logs.

1. **PRINCIPAL SOIL TYPE** – The major soil type by weight of material or by behaviour.

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	0.075 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 FINE GRAINED SOILS** – The following terms are used relative to undrained shear strength and Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm. It is noted that this correlation needs to be used with caution as the correlation is only very approximate.

Description	Undrained Shear Strength, C_u (kPa)	N Value
Very Soft	Less than 12	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 150	15 to 30
Hard	Over 150	Over 30

LIMITATION

General Terms and Conditions

ParklandGEO

THE PARKLANDGEO CONSULTING GROUP
GENERAL TERMS, CONDITIONS AND LIMITATIONS

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

1. STANDARD OF CARE - In the performance of professional services, ParklandGEO used the 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 in any manner.

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 or environmental consulting practice in this area. ParklandGEO will not be responsible for the interpretation by others of the information developed.

3. SITE INFORMATION - The CLIENT has agreed to provide all information with respect to the past, present and proposed conditions and use of the Site, whether specifically requested or not. The CLIENT acknowledged that in order for ParklandGEO to properly advise and assist the CLIENT, ParklandGEO has relied on full disclosure by the CLIENT of all matters pertinent to the Site investigation.

4. 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 has agreed that "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. ParklandGEO 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 has agreed that in the event that any such report is released to a third party, the above 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.

5. LIMITATIONS ON SCOPE OF INVESTIGATION AND WARRANTY DISCLAIMER
   There is no warranty, expressed or implied, by ParklandGEO that:
   a) the investigation uncovered all potential geo-hazards, contaminants or environmental liabilities on the Site; or
   b) the Site is entirely free of all geo-hazards or 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 geo-hazards or contaminants on the Site.

   The CLIENT acknowledged 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) unless specifically stated in the agreed Scope of Work, the investigation will not, nor is it intended to assess or detect potential contaminants or environmental liabilities on the Site;
   c) 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;
   d) any assessment is also dependent on and limited by the accuracy of the analytical data generated by the sample analyses;
   e) 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
   f) the laboratory testing program and analytical parameters selected are limited to those outlined in the CLIENT's authorized scope of investigation; and
   g) there are risks associated with the discovery of hazardous materials in and upon the lands and premises which may inadvertently discovered as part of the 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 and in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed. 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.

6. COST ESTIMATES - Estimates of remediation or construction costs can only be based on the specific information generated and the technical limitations of the investigation authorized by the CLIENT. Accordingly, estimated costs for construction or remediation are based on the known site conditions, which can vary as new information is discovered during construction. As some construction activities are an iterative exercise, ParklandGEO shall therefore not be liable for the accuracy of any estimates of remediation or construction costs provided.

7. LIMITATION OF LIABILITY - The CLIENT has agreed that to the fullest extent permitted by the law ParklandGEO's total liability to CLIENT for any and all injuries, claims, losses, expenses or damages whatsoever arising out of or in anyway relating to the Project is contractually limited, as outlined in ParklandGEO's standard Consulting Services Agreement. Further, the CLIENT has agreed that to the fullest extent permitted by law ParklandGEO is not liable to the CLIENT for any special, indirect or consequential damages whatsoever, regardless of cause.

8. INDEMNIFICATION - To the fullest extent permitted by law, the CLIENT has agreed to defend, indemnify and hold ParklandGEO, its directors, officers, employees, agents and subcontractors, harmless from and against any and all claims, defence costs, including legal fees on a full indemnity basis, damages, and other liabilities arising out of or in any way related to ParklandGEO's work, reports or recommendations.

Alberta Energy Regulator

RECLAMATION CERTIFICATE NO. 00372762-00-00
LICENSE NO. 0016447

This reclamation certificate is issued pursuant to Section 138 of the Environmental Protection and Enhancement Act (the "Act"), following a review of the information provided in the application. No reclamation inquiry has been held.

This certifies that the surface of the land held by Canadian Oil & Gas International Inc.

within SW Sec. 24 Tp. 039 Rge. 27 W4M

in connection with or incidental to COJI JOFFFRE 3-24-39-27 WELL, as shown outlined in yellow on the attached plan(s), complies with the conservation and reclamation requirements of Part 6 of the Act.

Issued this 8th day of October, 2015

Designated Inspector under the Act

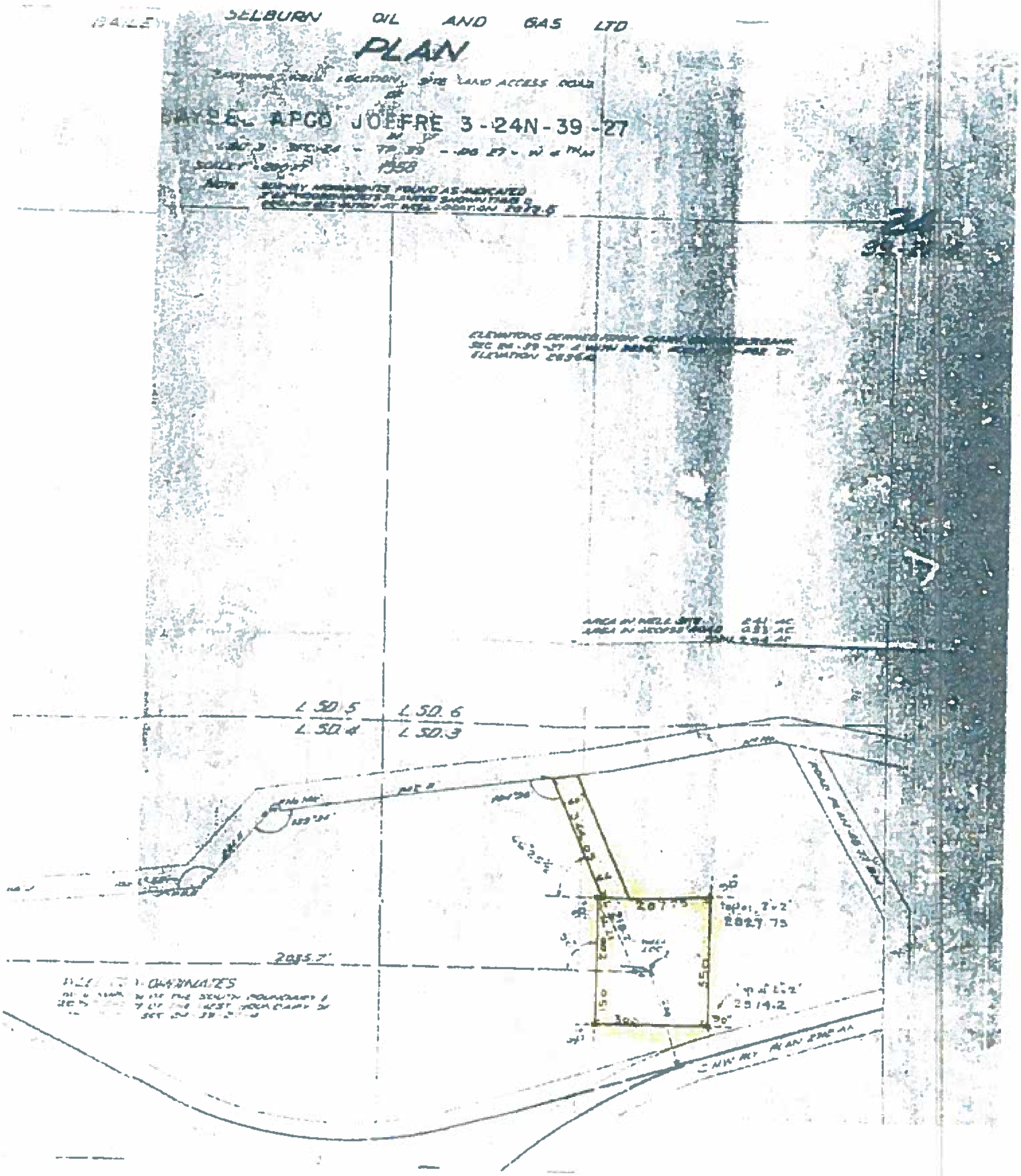
Operator/Agent:

Canadian Oil & Gas International Inc.
RR 3
Eckville, Alberta
T0M 0X0

The AER may cancel this reclamation certificate pursuant to Section 139 of the Act where the AER is of the opinion that further work may be necessary to conserve and reclaim the above specified land to which this certificate relates.

The Responsible Energy Development Act (REDA) permits the filing of a request for a regulatory appeal by an eligible person in regards to the appealable decision as defined in Section 36 of REDA.

If you are eligible to file a request for a regulatory appeal and you wish to do so, you must submit your request in the form and manner and within the timeframe required by the AER. Filing requirements are set out in section 30 of the Alberta Energy Regulator Rules of Practice available on the AER website, www.aer.ca, under Rules & Directives > Acts, Regulations and Rule. Regulatory appeal requests should be e-mailed to RegulatoryAppeal@aer.ca.



SELBURN OIL AND GAS LTD
PLAN
LOCATION, SITE AND ACCESS ROAD
JOFFRE 3-24N-39-27
1958
SURVEY MONUMENTS FOUND AS INDICATED
L.S.D. 5
L.S.D. 6
L.S.D. 4
L.S.D. 3
2035.7'
2027.75
2014.2