Geotechnical Investigation

South Claresholm Subdivision
SE 23-12-27-W4M
Claresholm, Alberta

Submitted To:
ISL Engineering and Land Services Ltd.
Calgary, Alberta

Submitted By:
Lone Pine Geotechnical Ltd.
Calgary, Alberta

Date: December 17, 2023
Project No: 1480

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1. Introduction

This report summarizes the findings of the geotechnical investigation undertaken by Lone Pine Geotechnical Ltd. for the proposed subdivision located within the southeast quarter section of 23-12-27-W4M, in Claresholm, Alberta. The purpose of the investigation was to assess the soil and groundwater conditions at the site and provide geotechnical recommendations for the subdivision.

The scope of work for the geotechnical investigation was outlined in our proposal dated October 13, 2023 (Proposal No. 1737-23). Authorization to proceed was given by Mr. Peter Villanueva, P.Eng., of ISL Engineering and Land Services Ltd. on October 18, 2023.

2. Background

2.1 Site Details

The proposed subdivision is located southwest of the intersection of Highway 2 and 39 Avenue West, on the south end of Claresholm, Alberta. The location of the site is shown on Figure 1 in Appendix A.

At the time of the geotechnical investigation, the site consisted of agricultural crop land with a gently rolling topography. Existing surface grades were generally less than 10 percent. Three photographs taken on November 24, 2023, are presented on Figure 4 in Appendix A. The site was surrounded by similar agricultural crop land, a large residential property, commercial and light industrial properties along Highway 2, and the Bridges at Claresholm Golf Course.

2.2 Project Details

The 134 acre subdivision will consist of residential and commercial areas. Single family houses, townhouses, medium density condominiums, and seniors housing have been proposed in the residential areas. The commercial areas have been proposed along the east and north sides of the subdivision and are expected to consist of retail and warehouse buildings. A road network has been proposed to provide access throughout the subdivision. The proposed subdivision layout is shown on Figure 3, in Appendix A.

The development of the subdivision will consist of stripping, grading, underground utility installations, pond construction, road construction, and building construction. The subdivision will be tied into the Town of Claresholms municipal services for water supply, sewage disposal, and stormwater management. A stormwater pond about 6 acres in size has been proposed on the south side of the subdivision. Cuts and fills no greater than 2.0 m and post-development grades no steeper than 15 percent are anticipated throughout the subdivision.

2.3 Geological Setting

Based on a review of geological maps, published information, and the writers experience, the Town of Claresholm generally consists of glacial soil deposits (till), underlain by bedrock of the Willow Creek Formation. This bedrock formation generally consists of claystone with interbedded sandstone. The bedrock was formed during the Upper Cretaceous and Paleocene Epochs through the cementation of ancient soil particles.

3. Investigation Methodology

3.1 Field Work

Fourteen boreholes were drilled at the site on November 23 and 24, 2023, using a truck mounted drilling rig operated by Evergreen Drilling Ltd. The boreholes were drilled to depths ranging from 6.5 to 8.0 m at the locations shown on Figures 2 and 3 in Appendix A.

The soils encountered in the boreholes were visually examined and logged by Lone Pine Geotechnical Ltd. in accordance with the Modified Unified Soil Classification System (MUSCS). Standard Penetration Tests (SPTs) were performed at 1.5 m intervals and soil samples were collected at various depths in the boreholes.

Standpipe piezometers were installed into the boreholes at the completion of drilling. The groundwater levels in the piezometers were measured on December 12, 2023. The borehole locations and elevations were surveyed by Zoom Surveys Ltd.

3.2 Laboratory Testing

Laboratory tests were performed on the soil samples collected from the boreholes. The tests included moisture content, organic content, plasticity, grain size, and sulphate concentration. The laboratory test results are presented on the borehole logs in Appendix B.

4. Subsurface Conditions

The detailed soil and groundwater conditions encountered in the boreholes are summarized on the borehole logs in Appendix B, along with explanations of the classification system, the symbols, and the terminology used on the logs.

4.1 Soil Conditions

180 to 320 mm thick layers of topsoil were encountered in the boreholes. The topsoil was organic, dark brown to black, damp to moist, and contained occasional rootlets. It is possible that thicker topsoil is present in other areas of the site.

The topsoil was underlain by silt deposits which extended to depths ranging from 0.4 to 1.4 m in the boreholes. The silt was generally sandy, stiff, non to low plastic, and damp to moist. The moisture contents of eleven samples ranged from 8 to 11 percent. The silt contained varying proportions of clay and was generally light brown in colour.

Glacial clay deposits (clay till) were encountered below the silt and extended beyond the 6.5 to 8.0 m depths drilled in the boreholes. The clay till was generally silty, low to medium plastic, and damp to moist. The moisture contents of forty seven samples ranged from 10 to 16 percent, and the liquid limits of five samples ranged from 31 to 44 percent. The SPTs in the boreholes indicated that the clay till varied from stiff to hard in consistency and generally became stiffer with depth. The clay till contained some sand, trace gravel, and occasional cobbles, silt seams, sand seams, rust specks, rust stains, coal fragments, and precipitates. In Boreholes 4, 10, 12, and 14, layers of sand and silt were encountered at random depths within the clay till. In Borehole 9, a boulder was encountered within the clay till at a depth of 4.7 m.

The following table summarizes the general soil profiles encountered in the boreholes:

Table 1 – General Soil Profiles

Borehole	Topsoil Thickness (mm)	Silt Depth (m)	Clay Till Depth (m)	Borehole Depth (m)
1	320	0.3	1.2	6.5
2	280	0.3	1.1	8.0
3	230	0.2	0.8	6.5
4	180	0.2	1.0	8.0
5	290	0.3	1.4	6.5
6	260	0.3	1.0	6.5
7	300	0.3	1.4	6.5
8	180	0.2	0.9	6.5
9	240	0.2	1.4	6.5
10	240	0.2	0.8	8.0
11	200	0.2	0.8	6.5
12	190	0.2	0.8	6.5
13	200	0.2	0.4	8.0
14	200	0.1	0.4	6.5

4.2 Groundwater Conditions

Standpipe piezometers were installed into the boreholes at the completion of drilling. The groundwater levels in the piezometers were measured on December 12, 2023. The measurements are summarized in the following table:

Table 2 – Groundwater Measurements

Borehole	Ground Elevation (m)	Groundwater on December 12, 2023	
		Depth (m)	Elevation (m)
1	1024.91	6.15	1018.76
2	1025.72	5.84	1019.88
3	1026.33	3.81	1022.52
4	1024.70	4.46	1020.24
5	1024.86	> 6.46 (Dry)	< 1018.40
6	1025.45	4.92	1020.53
7	1023.35	4.28	1019.07
8	1023.21	5.36	1017.85
9	1024.25	4.41	1019.84
10	1024.51	3.72	1020.79
11	1022.86	4.63	1018.23
12	1021.75	3.98	1017.77
13	1022.94	3.83	1019.11
14	1023.46	3.49	1019.97

The groundwater levels at the site will fluctuate seasonally and typically peak during the spring and summer months. The near surface soils at the site are susceptible to perched groundwater conditions after snowmelt and heavy rainfall at certain times of the year.

5. Recommendations

The soil and groundwater conditions at the site will be suitable for the proposed subdivision provided that the proper precautions are followed during design and construction. Geotechnical recommendations for design and construction are presented below.

5.1 Site Preparation

5.1.1 Grading

Cuts and fills no greater than about 2.0 m are anticipated during the grading of the subdivision. All topsoil, vegetation, and deleterious soils should be stripped from the areas to be developed prior to grading. General engineered fill used for grading should consist of low to medium plastic cohesive soil or well graded granular soil. The fill should be free of organics, debris, oversized rocks, and unsuitable soils such as high plastic clays.

The existing silt and clay till at the site will be suitable for reuse as general engineered fill provided that they are placed in accordance with the compaction specifications in Section 5.1.2 below. Any offsite soils considered for use as fill should be approved by Lone Pine Geotechnical Ltd. prior to being brought to the site.

5.1.2 Compaction

General engineered fill should be placed in uniform lifts compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD). The maximum compacted lift thickness should not exceed 200 mm. The fill should be placed at moisture contents within 2 percent of the Optimum Moisture Content (OMC). Moisture conditioning (ie. drying, wetting, mixing) may be required to achieve the required level of compaction. General engineered fill should not be placed on exposed grades steeper than 20 percent.

The ability of compaction equipment to achieve compaction is an important consideration. Cohesive soils are best compacted with padfoot rollers and granular soils are best compacted with smooth drum rollers.

The time of year that the fill is placed is also an important consideration. Achieving compaction during freezing atmospheric conditions can be difficult since fill cannot be allowed to freeze prior to placement. Furthermore, moisture conditioning of fill is not possible during freezing conditions. If fill placement during freezing conditions is proposed, the methodology should be reviewed and approved by Lone Pine Geotechnical Ltd.

5.1.3 Excavations

All temporary excavations at the site must be undertaken in accordance with Alberta Occupational Health and Safety (OHS) regulations. Temporary side slopes should be cut back to 1H:1V for excavations up to 4.0 m in depth. Flatter side slopes may be required for excavations in which groundwater seepage is encountered. The bottom 1.5 m of excavations in competent clay till may be cut vertical. Any proposed excavations deeper than 4.0 m should be reviewed and approved by Lone Pine Geotechnical Ltd. on a case-by-case basis.

The stability of side slopes decreases with time, so the length of time that temporary excavations are left open should be minimized. All excavations should be protected from surface water inflow and groundwater seepage. If inflow or seepage occur, diversion ditches, sumps, and pumps should be used for dewatering. All temporary surcharge loads, such as stockpiles, should be kept back from the edge of excavations a distance of at least the excavation depth.

5.1.4 Underground Utilities

The silt and clay till at the site are expected to provide adequate support for underground utilities. Minor deflections of utility pipes are normal and should be expected. The specified pipes should be capable of withstanding these deflections. Requirements for bedding gravel within the pipe zone of utility trenches are dependent on the pipe class, pipe diameter, trench geometry, and subgrade conditions.

The excavation recommendations in Section 5.1.3 should be followed for underground utility installations. Utility trenches should be backfilled with general engineered fill as defined in Section 5.1.1. The compaction specifications in Section 5.1.2 should be followed during backfilling.

Minor settlement of compacted backfill in utility trenches is normal and should be expected. All fills will settle, even when placed to a high level of compaction. The magnitude of settlement is dependent on the fill thickness, fill type, fill density, fill moisture, and the loading applied to the surface. The potential for differential settlement will be dependent on the variation of these factors over a given area. To reduce the risk of settlement on paved surfaces above utility trenches, it is recommended to delay paving as long as possible after backfilling the trenches.

Trenchless methods such as horizontal directional drilling (HDD) may be considered as an alternative to traditional open trench installations. One advantage of trenchless methods is that they minimize the risk of settlement on paved surfaces above utility trenches.

5.1.5 Soil Erodibility

Soil erodibility is the susceptibility of a soil to detachment and transport from rainfall and surface water flow. The soil erodibility factor (k-value) is a design parameter required for the development of erosion and sediment control practices for a given site. The near surface soils at this site consisted of silt. Based on the results of laboratory tests on three representative samples of the silt, a k-value of 0.035 t·ha·h / ha·MJ·mm may be used. This k-value was estimated using the nomograph method outlined in the City of Calgary's erosion and sediment control guidelines.

5.2 Commercial Construction

Commercial areas have been proposed along the east and north sides of the subdivision. The soil and groundwater conditions encountered during the investigation are suitable for several building foundation types, including concrete footings, bored concrete piles, helical piles, and driven steel piles. Piles may be more practical than footings for buildings with higher foundation loads because the higher strength properties of the deeper clay till would be utilized in the design of piles.

Grade supported floor slabs are expected to perform adequately for buildings provided that the recommendations in Section 5.1 are followed during the grading of the subdivision. Floor slabs should be underlain with at least 100 mm of compacted gravel meeting the requirements of Section 9.16.2 of the Building Code. If very strict settlement tolerances are required for slabs, structurally supported floor slabs should be considered.

Foundation design considerations will vary throughout the commercial area of the subdivision. Detailed recommendations for foundations (ie. design parameters) for individual buildings have not been provided in this report since it has been assumed that building specific geotechnical investigations will be performed prior to construction in accordance with Building Code requirements.

5.3 Residential Construction

5.3.1 Foundations

Residential areas consisting of single family houses, townhouses, medium density condominiums, and seniors housing have been proposed throughout the subdivision. The soil and groundwater conditions encountered during the investigation will be suitable for standard residential foundations consisting of concrete footings.

Footings bearing on the native silt or clay till at the site may be designed using a maximum allowable bearing resistance of 100 kPa. Footings may also bear on properly compacted general engineered fill, subject to review by Lone Pine Geotechnical Ltd. The design and construction of residential foundations should conform to the Building Code.

It is recommended that all bearing surfaces below footings be inspected by a geotechnical engineer prior to concrete placement. Bearing surfaces should not be allowed to become disturbed, saturated, dried out, or frozen, during and after construction. Prolonged exposure of bearing surfaces to the elements should be avoided.

For protection against frost, perimeter footings in continuously heated structures should be founded at least 1.4 m below grade. Isolated exterior footings and footings in unheated structures should be founded at least 2.1 m below grade.

5.3.2 Weeping Tile

Permanent subdrainage systems (weeping tile) are recommended for all below grade areas of residential buildings such as house basements. The weeping tile drains should consist of 100 mm diameter perforated plastic pipes surrounded by free draining washed rock. The rock should provide at least 150 mm of cover over the pipes and should be wrapped in non-woven filter fabric. The drains should be sloped towards one or multiple collection sumps. The sumps should be equipped with pumps for dewatering.

Surface water inflow into weeping tile drains can be significantly increased by poor drainage surrounding residential buildings and improperly directed roof downspouts. Proper sloping around foundation walls, as discussed in Section 5.3.3 below, will be very important.

5.3.3 Backfill

Backfill should only be placed against foundation walls once the concrete has gained enough strength to support the lateral earth pressures exerted by the backfill. During placement, careful attention should be paid to the compaction effort exerted on the backfill to prevent excessive pressures from developing on walls. Only light, hand operated compaction equipment should be used within 1.0 m of walls.

The areas surrounding residential buildings should be sloped to shed surface water away. A grade of at least 2 percent over a distance of at least 2 m is recommended away from foundation walls. Roof downspouts should discharge well clear of walls.

5.4 Concrete

The concentration of sulphates in the soil samples tested as part of the geotechnical investigation indicated a severe potential for sulphate attack on subsurface concrete. Therefore, Sulphate Resistant (Type HS) cement is recommended for use in concrete in direct contact with the soils represented by these samples.

Concrete used at the site should be chosen in accordance with CSA Standard CAN-A23.1-19. All concrete exposed to freezing temperatures should be air entrained and protected from freezing temperatures during curing. Good finishing practices should be followed during the placement of concrete.

5.5 Stormwater Detention Pond

A stormwater detention pond is expected to perform adequately at the proposed location on the south side of the subdivision. Detention ponds temporarily impound stormwater during peak flows until the water is gradually removed by evaporation or by other means. Design considerations for detention ponds include sizing, side slope stability, erosion protection, liner permeability, and the

influence of impounded stormwater on the groundwater in the surrounding area. Lone Pine Geotechnical Ltd. can provide further recommendations for detention ponds if required.

5.6 Pavement

5.6.1 Subgrade Preparation

The exposed subgrade below paved surfaces should be scarified to the depths specified in Table 3 and recompacted to at least 98 percent of SPMDD. The subgrade should then be proof rolled under the supervision of a geotechnical engineer. Any soft areas identified during the proof roll should be removed and replaced with gravel compacted to at least 98 percent of SPMDD. The gravel type and gravel thickness should be at the discretion of the geotechnical engineer on site during the proof roll. Standard road construction practice is to replace soft areas with gravel, increasing the thickness of the granular sub-base in the pavement structure.

The use of geosynthetics may also be required if soft areas are identified on the subgrade. Geosynthetics should be chosen carefully based on their proposed application. Filter fabrics are used for separation, geogrids are used for subgrade improvement, and combigrids are used for both separation and improvement.

5.6.2 Pavement Structures

The pavement structures for the roads within the subdivision should be designed and constructed in accordance with Town of Claresholm specifications. The following table presents the Town of Claresholms minimum pavement structures for various road classifications:

Table 3 – Pavement Structures

	Paved Lane	Local	Collector	Arterial / Industrial / Commercial
Asphalt Concrete Pavement	75 mm	75 mm	90 mm*	125 mm**
Granular Base (20 mm Crushed Gravel)	75 mm	100 mm	100 mm	150 mm
Granular Sub-Base (75 mm Pit-Run Gravel)	200 mm	250 mm	300 mm	350 mm
Subgrade Preparation (Scarification Depth)	200 mm	200 mm	300 mm	300 mm

* 50 mm base lift and 40 mm top lift.
** 75 mm base lift and 50 mm top lift.

The thicknesses above are the minimum requirement. As discussed in Section 5.6.1, additional gravel and/or geosynthetics may be required to ensure that the subgrade provides the required level of support.

5.6.3 Pavement Materials

The granular base and sub-base in the pavement structures should be compacted to at least 100 percent of SPMDD. The asphalt should be compacted to at least 93 percent of Maximum Relative Density (MRD). Asphalt should not be placed in lifts exceeding 75 mm in thickness. It is recommended to use pavement materials conforming to the following specifications:

Table 4 – Asphalt Mix Specifications

Asphalt Property	
Marshall Stability (kN, minimum)	6.7
Marshall Flow (mm)	1.5 – 3.0
Air Voids (%)	3.5 – 4.5
Voids in Mineral Aggregate (%, minimum)	15.0
Asphalt Content (% of total mix)	5.0 – 8.0
Retained Stability (%, minimum)	75.0

Table 5 – Base and Sub-Base Specifications

Gravel Property	20 mm Crushed Gravel	75 mm Pit-Run Gravel
Fractures (≥ 2 faces) (%, minimum)	60	–
Los Angeles Abrasion Loss (%, maximum)	50	–
Plasticity Index (%, maximum)	6	8

Table 6 – Base and Sub-Base Gradations

Sieve Size (mm)	Passing by Weight (%)	
	20 mm Crushed Gravel	75 mm Pit-Run Gravel
80		100
50		55 – 100
25		38 – 100
20	100	
16	84 – 94	32 – 85
10	63 – 86	
5.0	40 – 67	20 – 65
1.250	20 – 43	
0.630	14 – 34	
0.315	9 – 26	6 – 30
0.160	5 – 18	
0.080	2 – 10	2 – 10

Alternative pavement materials could be considered upon review by Lone Pine Geotechnical Ltd.

5.6.4 Drainage

Paved surfaces should be sloped to remove surface water as quickly as possible. Allowing water to pond on surfaces for too long can cause the saturation of the underlying subgrade, which can lead to subsidence or differential frost heave issues.

5.7 Inspection and Materials Testing

Lone Pine Geotechnical Ltd. should review all geotechnical specifications pertaining to the subdivision prior to construction. Lone Pine Geotechnical Ltd. should also perform inspection and materials testing during construction to verify that the actual conditions at the site are consistent with those assumed in this report. Based on the Town of Claresholms specifications, the following inspection and materials testing will be required:

- Monitoring and compaction testing during stripping and grading.
- Monitoring and compaction testing during pond construction.
- Monitoring and compaction testing during underground utility installations.
- Compaction, concrete, and asphalt testing during surface works.
- Geotechnical foundation inspections for residential and commercial buildings.

Construction at the site should be performed by qualified contractors experienced in earthworks, ponds, roads, and buildings.

6. Limitations

This report has been prepared for the use of ISL Engineering and Land Services Ltd. and the Town of Claresholm for the specified application to the proposed subdivision located within the southeast quarter section of 23-12-27-W4M, in Claresholm, Alberta. It may not be used by any third party without the express written consent of Lone Pine Geotechnical Ltd. Any use of this report by a third party is the responsibility of such third party.

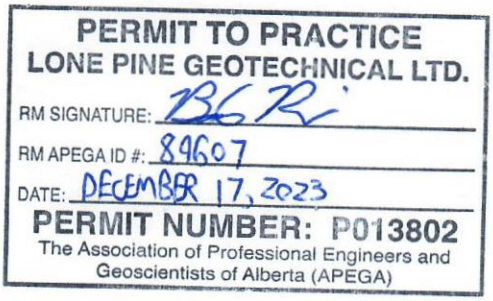
This report is based on the findings in fourteen boreholes, laboratory testing, and a review of available information provided to Lone Pine Geotechnical Ltd. by ISL Engineering and Land Services Ltd. If different subsurface conditions or information are encountered during later stages of the project, Lone Pine Geotechnical Ltd. must be notified, and this report should be reviewed and revised, as required. This report has been prepared in accordance with generally accepted geotechnical engineering practices. No other warranty, either expressed or implied, is made. Slope stability, flood plain, environmental, hydrogeological, and archeological assessments are outside the scope of this report.

7. Closure

Lone Pine Geotechnical Ltd. trusts that this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
Lone Pine Geotechnical Ltd.

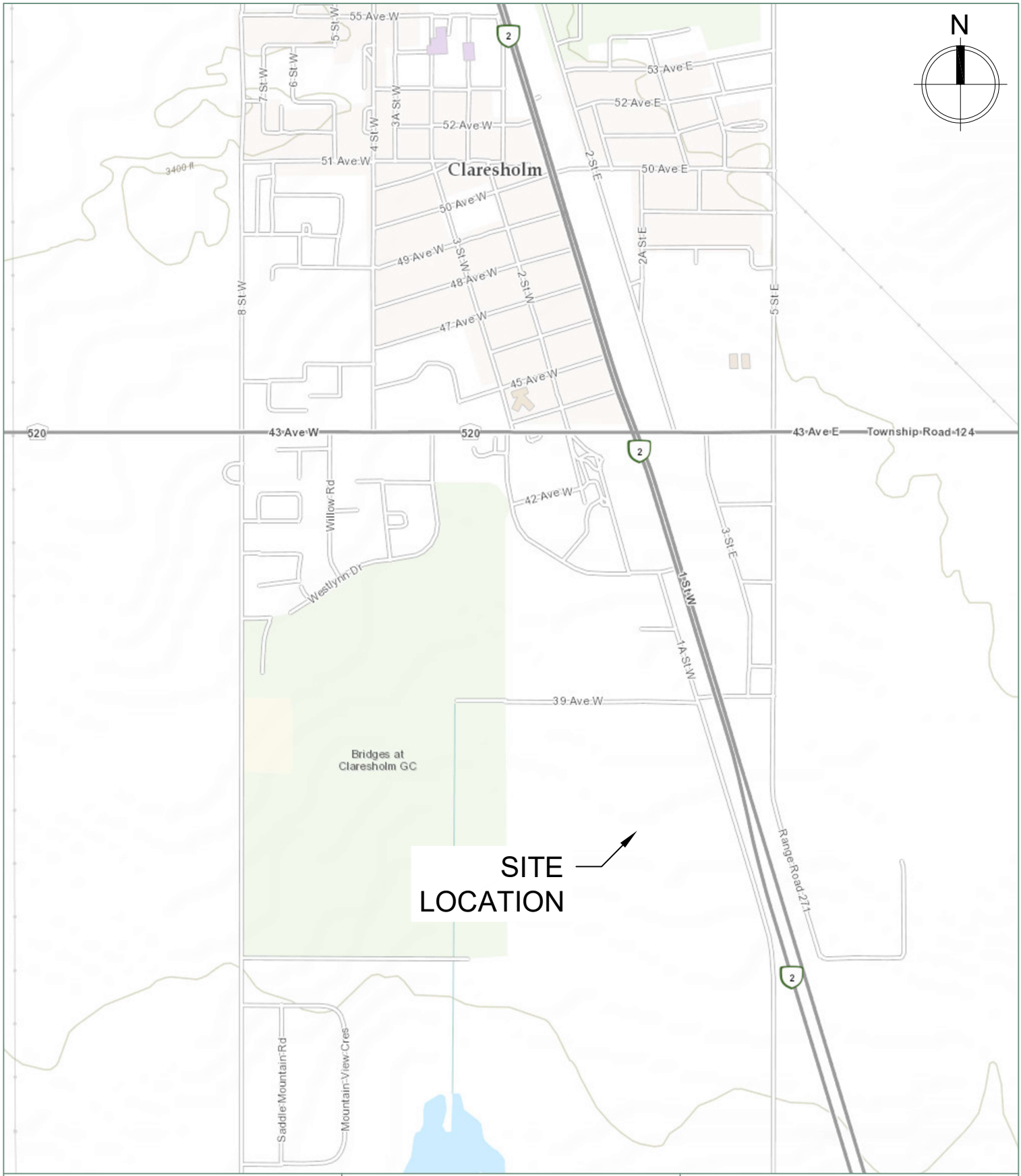
December 17, 2023



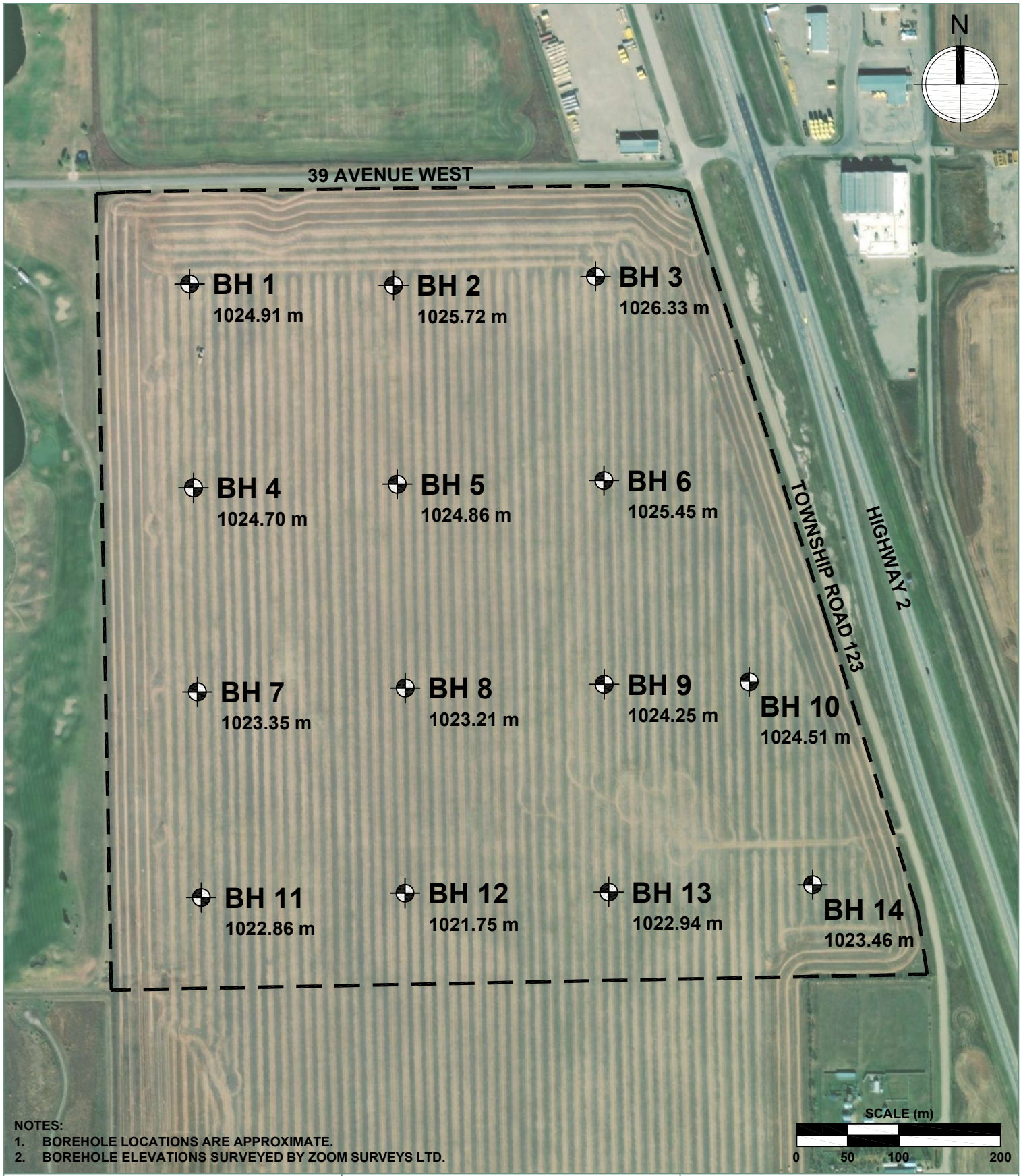
Bartek Ryczywolski, P.Eng.
Principal Geotechnical Engineer

Appendix A

Figure 1 – Site Location
Figure 2 – Borehole Locations
Figure 3 – Subdivision Layout
Figure 4 – Photographs

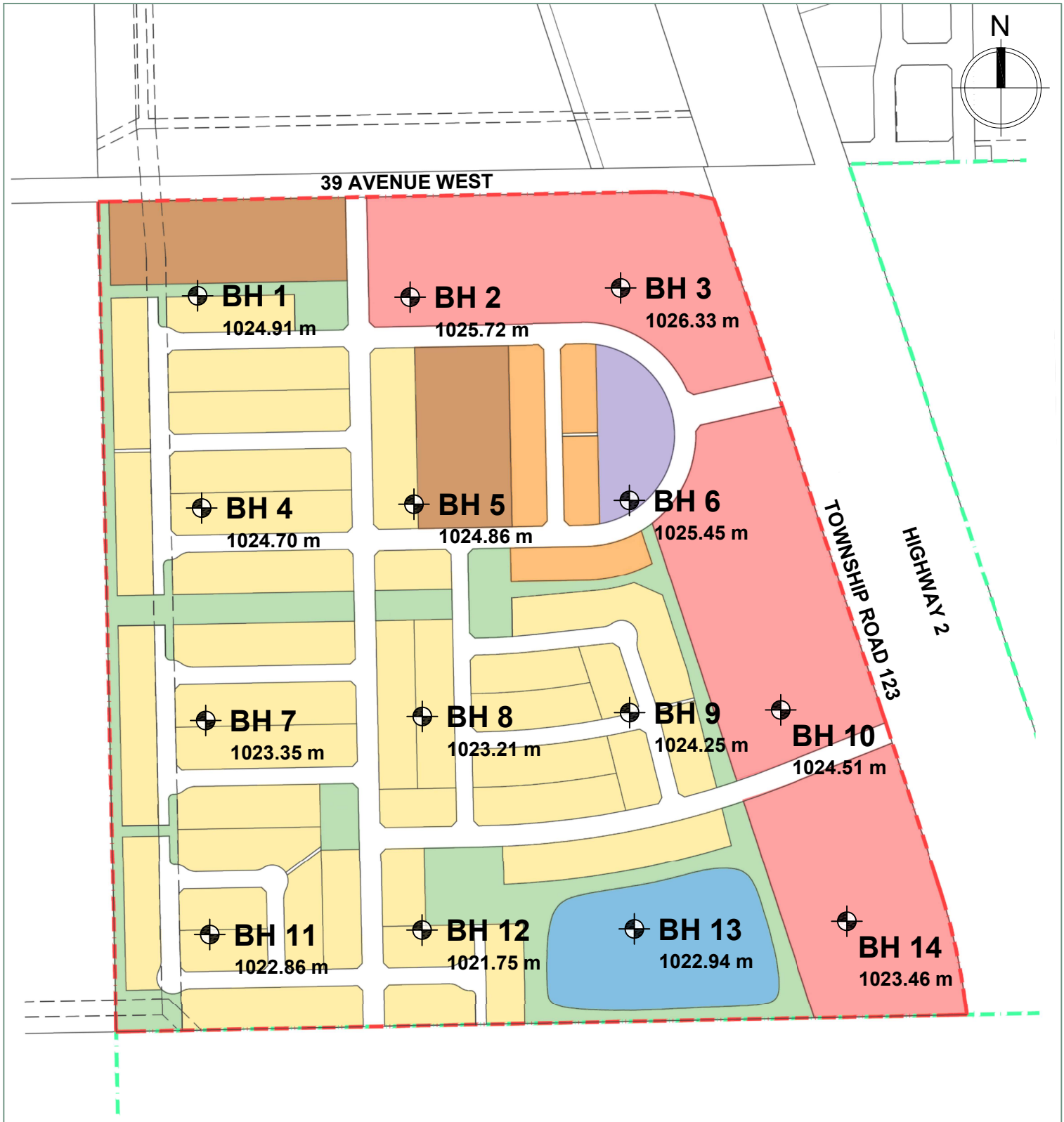


CONSULTANT	CLIENT	TITLE		
LONE PINE GEOTECHNICAL LTD	ISL ENGINEERING AND LAND SERVICES LTD.	SITE LOCATION		
	PROJECT	DRAWN BY	REVISION NO.	SCALE
	GEOTECHNICAL INVESTIGATION SOUTH CLARESHOLM SUBDIVISION SE 23-12-27-W4M, CLARESHOLM, ALBERTA	DB	0	
		DATE	PROJECT NO.	FIGURE NO.
		DEC 2023	1480	1



NOTES:
1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE ELEVATIONS SURVEYED BY ZOOM SURVEYS LTD.

CONSULTANT	CLIENT	TITLE		
LONE PINE GEOTECHNICAL LTD	ISL ENGINEERING AND LAND SERVICES LTD.	BOREHOLE LOCATIONS		
PROJECT	DRAWN BY	REVISION NO.	SCALE	
GEOTECHNICAL INVESTIGATION SOUTH CLARESHOLM SUBDIVISION SE 23-12-27-W4M, CLARESHOLM, ALBERTA	DB	0	1:5000	
	DATE	PROJECT NO.	FIGURE NO.	
	DEC 2023	1480	2	



NOTES:
1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE ELEVATIONS SURVEYED BY ZOOM SURVEYS LTD.

SCALE (m)
0 50 100 200

CONSULTANT	CLIENT	TITLE		
LONE PINE GEOTECHNICAL LTD	ISL ENGINEERING AND LAND SERVICES LTD.	SUBDIVISION LAYOUT		
PROJECT	DRAWN BY	REVISION NO.	SCALE	
GEOTECHNICAL INVESTIGATION SOUTH CLARESHOLM SUBDIVISION SE 23-12-27-W4M, CLARESHOLM, ALBERTA	DB	0	1:5000	
	DATE	PROJECT NO.	FIGURE NO.	
	DEC 2023	1480	3	

PHOTOGRAPH 1:
SOUTH SIDE OF THE PROPOSED SUBDIVISION AREA

PHOTOGRAPH 2:
WEST SIDE OF THE PROPOSED SUBDIVISION AREA

PHOTOGRAPH 3:
GEOTECHNICAL DRILLING OF BOREHOLE 13

CONSULTANT	CLIENT	TITLE		
LONE PINE GEOTECHNICAL LTD	ISL ENGINEERING AND LAND SERVICES LTD.	PHOTOGRAPHS		
PROJECT	DRAWN BY	REVISION NO.	SCALE	
GEOTECHNICAL INVESTIGATION SOUTH CLARESHOLM SUBDIVISION SE 23-12-27-W4M, CLARESHOLM, ALBERTA	DB	0		
	DATE	PROJECT NO.	FIGURE NO.	
	DEC 2023	1480	4	

Appendix B

Borehole Logs
Explanation of Terminology and Symbols

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 1

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	SPT (N)	Other Data
0			TOPSOIL (320 mm), organic, dark brown to black, occasional rootlets, moist.					
			SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp.		G1	8		Grain Size (G1) Clay = 26 % Silt = 43 % Sand = 31 %
1	1024		CLAY TILL, silty, some sand, trace gravel, very stiff, low to medium plastic, brown, occasional silt seams, sand seams, rust specks, coal fragments, and precipitates, damp to moist.					
					S1		23	Organics (G1) = 2.4 %
2	1023				G2	12		
3	1022				S2		27	Sulphates (S2) = 0.52 %
			~ moist at 3.8 m.					
4	1021				G3	13		
			~ occasional cobbles at 4.5 m.					
					S3		35	
5	1020				G4	16		
6	1019				S4		24	
			End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 6.15 m on Dec 12, 2023.					
7	1018							
8	1017							
9	1016							

Moisture Content (%): PL, MC, LL; 0 10 20 30 40 50

Standard Penetration Test (N): 0 10 20 30 40 50

Piezometer Installation: .3, 3.5, 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 314961E, 5543036N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1024.91 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH1.bor

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 2

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data
0			TOPSOIL (280 mm), organic, dark brown, occasional rootlets, damp to moist.							
	1025		SILT, sandy, some clay, stiff, non to low plastic, light brown, damp to moist.		G1	8				Sulphates (G1) = 0.11 %
1			CLAY TILL, silty, some sand, trace gravel, very stiff, low to medium plastic, brown, occasional silt seams, sand seams, cobbles, rust specks, coal fragments, and precipitates, damp to moist.							
	1024				S1			19		
2										
	1023				G2	11				
3					S2			45		
	1022									
4			~ moist at 4.0 m.		G3	15				
	1021				S3			30		
5										
					G4	14				
	1020									
6					S4			26		
	1019									
7					G5	14				
	1018				S5			22		
8			End of borehole at 8.0 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 5.84 m on Dec 12, 2023.							
	1017									
9										

Piezometer Installation: .3, 3.5, 8

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315154E, 5543017N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1025.72 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH2.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 3

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	SPT (N)	Other Data
0	1026		TOPSOIL (230 mm), organic, dark brown, occasional rootlets, damp to moist.					
			SILT, sandy, clayey, stiff, non to low plastic, light brown, damp to moist.		G1	11		
1	1025		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, rust specks, coal fragments, and precipitates, damp to moist.		S1		9	
2	1024				G2	14		Plasticity (G2) LL = 31 % PL = 14 % PI = 17 %
			~ very stiff at 2.6 m.					
3	1023				S2		21	
			~ moist at 3.5 m.					
4	1022				G3	14		
					S3		34	
5	1021							
					G4	12		
6	1020				S4		27	Sulphates (S4) = 0.52 %
7	1019		End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 3.81 m on Dec 12, 2023.					
8	1018							
9								

Moisture Content (%): PL, MC, LL; 0 10 20 30 40 50

Standard Penetration Test (N): 0 10 20 30 40 50

Piezometer Installation: .3, 3.5, 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315353E, 5543024N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1026.33 m

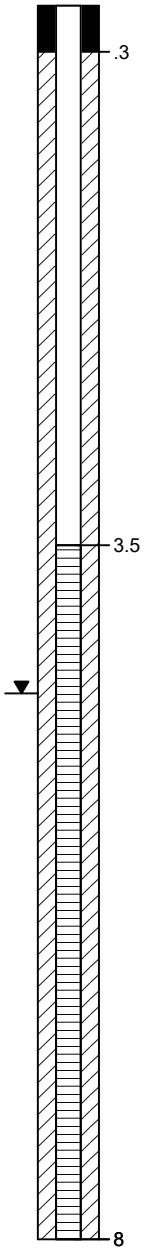
12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH3.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 4

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data
0			TOPSOIL (180 mm), organic, dark brown, occasional rootlets, damp.							
	1024		SILT, sandy, some clay to clayey, stiff, non to low plastic, brown, moist.							
1			~ light brown, damp at 0.3 m.							
			CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, and precipitates, damp to moist.		G1	14				Plasticity (G1) LL = 36 % PL = 14 % PI = 22 %
	1023				S1			9		Sulphates (S1) = 0.20 %
2			~ 0.4 m thick silty sand layer at 1.6 m.							
			~ very stiff, occasional cobbles, at 2.0 m.		G2	12				
	1022									
3					S2			38		
	1021									
4					G3	15				
			~ occasional rust specks and rust stains, moist, at 4.4 m.							
	1020				S3			26		
5					G4	14				
			~ hard, occasional coal fragments at 5.4 m.							
	1019									
6					S4			34		
	1018				G5	14				
7										
	1017				S5			41		
8			End of borehole at 8.0 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 4.46 m on Dec 12, 2023.							
	1016									
9										

Piezometer Installation



LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 314964E, 5542837N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1024.70 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH4.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 5

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	SPT (N)	Other Data
0			TOPSOIL (290 mm), organic, dark brown, occasional rootlets, damp to moist.					
1	1024		SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp.		G1	9		
2	1023		CLAY TILL, silty, some sand, trace gravel, very stiff, low to medium plastic, brown, occasional silt seams, sand seams, cobbles, rust specks, coal fragments, and precipitates, damp to moist.		S1		19	
					G2	10		
3	1022				S2		21	Sulphates (S2) = 0.60 %
4	1021				G3	12		
5	1020		~ hard, moist at 5.5 m.		S3		28	
6	1019				G4	15		
					S4		37	
7	1018		End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Dry on Dec 12, 2023.					
8	1017							
9	1016							

Moisture Content (%): PL, MC, LL; 0 10 20 30 40 50

Standard Penetration Test (N): 0 10 20 30 40 50

Piezometer Installation: .3, 3.5, 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315159E, 5542819N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1024.86 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH5.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 6

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data
0	1025		TOPSOIL (260 mm), organic, dark brown, occasional rootlets, damp to moist.							
			SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, occasional precipitates, damp to moist.		G1	11				Sulphates (G1) = 0.47 %
1	1024		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, rust specks, coal fragments, and precipitates, damp to moist.		S1			14		
2	1023				G2	13				
			~ very stiff at 2.8 m.							
3	1022				S2			23		
4	1021				G3	11				
					S3			33		
5	1020		~ occasional rust stains, moist, at 5.0 m.							
					G4	13				
6	1019				S4			25		
			End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 4.92 m on Dec 12, 2023.							
7	1018									
8	1017									
9										

Piezometer Installation: .3; 3.5; 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315359E, 5542825N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1025.45 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH6.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 7

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	SPT (N)	Other Data
0	1023		TOPSOIL (300 mm), organic, dark brown to black, occasional rootlets, moist.					
			SILT, sandy, some clay to clayey, stiff, non to low plastic, brown, moist.					
1			~ light brown, damp at 0.4 m.		G1	8		Sulphates (G1) = 0.17 %
	1022		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, and precipitates, damp to moist.		S1		14	
2			~ very stiff at 2.2 m.		G2	12		
	1021							
3			~ sandy, some silt to silty, at 3.0 m.		S2		24	
	1020							
4					G3	12		
	1019							
			~ silty, some sand, occasional cobbles, rust specks, rust stains, and coal fragments, moist, at 4.6 m.		S3		40	
5								
	1018							
6					G4	16		
	1017				S4		29	
			End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 4.28 m on Dec 12, 2023.					
7	1016							
8	1015							
9								

Moisture Content (%): PL, MC, LL; 0 10 20 30 40 50

Standard Penetration Test (N): 0 10 20 30 40 50

Piezometer Installation: .3, 3.5, 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 314938E, 5542647N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1023.35 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH7.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 8

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data	Piezometer Installation
0	1023		TOPSOIL (180 mm), organic, dark brown, occasional rootlets, damp to moist.								.3
			SILT, sandy, some clay, stiff, non to low plastic, light brown, damp.		G1	9					
1	1022		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, rust specks, coal fragments, and precipitates, damp to moist.		S1			13			
2	1021		~ very stiff at 2.5 m.		G2	13				Plasticity (G2) LL = 31 % PL = 16 % PI = 15 %	
3	1020				S2			20			3.5
4	1019				G3	15					
					S3			23			
5	1018		~ moist at 5.0 m.		G4	16					
6	1017				S4			27		Sulphates (S4) = 0.60 %	
7	1016		End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 5.36 m on Dec 12, 2023.								6.5
8	1015										
9											

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315140E, 5542652N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1023.21 m

12-19-2023 C:\Lone Pine Geotechnical Ltd\Projects\1480 - Claresholm South Subdivision\Borehole Logs\1480 - BH8.bo

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 9

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	SPT (N)	Other Data
0	1024		TOPSOIL (240 mm), organic, dark brown, occasional rootlets, damp to moist.					
			SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp to moist.		G1	9		
1	1023							
			CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, cobbles, rust specks, coal fragments, and precipitates, damp to moist.		S1		15	Sulphates (S1) = 0.47 %
2	1022		~ sandy, some silt, at 1.8 m.					
			~ silty, some sand, very stiff at 2.3 m.		G2	14		
3	1021				S2		25	
4	1020				G3	14		
			~ moist at 4.5 m.					
			~ boulder at 4.7 m.		S3		50	50 Blows for 130 mm
5	1019							
					G4	15		
6	1018				S4		28	
			End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 4.41 m on Dec 12, 2023.					
7	1017							
8	1016							
9								

Moisture Content (%): PL, MC, LL; 0 10 20 30 40 50

Standard Penetration Test (N): 0 10 20 30 40 50

Piezometer Installation: .3, 3.5, 6.5

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315328E, 5542624N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1024.25 m

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 10

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data	Piezometer Installation
0			TOPSOIL (240 mm), organic, dark brown, occasional rootlets, damp.								.3
	1024		SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp.		G1	11				Grain Size (G1) Clay = 29 % Silt = 44 % Sand = 27 % Organics (G1) = 3.8 %	
1			CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional precipitates, damp to moist.								
	1023		~ very stiff, occasional sand seams, at 2.1 m.		S1			15			
2											
	1022				G2	13					
3											
					S2			23		Sulphates (S2) = 0.48 %	
	1021										3.5
4			~ moist at 4.0 m.		G3	11					
	1020										
					S3			37			
5			~ hard, occasional rust specks, rust stains, and coal fragments at 5.1 m.		G4	14				Plasticity (G4) LL = 41 % PL = 17 % PI = 24 %	
	1019										
6											
			~ 0.1 m thick saturated silty sand layer at 6.3 m.		S4			37			
	1018										
					G5	15					
7											
	1017										
					S5			33			
8			End of borehole at 8.0 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 3.72 m on Dec 12, 2023.								8
	1016										
9											

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315469E, 5542624N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1024.51 m

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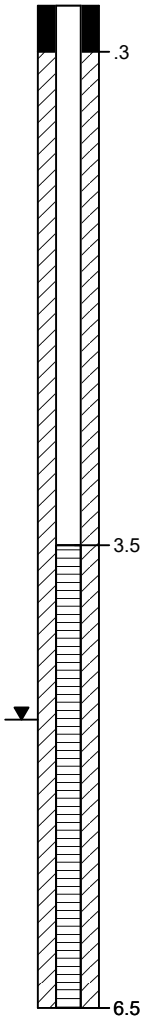
CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 11

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data
0			TOPSOIL (200 mm), organic, dark brown to black, occasional rootlets, moist.							
					G1	9				Grain Size (G1) M. Sand = 5 % F. Sand = 37 % Silt/Clay = 58 %
			SILT, sandy, some clay, stiff, non to low plastic, brown, damp.							
1	1022		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, sand seams, cobbles, and precipitates, damp to moist.							
					S1			12		
2	1021		~ very stiff at 2.6 m.							
					G2	10				Sulphates (G2) = 0.08 %
3	1020				S2			22		
			~ occasional rust specks, rust stains, and coal fragments at 3.8 m.							
4	1019				G3	13				
					S3			33		
5	1018		~ moist at 5.0 m.							
					G4	16				
6	1017				S4			27		
			End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 4.63 m on Dec 12, 2023.							
7	1016									
8	1015									
9	1014									

Piezometer Installation



LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 314940E, 5542445N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1022.86 m

CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 12

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data	Piezometer Installation
0			TOPSOIL (190 mm), organic, dark brown to black, occasional rootlets, moist.								.3
	1021		SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp.		G1	11				Grain Size (G1) Clay = 36 % Silt = 40 % Sand = 24 %	
1			CLAY TILL, silty, some sand, trace gravel, very stiff, low to medium plastic, brown, occasional silt seams, sand seams, cobbles, and precipitates, damp to moist.								
	1020				S1			23		Organics (G1) = 3.5 %	
2					G2	12					
			~ 0.5 m thick light grey sandy silt layer at 2.4 m.								
	1019										
3			~ 0.2 m thick light red sandy silt layer at 2.9 m.								
					S2			19		Sulphates (S2) = 0.47 %	
	1018										3.5
4			~ 0.5 m thick wet silty sand layer at 3.9 m.		G3	15					
			~ very stiff to hard, occasional rust specks, rust stains, and coal fragments, moist, at 4.4 m.								
	1017				S3			29			
5					G4	13					
	1016										
6					S4			33			
	1015		End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 3.98 m on Dec 12, 2023.								6.5
7											
	1014										
8											
	1013										
9											

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315144E, 5542448N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1021.75 m

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CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 13

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data	Piezometer Installation
0			TOPSOIL (200 mm), organic, dark brown, occasional rootlets, damp.								.3
			SILT, sandy, some clay to clayey, stiff, non to low plastic, light brown, damp.								
1	1022		CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, rust specks, coal fragments, and precipitates, damp to moist.		G1	12				Plasticity (G1) LL = 44 % PL = 18 % PI = 26 %	
					S1			14			
2	1021		~ very stiff at 2.3 m.		G2	14					
3	1020				S2			23			3.5
					G3	12				Grain Size (G3) Clay = 31 % Silt = 37 % Sand = 28 % Gravel = 4 %	
4	1019		~ moist at 4.2 m.								
					S3			34			
5	1018				G4	13					
			~ occasional sand seams and rust stains at 5.5 m.								
6	1017				S4			24		Sulphates (S4) = 0.55 %	
7	1016				G5	14					
					S5			28			
8	1015		End of borehole at 8.0 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 3.83 m on Dec 12, 2023.								8
9	1014										

LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315332E, 5542418N

LOGGED BY: BR
DRILLED ON: NOVEMBER 24, 2023
GROUND ELEVATION: 1022.94 m

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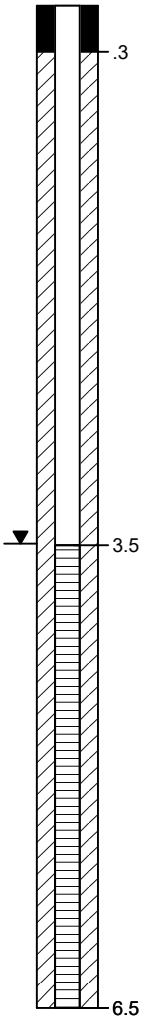
CLIENT: ISL ENGINEERING AND LAND SERVICES LTD.
PROJECT: SOUTH CLARESHOLM SUBDIVISION
PROJECT NO: 1480
LOCATION: SE 23-12-27-W4M, CLARESHOLM, ALBERTA
NOTES:

BOREHOLE 14

Depth (m)	Elevation (m)	Soil Symbol	Soil Description	Sample Type	Sample No.	MC (%)	Moisture Content (%) PL MC LL (0 10 20 30 40 50)	SPT (N)	Standard Penetration Test (N) (0 10 20 30 40 50)	Other Data
0			TOPSOIL (200 mm), organic, dark brown, occasional rootlets, damp.							
	1023		SILT, sandy, clayey, stiff, non to low plastic, light brown, damp.		G1	11				
1			CLAY TILL, silty, some sand, trace gravel, stiff, low to medium plastic, brown, occasional silt seams, cobbles, rust specks, coal fragments, and precipitates, damp to moist.							
	1022				S1			13		
2			~ 0.8 m thick moist silty sand layer at 2.0 m.							
					G2	13				Sulphates (G2) = 0.18 %
	1021		~ very stiff at 2.8 m.							
3					S2			22		
	1020		~ moist at 3.5 m.							
4					G3	13				
	1019				S3			36		
5										
	1018				G4	14				
6					S4			24		
	1017		End of borehole at 6.5 m. Standpipe piezometer installed. Backfilled with auger cuttings and sealed with bentonite. Dry upon completion. Water level at 3.49 m on Dec 12, 2023.							
7										
	1016									
8										
	1015									
9										

Piezometer Installation



LONE PINE GEOTECHNICAL LTD

DRILLED BY: EVERGREEN DRILLING LTD.
DRILL RIG: TRUCK MOUNTED
DRILL METHOD: SOLID STEM AUGER
NOTES: UTM 315530E, 5542423N

LOGGED BY: DB
DRILLED ON: NOVEMBER 23, 2023
GROUND ELEVATION: 1023.46 m

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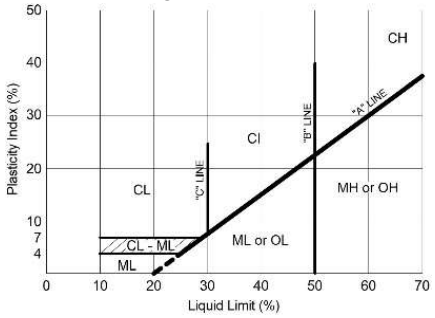
EXPLANATION OF TERMINOLOGY AND SYMBOLS

LONE PINE GEOTECHNICAL LTD

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISION			GROUP SYMBOL	PLOT SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS More than 50 % retained on 75 µm sieve	**GRAVELS** More than 50 % of coarse fraction retained on 4.75 mm sieve	**CLEAN GRAVELS**	**GW**		Well graded gravels, gravel-sand mixtures, little or no fines	Less than 5 % passes 75 µm sieve	$C_u = D_{60} / D_{10} > 4$ $C_c = (D_{30})^2 / D_{10}D_{60} = 1$ to 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting both criteria for GW
		GRAVELS WITH FINES	**GM**		Silty gravels, gravel-sand-silt mixtures	More than 12 % passes 75 µm sieve	Atterberg limits below A-line or plasticity index less than 4
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A-line or plasticity index more than 7
	SANDS More than 50 % of coarse fraction passes 4.75 mm sieve	**CLEAN SANDS**	**SW**		Well graded sands, gravelly sands, little or no fines	Less than 5 % passes 75 µm sieve	$C_u = D_{60} / D_{10} > 6$ $C_c = (D_{30})^2 / D_{10}D_{60} = 1$ to 3
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting both criteria for SW
		SANDS WITH FINES	**SM**		Silty sands, sand-silt mixtures	More than 12 % passes 75 µm sieve	Atterberg limits below A-line or plasticity index less than 4
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above A-line or plasticity index more than 7
FINE GRAINED SOILS More than 50 % passes the 75 µm sieve	**SILTS** Below A-line Neg. organics	**LIQUID LIMIT** < 50	**ML**		Inorganic silts, very fine sands, silty or clayey fine sands or clayey silts of slight plasticity	Soil classification is based on the plasticity chart	
		LIQUID LIMIT > 50	**MH**		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts		
	CLAYS Above A-line Neg. organics	**LIQUID LIMIT** < 30	**CL**		Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		LIQUID LIMIT 30 - 50	**CI**		Inorganic clays of medium plasticity, silty clays		
		LIQUID LIMIT > 50	**CH**		Inorganic clays of high plasticity, fat clays		
	ORGANIC SILTS AND CLAYS Below A-line	**LIQUID LIMIT** < 50	**OL**		Organic silts and organic silty clays of low plasticity		
		LIQUID LIMIT > 50	**OH**		Organic clays of medium to high plasticity		
HIGHLY ORGANIC SOILS			**PT**		Peat and other highly organic soils	Strong colour or odour and often fibrous texture	

PLASTICITY CHART



1. Boundary classification for soil with characteristics of two groups are given combined group symbols (ie. GW-GC is a well graded gravel sand mixture with clay binder between 5 % and 12 %).
2. Soil classification is in accordance with the Unified Soil Classification System (ASTM D2487) with the exception that inorganic clays of medium plasticity (CI) are recognized.

EXPLANATION OF TERMINOLOGY AND SYMBOLS

Grain Sizes of Soils – The following table presents the grain size ranges for soils.

Soil	Grain Size (mm)
Boulders	> 300
Cobbles	75 – 300
Coarse Gravel	19 – 75
Fine Gravel	4.75 – 19
Coarse Sand	2.00 – 4.75
Medium Sand	0.425 – 2.00
Fine Sand	0.075 – 0.425
Silt & Clay	< 0.075

Minor Soil Fractions – The following descriptors are used for describing minor soil fractions on borehole logs.

Descriptor*	Example	Percentage by Weight (%)
“and”	“and gravel”	> 35
“y” adjective	“silty”	20 – 35
“some”	“some sand”	10 – 20
“trace”	“trace clay”	1 – 10

* Descriptors not necessarily applicable for soil classification based on the plasticity chart.

Compactness of Cohesionless Soils – The following terms are used for describing the relative density of cohesionless soils on borehole logs.

Descriptive Term	Relative Density (%)	SPT N Value*
Very Loose	< 20	0 – 4
Loose	20 – 40	4 – 10
Compact	40 – 60	10 – 30
Dense	60 – 80	30 – 50
Very Dense	> 80	> 50

* SPT N Value from SPT Test performed in accordance with ASTM D1586. Uncorrected for overburden pressure effects.

Consistency of Cohesive Soils – The following terms are used for describing the undrained shear strength of cohesive soils on borehole logs.

Descriptive Term	Undrained Shear Strength (kPa)	SPT N Value*
Very Soft	< 12	0 – 2
Soft	12 – 25	2 – 4
Firm	25 – 50	4 – 8
Stiff	50 – 100	8 – 15
Very Stiff	100 – 200	15 – 30
Hard	> 200	> 30

* SPT N Value from SPT Test performed in accordance with ASTM D1586. Uncorrected for overburden pressure effects. Correlation is very approximate for cohesive soils and should be used with caution.