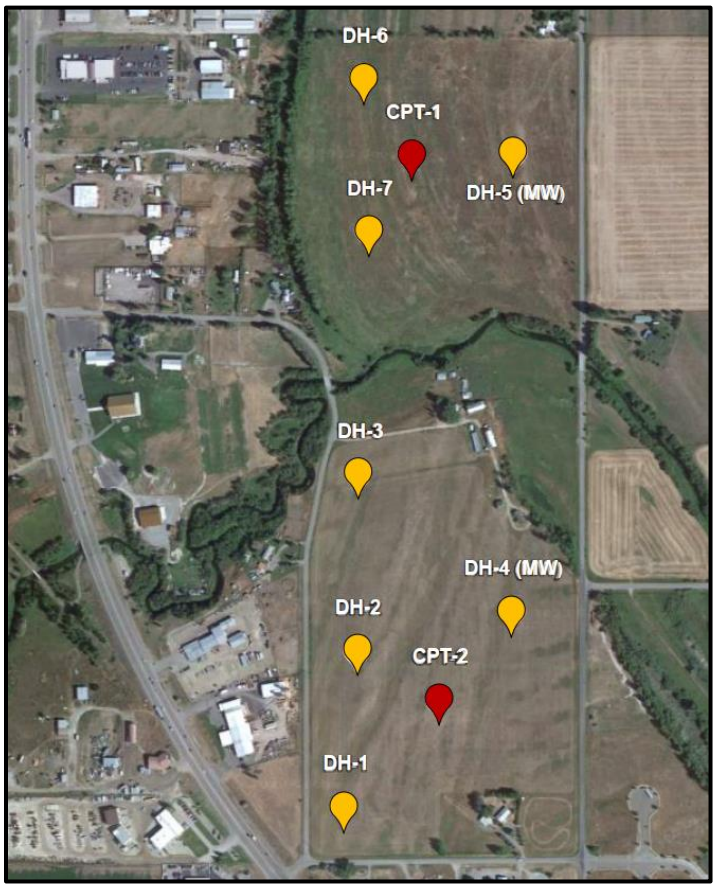
GEOTECHNICAL INVESTIGATION REPORT

225 Snowline Lane
Kalispell, Montana

Alpine Geotechnical Project No. 23-966
January 25, 2024



Prepared for:

Flathead County Commissioners Office

Prepared by:

120 Round Stone Drive, Suite 101
Kalispell, Montana 59901
406.257.6479

January 25, 2024

Whitney Aschenwald
Flathead County Commissioners Office
waschenwald@flathead.mt.gov

Re: Report of Preliminary Geotechnical Investigation
225 Snowline Lane
Kalispell, Montana

Dear Ms. Aschenwald:

Alpine Geotechnical, LLC (Alpine) has completed the preliminary geotechnical investigation report for the above referenced project. The purpose of this geotechnical investigation was to provide preliminary subsurface information and engineering recommendations regarding future development of the approximate 115-acre property at 225 Snowline Lane in Kalispell, Montana. The results of our field investigation, preliminary engineering recommendations, exploration location plan, Cone Penetrometer Testing (CPT) soundings, boring logs, and particle size analysis test results are included in this report. These services were provided in accordance with our proposal dated November 3, 2023 and subsequent authorization to proceed.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service to you, please contact us.

Sincerely,
ALPINE GEOTECHNICAL

Kagan Rutz, P.E.
Principal/Senior Engineer

Cliff Clark
Staff Geological Engineer

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SUMMARY OF KEY GEOTECHNICAL CONSIDERATIONS

The following presents a summary of key geotechnical considerations and recommendations based on the preliminary geotechnical investigation:

- Typical subsurface conditions include limited thickness of topsoil atop native loose silty sand and poorly graded sand that extends to a depth of 25 to 40 feet +/- below existing grade.

- Groundwater is present at depths of about 20 feet +/- below grade on the southern (upper) portion of the site that is being considered for a new detention facility. Groundwater is present at 10 feet +/- on the northern (lower) portion of the site that currently has no specific development plans and much of which lies in the floodplain. One groundwater monitoring well was installed on each side of Ashley Creek to allow for future periodic groundwater monitoring.

- Based on the results of Cone Penetrometer Testing and drilled borings, ground improvement will likely be required to mitigate liquefaction of the native loose sands under all planned buildings. **The estimated cost of ground improvement is significant, because of the footprint size of the planned building, and is a very important consideration prior to purchase of the property.**

- From the 2021 International Building Code Section 1613.3.2, and ASCE 7-16 Table 20.3-1, the seismic site classification is F because of the liquefaction potential.

This summary should be used in conjunction with the entire report for complete understanding. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **CLOSURE/LIMITATIONS** should be read for an understanding of the report limitations.

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

225 Snowline Lane
Kalispell, Montana

Alpine Geotechnical Project No. 23-966
January 25, 2024

INTRODUCTION/PROJECT INFORMATION

Alpine Geotechnical has completed the preliminary subsurface investigation for the property at 225 Snowline Lane south of Kalispell. The property is 114.85 acres, and owned by Robert King. The property is currently within the due diligence period; therefore, the recommendations contained herein are provided to provide better understanding of current site conditions prior to purchase. Based on preliminary plans, the focus of future development will be along the southern portion of the property (approximately 25 acres), which is referred to as 'King Property A'. Initial plans for this area include an approximate 145,000 sq. ft. Detention Facility. An additional 23 +/- acres south of Ashley Creek on the higher elevation portion of the property is referred to as 'King Property B'. No development plans currently exist for the property north of Ashley Creek, which is the balance of the 114.85 acres, much of which are in the floodplain. In accordance with our proposal, a total of two (2) CPT pushes and seven (7) borings were drilled to identify subsurface conditions across the entire property. The purposes of this report are to describe the subsurface conditions encountered across the site, present the test data, and provide preliminary geotechnical recommendations for future development.

EXPLORATION PROCEDURES

Field Exploration

Subsurface exploration via CPT took place November 15, 2023, and included two (2) CPT pushes, designated CPT-1 through CPT-2. The drilling took place December 8 and 11, 2023, and included seven (7) borings, designated DH-1 through DH-7. The drilling and CPT pushes were conducted using a truck-mounted drill rig (Diedrich D-50) equipped with a Vertek drill rig conversion CPT system operated by Alpine Geotechnical.

The Vertek CPT system is equipped with a seismic cone and a series of instruments on the end of a rod string, which is pushed into the ground at a constant rate of approximately 0.8 inches per second providing continuous measurements of subsurface parameters. The total force acting on the cone face, Qc, divided by the projected area of the cone, Ac, produces a measurement of cone resistance, qc; the total force acting on the friction sleeve, Fs, divided by the surface area of the friction sleeve, As, produces a measurement of sleeve friction, fs, and pressure is also measured behind the cone for a measurement of pore water pressure, u. Dissipation tests are

performed by stopping the penetration and measuring the decay of pore pressure with time. Shear wave velocity (Vs) is measured by using a seismic source at the surface delivered by a blow of a sledge hammer on a steel plate connected to the ground with a piezometric trigger to detect initial wave time, recording the incoming wave in one (or all) of three accelerometers, and repeating the process at known depth intervals. The results of the field investigation are presented on the CPT logs and sounding summary. The Logs present delineation of subsurface strata as determined from nearby drilling and samples recovered during the previous field investigations and inference made from correlations of the CPT data.

The borings were advanced using a truck mounted, rotary drill rig (Diedrich D50) using continuous flight hollow-stem augers owned and operated by Alpine Geotechnical. Representative samples were obtained by split-barrel sampling methods in general accordance with ASTM D1586, where the standard penetration resistance value (SPT-N) is recorded by counting the number of blows required to advance a standard 2-inch outside diameter split-barrel sampler 12 inches following the initial 6-inch seating penetration. The energy in the SPT test is delivered by a 140-pound hammer with a free fall of 30 inches. The SPT-N value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils. Information provided on the boring logs and test pits attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled by the drill crew with auger cuttings at the conclusion of each boring.

A field log of each boring was prepared by our staff engineer. These logs included visual classifications of the subsurface materials encountered during drilling as well as interpretation of the subsurface conditions between samples. The logs also contain the field SPT results, natural moisture content, groundwater information, and any boring-specific comments. Based on our field classifications and laboratory test results, the estimated group symbol for each stratum is shown on the logs, according to the Unified Soil Classification System (USCS).

SITE CONDITIONS

The planned Detention Facility is to be located along the southernmost 25 acres +/- on the south end of the property. This property is primarily undeveloped, except for a few residential and agricultural buildings along the northeastern portions of the property. The topography along the King Property is slightly rolling and slopes downward along the north end. The purchase also includes a 60-acre tract to the north Ashley Creek. This area is situated about 15 feet lower in elevation and is located within the floodplain. Ashley Creek runs along the southern end of this area, and essentially divides the lower and upper portions of the property.

SUBSURFACE CONDITIONS

Geology

The project site is located south of Kalispell, Montana, which lies in the Rocky Mountain Trench bounded by the Salish Mountains to the west and the Swan Range to the east. These mountain

ranges were formed during Tertiary tectonic activity in which Precambrian Belt rocks were faulted and uplifted. Pleistocene mountain and continental glaciation advanced generally southeastward through the trench in the vicinity of Kalispell depositing generally competent till soils beneath the base of the ice sheet. As the glaciers retreated, a sequence of weaker lakebed and outwash alluvial soils were deposited over the glacial till as meltwater accumulated in areas where drainage was impeded by morainal features. In the project area, paleochannel alluvial deposits consisting of silty sand and poorly graded sand comprise the dominant near surface landform.

Soil Conditions

Based on the results of the CPT and borings, subsurface conditions across the project area can be generalized as variable thickness of organic silt topsoil atop native soils. The native soils consist of sandy silt in the upper 5-feet +/- and quickly transitions to silty sand and poorly graded sand at depth. The topsoil ranges in thickness from 6 inches to 12 inches across the sites. The underlying silt extends to depths ranging from 4 to 6 feet atop silty sand transitioning to poorly graded sand that extends to the total depth explored in all boring locations. CPT testing indicated transition to fine-grained soils beneath a depth of 25 to 30 feet. This will be explored via additional drilling during the final geotechnical phase. The poorly graded sand beneath the silt is generally loose to very loose, based upon SPT N-values ranging from 9 to 2 blows per foot and CPT q_c values ranging from 90 to 20 tsf. Natural moisture contents in this stratum range from 3 to 36 percent, with higher moisture contents resulting from saturated conditions below the groundwater level.

Particle size testing (ASTM C117 & C136) of soils taken from the borings are shown in the table below:

Boring	Depth (ft)	Passing No. 200 (%)	Classification
DH-1	5.0	48	Silty SAND (SM)
DH-1	10.0	5	Poorly graded SAND (SP)
DH-2	15.0	2	Poorly graded SAND (SP)
DH-3	20.0	5	Poorly graded SAND with silt (SP-SM)
DH-4	25.0	2	Poorly graded SAND (SP)

Complete laboratory test results are shown in **Appendix B**.

Subsurface conditions encountered at each drill hole and CPT location are indicated on the individual logs. The attached logs should be reviewed for a detailed description of the conditions encountered at the individual investigation locations.

Groundwater Conditions

The borings and CPT's were observed for groundwater during drilling and immediately after completion. Groundwater was encountered across the entire property based on boring and CPT

results at depths ranging from 22 to 23 feet below existing grade on the area south of Ashley Creek. The northern floodplain area shows groundwater depths ranging from 10 to 11 feet below existing grade. Groundwater monitoring wells were installed at Borings DH-4 and DH-5 for future periodic monitoring. The attached boring and CPT logs show the groundwater levels at each location at the time of drilling.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff, and other hydrologic factors not evident at the time the borings and CPT's were performed.

PRELIMINARY ENGINEERING RECOMMENDATIONS

Geotechnical Considerations

The project site has loose silty sand and/or poorly graded sand as the predominant native subgrade material. This presents numerous challenges for design and construction of the proposed facilities. The most significant challenge is that the saturated portion of the native loose sand below the groundwater level is potentially liquefiable during a moderate seismic event. Liquefaction involves a sudden loss of strength in saturated, loose, cohesionless soils due to a rapid change in a stress condition such as a seismic event, which causes the soils to behave like a liquid which can lead to significant reduction in bearing capacity and large settlements of structures. Our analysis was conducted by the methodology recommended by Idriss and Boulanger, 2008, which uses a user defined earthquake magnitude, peak ground acceleration for a probabilistic seismic event return period based on latitude/longitude, corrected field SPT N-values or CPT q_c values, unit weights, and percent finer than the #200 sieve. All inputs were based upon physical measurements or field data, except for the peak ground acceleration and earthquake magnitude. We used 6.0 magnitude for design earthquake and determined the peak ground acceleration based upon the latitude/longitude and ASCE 7 Hazard Tool which uses USGS mapping. All structures for this property should be classified as a risk category IV Essential Facility.

Liquefaction mitigation of the underlying loose, saturated sands involves ground improvement to increase the relative density and decrease void space either through replacement or densification or a combination of both. Typical methods include vibro-compaction, dynamic compaction, vibro-replacement (stone columns), deep soil mixing, compaction grouting, driven piles, and others. All require specialty contractors with specialized equipment. **Given the granular and relatively clean nature of the sand below groundwater, we believe either vibro-compaction or vibro-replacement (stone columns) ground improvement is likely the best option for this project.**

The native sand across the proposed building sites has a high probability of liquefaction during a moderate seismic event, which is estimated to cause lateral spreading and significant vertical displacement (settlement) of approximately 3 to 7 inches based on our SPT and Keller North America's CPT based liquefaction analysis. Based on our subsurface data gathered via geotechnical drilling and CPT, our analysis indicates that minimum in-situ SPT N_{60} values = 23,

or CPT q_c values = 90 throughout the native poorly graded sand would be required to provide an adequate factor of safety against liquefaction for this design seismic event and keep settlement at a tolerable level. The critical N-values and q_c values have been based upon our gathered subsurface data and a seismic event with a 98% probability of non-exceedance in a 50-year period, which corresponds to a 2,475-year return period.

Detailed design and evaluation of liquefaction mitigation measures are beyond the scope of the current investigation and report. Typically, specialty contractors have proprietary ground improvement systems and will complete the design and construction. Regardless of the selected method of ground improvement, additional drilling and/or CPT by Alpine Geotechnical will be required during the final geotechnical phase to better understand the in-situ soil conditions, which will help accurately define the project scope and ground improvement areas as it pertains to final building layout and design.

For preliminary and budgeting purposes, we have discussed this site with Keller North America, specifically the Salt Lake City, Utah location. We have sent them our CPT soundings and boring logs for the southern portion of the property. They have done their own preliminary liquefaction analysis and prepared a preliminary ground improvement plan based on stone columns which includes 30-inch diameter stone columns installed at an 8-foot center to center spacing to a depth of 35 feet below final site. The rough order of magnitude cost range for the ground improvement to effectively treat a plan area of 145,000 square feet to mitigate liquefaction is **$2.5 to $3 Million**. The area of treatment must extend beyond the actual building footprint a minimum of 5 feet laterally on all sides. Keller North America is the foremost ground improvement engineering and construction firm in the region. The post ground improvement total settlement would be less than 1 inch, which is tolerable for structures and is typically acceptable. It is important to recognize that this is a preliminary cost estimate based on limited subsurface information, and is intended to serve only as a relative order of magnitude figure. We believe the soils are reasonably homogenous across the proposed building area, so we do believe this preliminary budget to be reasonably accurate. Liquefaction triggering analysis is complex, and there are a variety of approaches to develop probability of liquefaction, as well as a variety of modeling that can be used to estimate settlement. Ultimately, a final ground improvement design and installation would be conducted by Keller North America, or a company with similar technical expertise and capabilities of Flathead County elects to proceed with the purchase of this property.

Keller North America's settlement estimate from liquefaction was 2.5 to 3.0 inches. Alpine estimated up to 5 to 6 inches of total settlement from liquefaction using a different (and less sophisticated) analysis method. We believe Keller's estimate is most likely more accurate, given their vast engineering capabilities and specialized expertise with modeling liquefaction and ground improvement design. However, using either analysis method, the estimated pretreatment settlement is excessive for commercial structures, and therefore ground improvement will be necessary. The estimated costs for ground improvement will be higher when higher pretreatment settlement estimates are used, because they require closer or deeper stone column spacing. For projected settlement of this magnitude one potential shallow foundation alternative that may be

feasible on this site is a rigid mat foundation. However, it will be critical to design a rigid mat foundation with as low of a contact pressure as possible, and provide a contact pressure that approximately equivalent to the overburden stress at the embedment depth. This is because of the size of the mat foundation; the depth of influence is very large and the soils are settlement prone under static loading as well as seismic loading. A rigid mat would need to be designed by a structural engineer and the feasibility of this design depends on numerous factors such as the interior layout and the spacing of the vertical loads across the building area and the more significant cost of this foundation relative to conventional construction. A rigid mat foundation would most likely need to be 18 to 30 inches thick and would be heavily reinforced with top and bottom reinforcement in both directions, for illustration purposes. Therefore, structural engineering and general contractor input would be required to consider this approach.

Seismic Site Classification

The project area is considered an area of moderate ground shaking potential. Mapping by the US Geological Survey for the project latitude and longitude indicates an estimated horizontal peak ground acceleration of 0.425g with a 98 percent probability of non-exceedance in a given 50-year period, which corresponds to a return period of 2,475 years. Because of the loose and potentially liquefiable sands, the following seismic site classification is appropriate:

Code Used	Site Classification
2021 International Building Code (IBC) [1]	F [2]

1. In general accordance with the *2021 International Building Code,* Section 1613.3.2, and ASCE 7-16 Table 20.3-1
2. The 2021 International Building Code and ASCE 7-16 require a site soil profile determination extending a depth of 100 feet for seismic site classification. Cone Penetrometer Testing extended to a maximum depth of 70 feet.

Following successful ground improvement and confirmation drilling, the site can be upgraded to a seismic site class E.

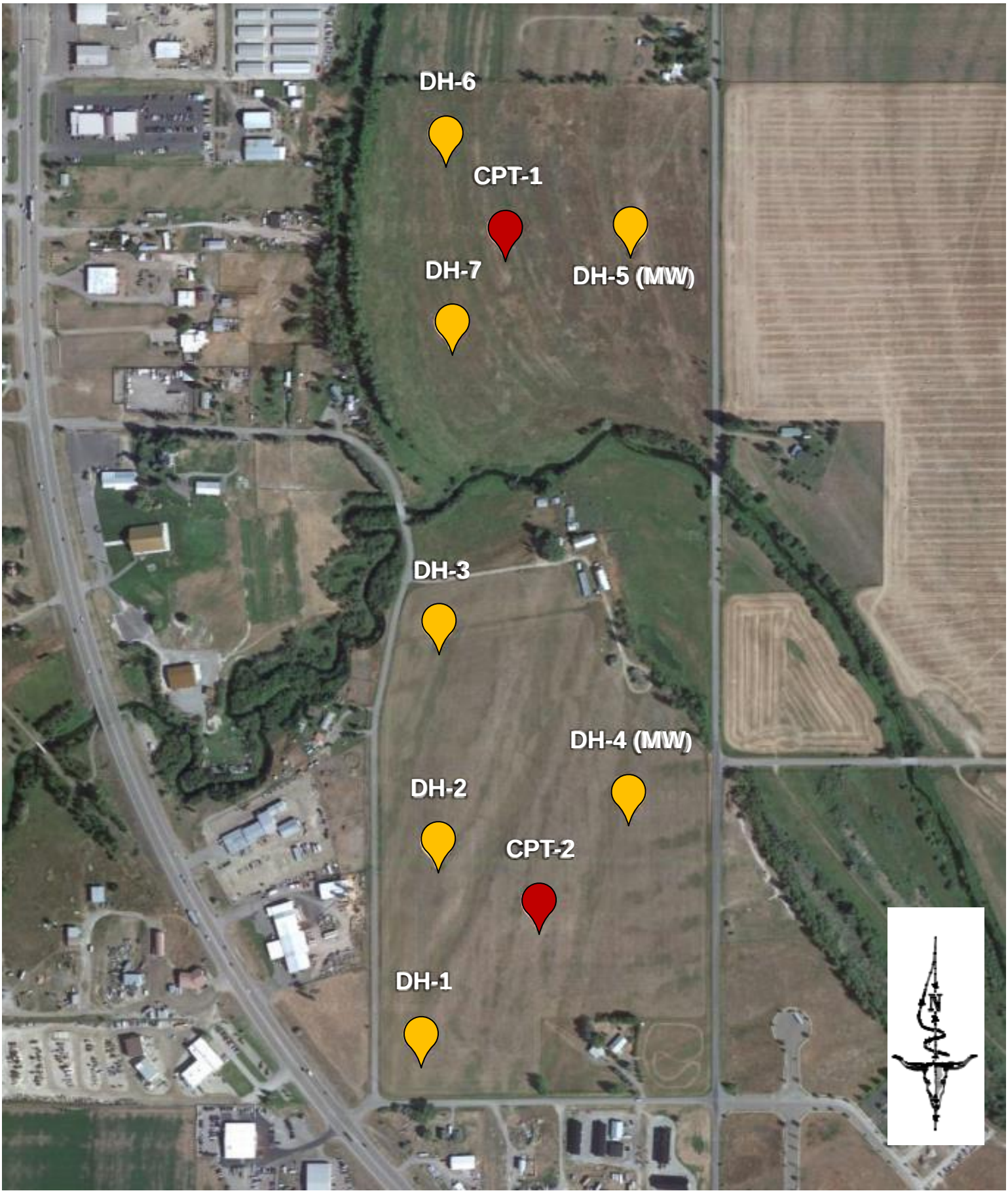
CLOSURE/LIMITATIONS

Alpine Geotechnical should be retained to provide a final geotechnical investigation following property purchase and prior to final design of buildings to provide comprehensive subsurface analysis and engineering recommendations. The analysis and recommendations presented in this report are based upon the limited data obtained from the borings and CPT's performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between boring or CPT locations, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until construction has commenced. If variations appear, Alpine should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. If changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Alpine Geotechnical reviews the changes and either verifies or modifies the conclusions of this report in writing.

ALPINE GEOTECHNICAL

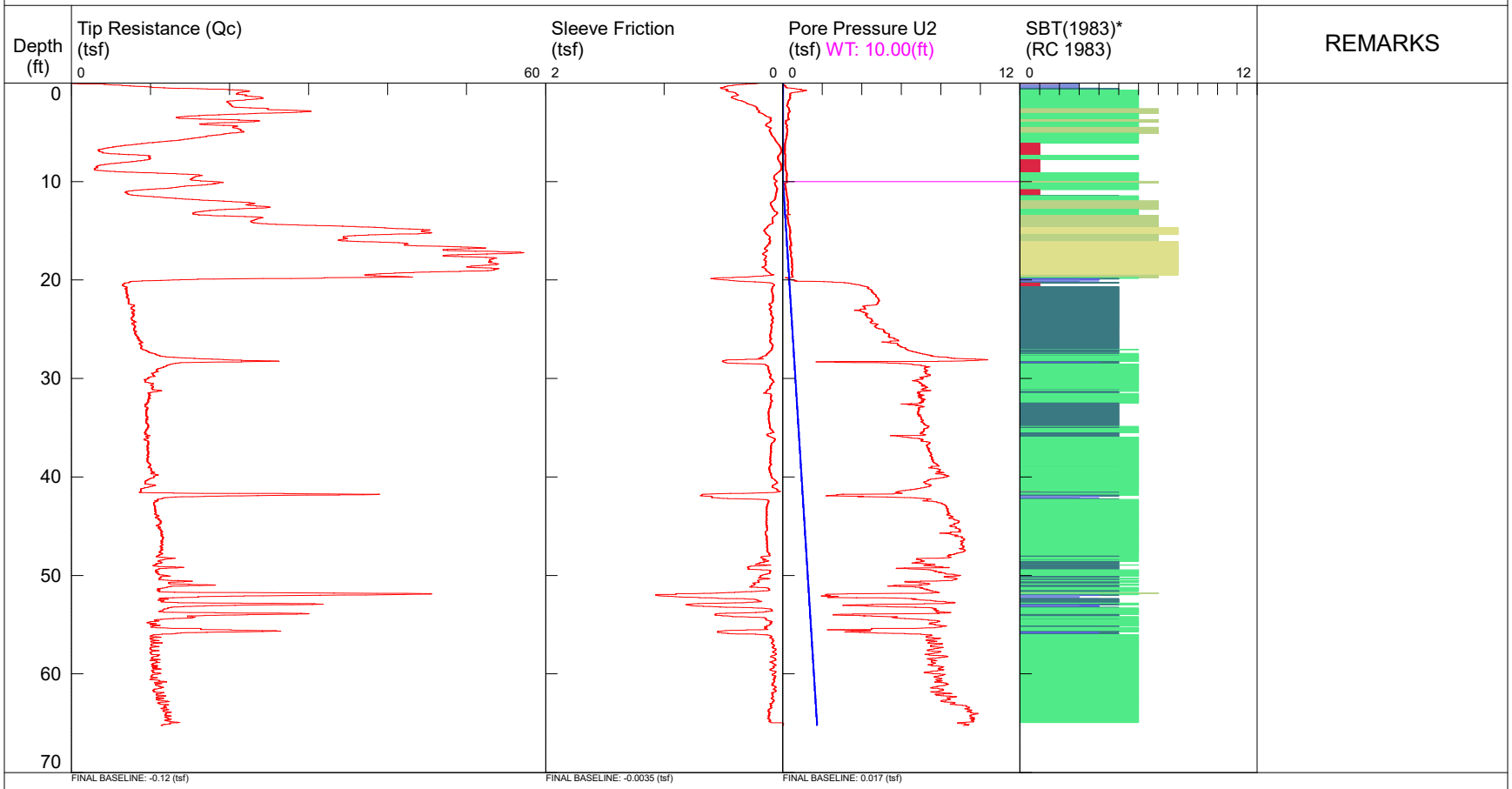
APPENDIX A



Project No.	23-966	ALPINE GEOTECHNICAL 120 Round Stone Drive Kalispell, MT 59901 PH. (406) 257-6479	**Exploration Location Plan**	**Exhibit**
Scale	NTS		225 Snowline Kalispell, Montana	A-1
Date	12-11-23			

SOUNDING

PROJECT: 225 Snowline Lane
TOTAL DEPTH: 65.240 ft
COMPANY: Alpine Geotechnical
TEST ID: CPT 1
TEST DATE: Tue 14/Nov/2023



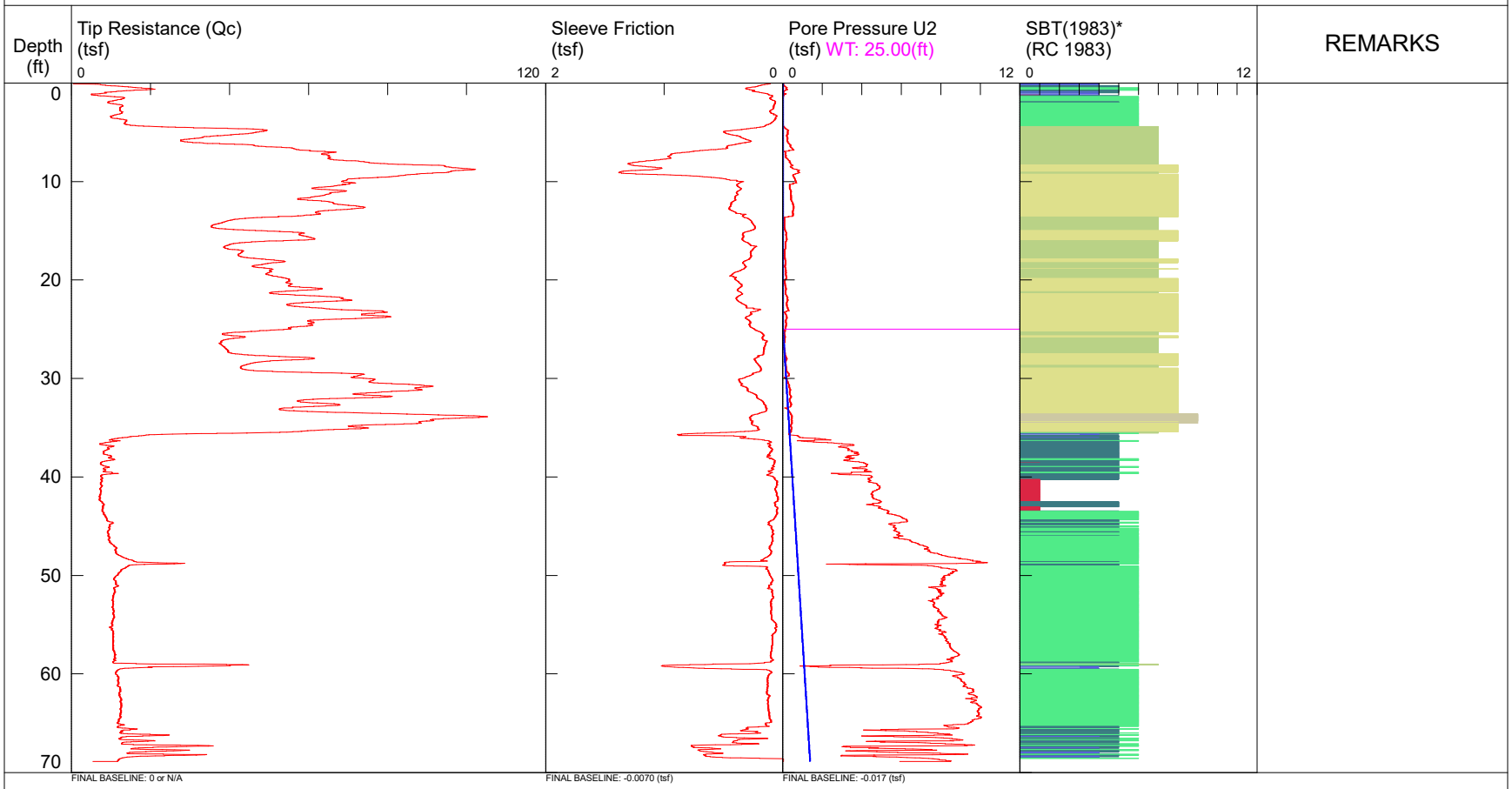
NOTES:: Example of notes

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

SOUNDING

PROJECT: 225 Snowline Lane
TOTAL DEPTH: 68.881 ft
COMPANY: Alpine Geotechnical
TEST ID: CPT 2
TEST DATE: Tue 14/Nov/2023



NOTES:: Example of notes

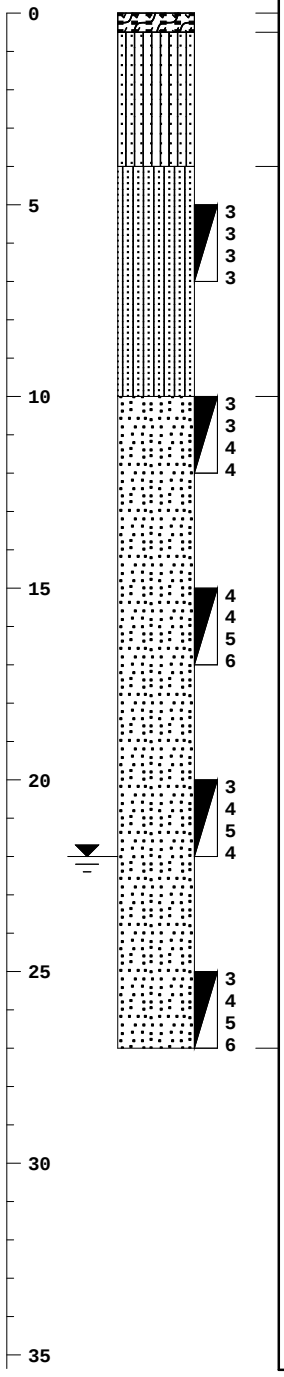
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

LOG OF BORING
NO.: DH-1

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.143260, -114.281612
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 22.0' At Completion ▼: 22.0'

Project No.: 23-966
Date: 12-08-23
Elevation: Existing
Logged By: Cliff Clark



ELEVATION/ DEPTH	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	N	CURVE 10 30 50
	OL	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 6" thick					
	ML	SILT with sand, brown, moist, medium stiff					
	SM	Silty SAND, brown, moist, loose	5		5'-7'	6	
	SP	Poorly graded SAND, brown, moist to wet, loose	2		10'-12'	7	
		With rust colored mottling below 15.0'	3		15'-17'	9	
			6		20'-22'	9	
			26		25'-27'	9	
		Color change to grey below 26.0'					
		End of Boring DH-1 at 27.0'					

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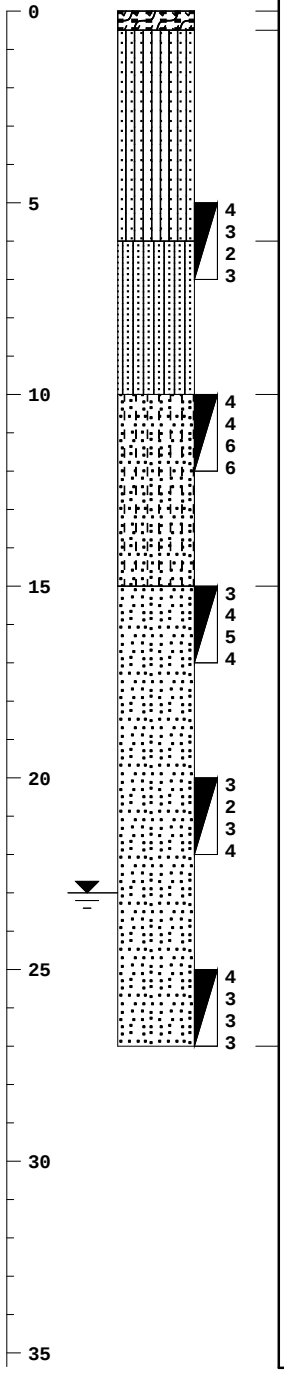
LOG OF BORING
NO.: DH-2

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.145269, -114.281386
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 23.0' At Completion ▼: 23.0'

Project No.: 23-966
Date: 12-08-23
Elevation: Existing
Logged By: Cliff Clark



ELEVATION/ DEPTH	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N
	OL	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 6" thick				
	ML	SILT with sand, brown, moist, medium stiff	9		5'-7'	5
	SM	Silty SAND, brown, moist, loose				
	SP-SM	Poorly graded SAND with silt, brown, moist, loose	3		10'-12'	10
	SP	Poorly graded SAND, brown, moist to wet, loose With rust colored mottling below 16.0'	7		15'-17'	9
			5		20'-22'	5
			27		25'-27'	6
		End of Boring DH-2 at 27.0'				

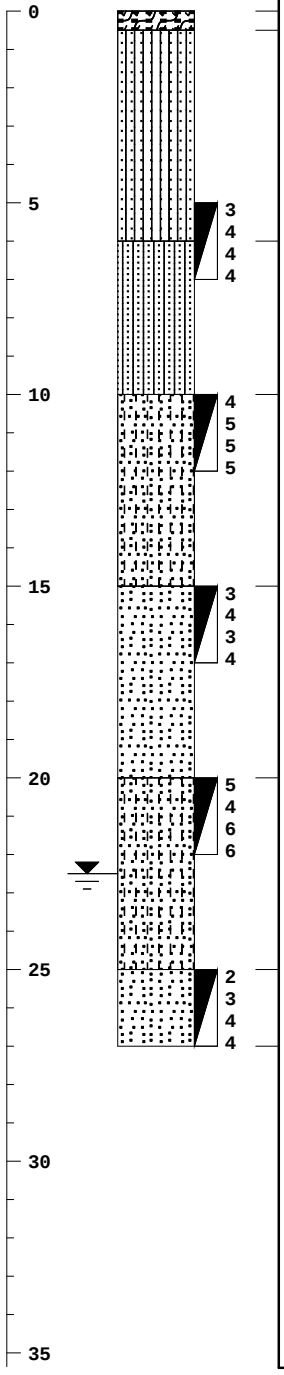
STANDARD PENETRATION TEST CURVE: 10 30 50

ALPINE GEOTECHNICAL

LOG OF BORING
NO.: DH-3

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.147599, -114.281347
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 22.5' At Completion ▼: 22.5'

Project No.: 23-966
Date: 12-08-23
Elevation: Existing
Logged By: Cliff Clark



ELEVATION/ DEPTH	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N	STANDARD PENETRATION TEST CURVE
	OL ML	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 6" thick SILT with sand, brown, moist, medium stiff					
5			6		5'-7'	8	
	SM	Silty SAND, brown, moist, loose					
10	SP-SM	Poorly graded SAND with silt, brown, moist, medium dense	7		10'-12'	10	
15	SP	Poorly graded SAND, brown, moist, loose	2		15'-17'	7	
20	SP-SM	Poorly graded SAND with silt, brown, moist to wet, medium dense	4		20'-22'	10	
25	SP	Poorly graded SAND, brown, wet, loose	28		25'-27'	7	
		End of Boring DH-3 at 27.0'					

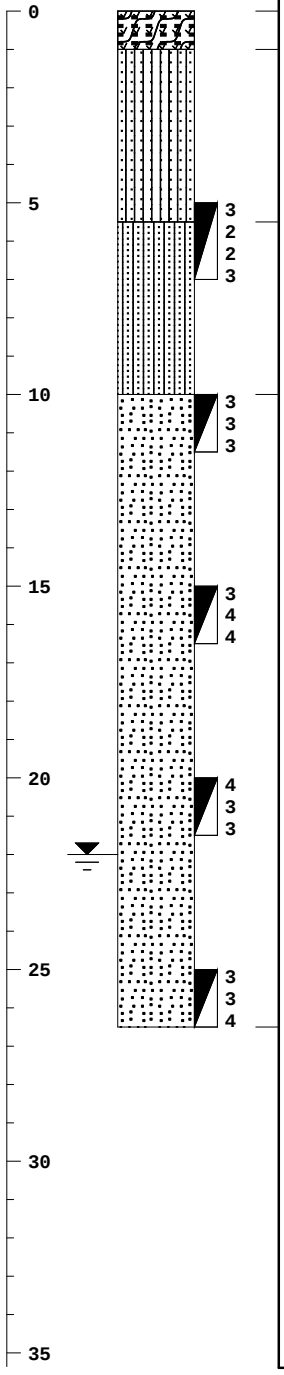
CURVE scale: 10 30 50

ALPINE GEOTECHNICAL

LOG OF BORING
NO.: DH-4

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.145794, -114.278295
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 22.0' At Completion ▼: 22.0'

Project No.: 23-966
Date: 12-11-23
Elevation: Existing
Logged By: Cliff Clark

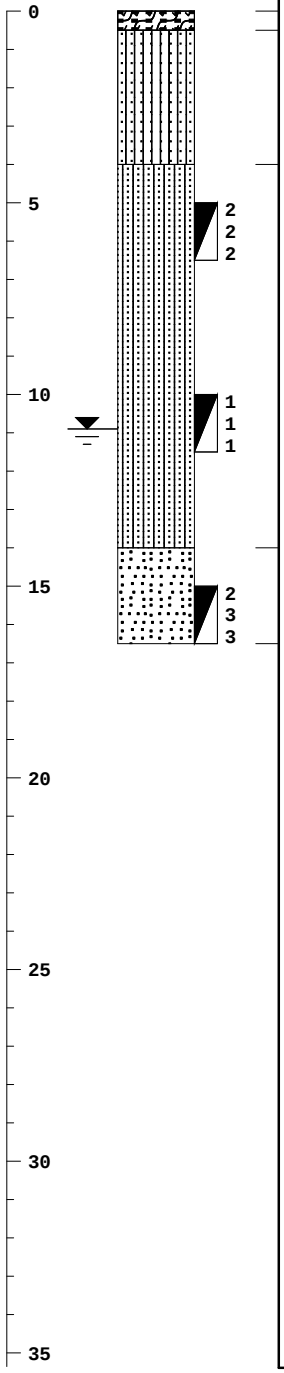


ELEVATION/ DEPTH	SOIL SYMBOLS, SAMPLERS AND TEST DATA	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N	STANDARD PENETRATION TEST CURVE
		OL	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 12" thick					10 30 50
		ML	Sandy SILT, brown, moist, medium stiff					
5	3 2 2 3	SM	Silty SAND, brown, moist, loose	7		5'-7'	4	
10	3 3 3	SP	Poorly graded SAND, brown, moist to wet, loose	3		10'-11'6"	6	
15	3 4 4			3		15'-16'6"	8	
20	4 3 3			6		20'-21'6"	6	
25	3 3 4			28		25'-26'6"	7	
			End of Boring DH-4 at 26.5'					

LOG OF BORING
NO.: DH-5

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.151790, -114.278276
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 10.9' At Completion ▼: 10.9'

Project No.: 23-966
Date: 12-11-23
Elevation: Existing
Logged By: Cliff Clark



USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	N
OL	Organic SILT topsoil with surficial grass, dark brown, moist, stiff, 6" thick				
ML	Sandy SILT, brown, moist, medium stiff				
SM	Silty SAND, brown, moist to wet, loose to very loose	4		5'-6'6"	4
	Wet with some interbedded rapid dilatant silt below 10.0'	32		10'-11'6"	2
SP	Poorly graded SAND, brown, wet, loose	31		15'-16'6"	6
	End of Boring DH-5 at 16.5'				

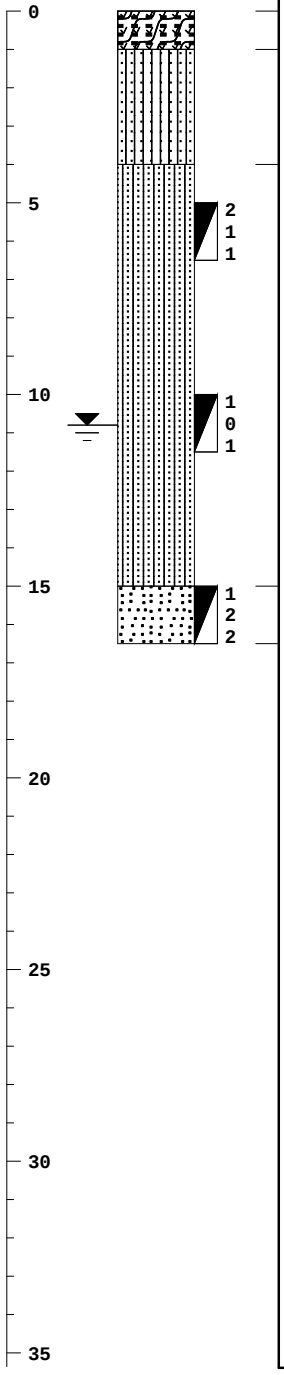
STANDARD PENETRATION TEST CURVE: 10 30 50

ALPINE GEOTECHNICAL

LOG OF BORING
NO.: DH-6

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.152754, -114.281205
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 10.8' At Completion ▼: 10.8'

Project No.: 23-966
Date: 12-11-23
Elevation: Existing
Logged By: Cliff Clark



ELEVATION/ DEPTH	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N
	OL	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 12" thick				
	ML	SILT with sand, brown, moist, medium soft				
	SM	Silty SAND, brown, moist, very loose	9		5'-6'6"	2
		Wet with some interbedded rapid dilatant silt with sand below 10.0'	36		10'-11'6"	1
	SP	Poorly graded SAND, brown, wet, loose	35		15'-16'6"	4
		End of Boring DH-6 at 16.5'				

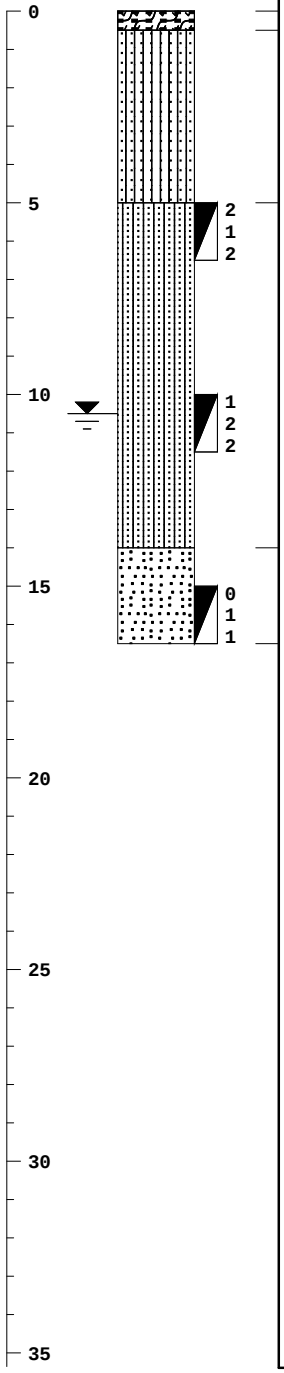
STANDARD PENETRATION TEST CURVE: 10 30 50

ALPINE GEOTECHNICAL

LOG OF BORING
NO.: DH-7

Project: 255 Snowline Lane
Client: Flathead County Commissioners Office
Location: See exploration location map: 48.150800, -114.281124
Driller: Alpine Geotechnical
Drill Rig: Diedrich D50
Depth to Water> Initial ▽: 10.5' At Completion ▽: 10.5'

Project No.: 23-966
Date: 12-11-23
Elevation: Existing
Logged By: Cliff Clark



ELEVATION/ DEPTH	USCS	Description	NM	DD	STANDARD PENETRATION TEST DEPTH	N
	OL	Organic SILT topsoil with surficial grass, dark brown, moist, soft, 6" thick				
	ML	Sandy SILT, brown, moist, soft				
5	SM	Silty SAND, brown, moist to wet, very loose to loose	12		5'-6'6"	3
10		Wet with some interbedded rapid dilatant silt below 10.0'	33		10'-11'6"	4
15	SP	Poorly graded SAND, grey/brown, wet, very loose	35		15'-16'6"	2
		End of Boring DH-7 at 16.5'				

STANDARD PENETRATION TEST CURVE
10 30 50

ALPINE GEOTECHNICAL

Pre- and Predicted Post-Stone Column Liquefaction Analysis

Project: Project Name

Pre-CPT Name: CPT-03 Surface Elev.: 0.0 ft (use 0 ft to plot depth instead of elevation)

by:

Date:

LIQUEFACTION ANALYSIS PARAMETERS

Triggering Method =	Boulanger & Idriss (2015)	
Vol. Settlement Method =	Zhang et al. (2002)	
Depth of GW During CPT =	22.00	ft
Depth of GW During Earthquake =	22.00	ft
Depth of Fill =	0.00	ft
Unit Weight of Fill =	120	pcf
PGApre =	0.35	g
Mw =	6.00	
Ic Threshhold =	2.6	
Use Kσ ? =	Yes	

Depth Weighting Factor

Use Df? Yes

z (ft)	Df
0	1
60	0
60.01	0
200	0

ADVANCED LIQUEFACTION PARAMETERS

Use Ic Transition Zones?	Yes - Method 2	Manual Trans Zones?	Yes
		Use Manual Thin Layer Cor.?	Yes
		Cyclic Softening Calc?	No
No. Trans. Zone Points:	4	Zhang et al. (2004) Lat. Sprd?	No
Ic_min and max =	1.6 3		

Perform Ground Improvement Analysis?: Stone Columns

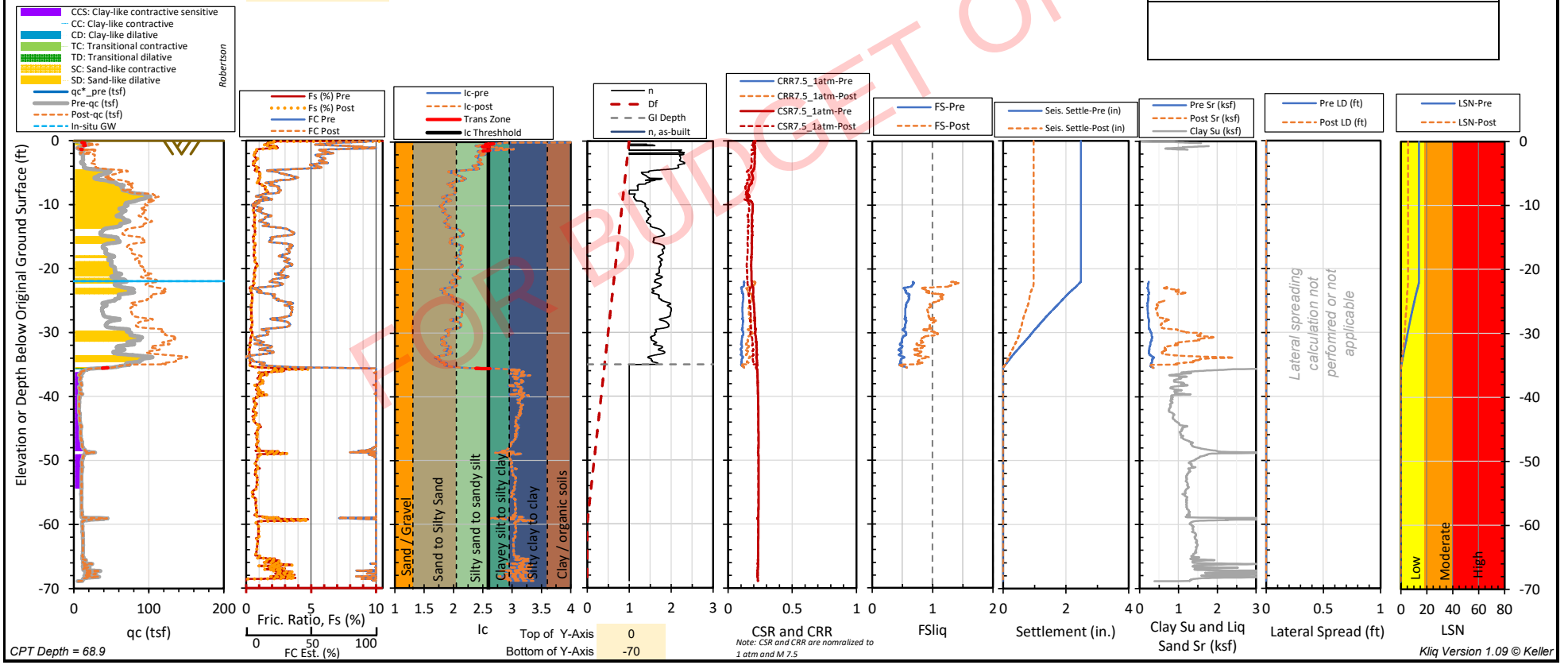
STONE COLUMN DESIGN PARAMETERS

Depth Below Existing Grade =	35	ft
Stone Column Diameter, D =	30	inch
Stone Column Spacing, S =	8	ft
Square or Triangular Layout =	Square	
ARR =	7.7	%
HBI Baez Scaling Factor (BSF):	Single	0.35
Post Ic Shift:	Use Pre	
Gr =	6	
Rrd = PGApost/PGApre =	0.949	
PGApost in Impr. Zone =	0.332	g

Volumetric Settlement Results:

Existing (Pre-Treatment) Condition = 2.5 in.

Post-Improvement Condition = 1.0 in.

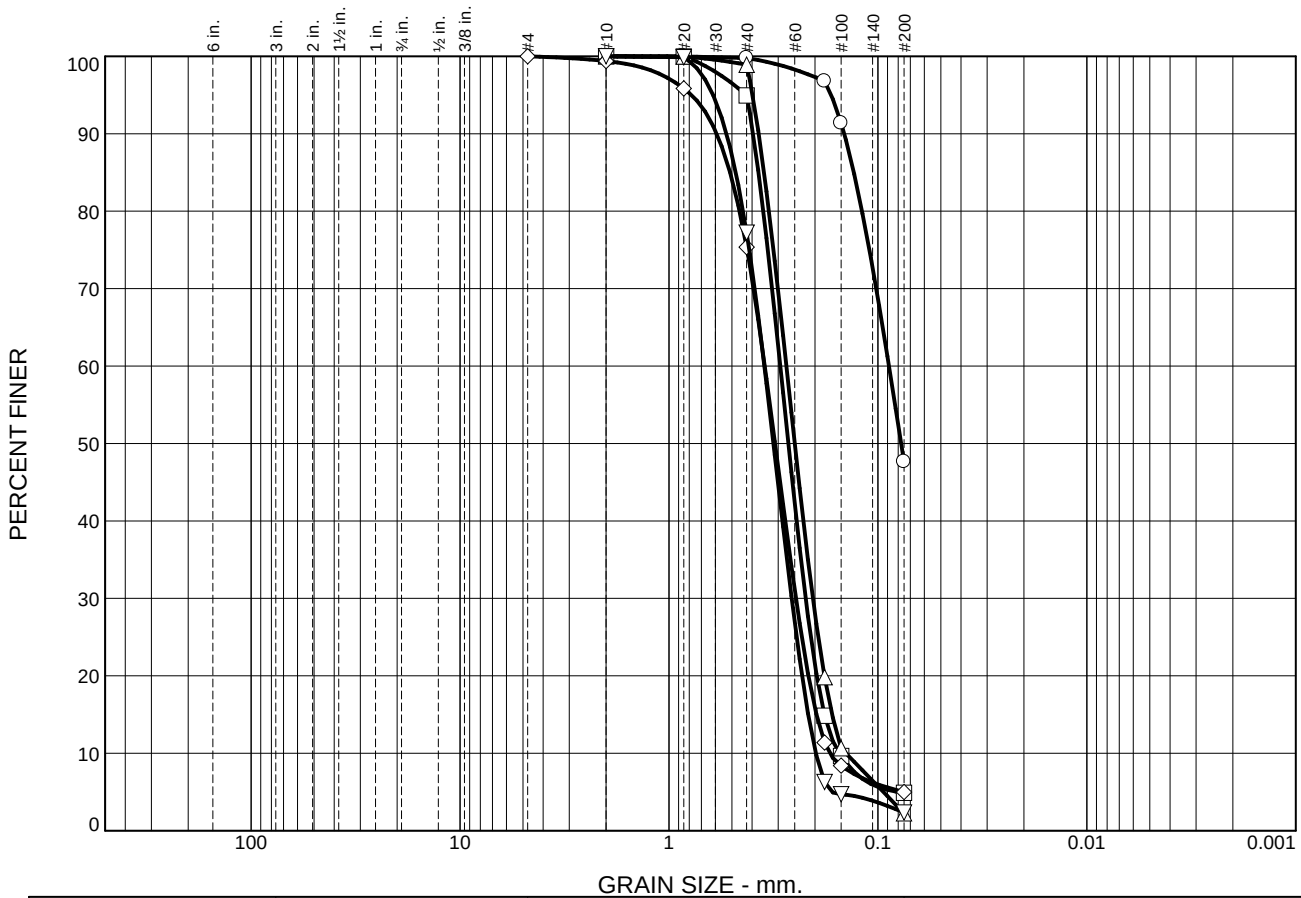


CPT Depth = 68.9

ALPINE GEOTECHNICAL

APPENDIX B

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	0	0	52	48	
□	0	0	0	0	5	90	5	
△	0	0	0	0	1	97	2	
◇	0	0	0	1	24	70	5	
▽	0	0	0	0	23	75	2	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	DH-1	9057	5.0	Silty SAND	SM
□	DH-1	9058	10.0	Poorly graded SAND	SP
△	DH-2	9064	15.0	Poorly graded SAND	SP
◇	DH-3	9070	20.0	Poorly graded SAND with silt	SP-SM
▽	DH-4	9076	25.0	Poorly graded SAND	SP

ALPINE GEOTECHNICAL

Client: Flathead County Commissioners Office

Project: 255 Snowline Lane

Project No.: 23-966 **Figure** B-1

ALPINE GEOTECHNICAL

APPENDIX C

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

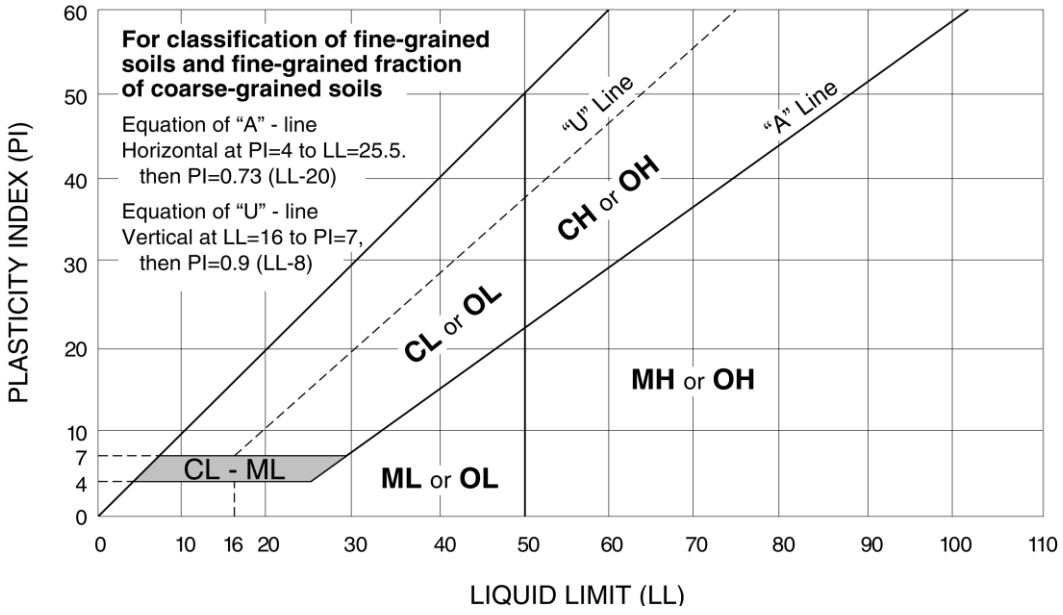
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 - 15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30