

CHILKOOT GEOLOGICAL ENGINEERS LTD.

Box 31146, Whitehorse, Yukon Y1A 5P7
chilkoot@northwestel.net (867) 335-5804 c



**Geotechnical Reconnaissance
Lot 1191 Henderson Corner (2014-0027 LTO)
Dawson City, Yukon – 2016**



Prepared For: Yukon Government – Energy, Mines & Resources
Date : August 17, 2016



TABLE OF CONTENTS

Geotechnical Reconnaissance Lot 1191 Henderson Corner (2014-0027 LTO) Dawson City, Yukon – 2016

SECTION	PAGE
1.0 INTRODUCTION	1
2.0 METHODOLOGY	2
2.1 Literature Review	2
2.2 Field Work Program	4
2.3 Laboratory Work Program	6
3.0 SITE CONDITIONS	7
3.1 General	7
3.2 Topography	7
3.3 Surface Drainage	8
3.4 Vegetation	8
3.5 Subsurface Conditions	9
4.0 DISCUSSIONS	11
5.0 RECOMMENDATIONS	12
6.0 CONCLUSIONS	15
7.0 LIMITATIONS	16
8.0 CLOSURE	17

APPENDICES

FIGURE 1	-	Site Location
FIGURE 2	-	Sampling Locations
FIGURE 3	-	Surficial Geology
FIGURE 4	-	Residential Development Feasibility
TABLE I	-	Stratigraphic Summary
APPENDIX A	-	Selection of Air Photos
APPENDIX B	-	Selection of Photos



1.0 INTRODUCTION

Chilkoot Geological Engineers Ltd. was retained by *Yukon Government (YG) - Energy Mines and Resources* to conduct a geotechnical reconnaissance of Lot 1191, Quad 116B/03 (2014-0027 LTO - 102863 CLSR) located at Henderson Corner near Dawson City, Yukon. The site is located approximately 23 km south of Dawson City on Klondike Highway #2, as noted in Figure 1.

The purpose of the reconnaissance was to assess the site conditions to determine the lots overall development feasibility from a geotechnical perspective. The intent was to delineate regions of the lot which would allow for residential development as a peat bog was noted on the southern half of the site during previous studies.

The geotechnical reconnaissance was conducted further to a Phase I Environmental Site Assessment (ESA) which was conducted by our firm in the summer of 2015.

Authorization to proceed was granted on July 4th, 2016 by *YG - Energy, Mines and Resources - Lands Management Branch - Program Manager, Mr.K.Fisher*. The field work was conducted on July 19th and 20th, 2016 in accordance with our May 30th, 2016 proposal.

A detailed description of our methodology and the findings of our reconnaissance have been provided below.



2.0 METHODOLOGY

Our work methodology was comprised of a literature review as well as field and laboratory work programs.

2.1 Literature Review

A literature review was conducted prior to the field work program to re-familiarize ourselves with the site conditions.

This involved a review of;

- a Phase I ESA report compiled by our firm entitled Phase I ESA - Lot 1191 – Henderson Corner (2014-0027 LTO), Dawson City, Yukon dated August 15th, 2015,
- YG – EMR library air photos,
- a surficial geology map entitled Surficial Geology, Dawson Region, Yukon (Open File 2014-12) by K.McKenna and P.Lipovsky,
- bedrock geology maps, and
- topographical resources.

Each of these resources has been summarized as follows;

Phase I Environmental Site Assessment

The Phase I ESA report was conducted by our firm to assess whether historical or current site usage involved the storage, use or disposal of hazardous substances on the subject property. The Phase I ESA provided a description of the site and regional conditions and assessed the potential that these activities (or those identified on adjacent properties), may have generated recognized environmental concerns such as contamination of the soil, sediment, soil vapor and/or groundwater.



In brief, the report indicated that there were no apparent on-site environmental conditions which would pose a concern beyond miscellaneous debris related to a squatter who was situated on the fill located in the north-west corner of the property (as noted in Figure 2). Historical or current site usage did not appear to involve the storage, use or disposal of hazardous substances on the subject property beyond incidental items associated with the squatter.

Air Photos

A selection of aerial photographs dating back to 1960 were reviewed to assess the terrain and regional conditions.

The 1960 and 1977 air photos noted that the site and much of the surrounding area was generally void of trees. A centrally located granular region traversing the site (east-west) can be seen as evidenced by the lighter colored band in the 1977 air photo.

A terrain analysis of the air photos suggests that the region is comprised of glaciofluvial deposits which are overlain by more recent sediments derived from the Klondike River. Many of the nearby properties which have been developed west of the subject property are situated on these deposits.

A selection of the air photos which were reviewed has been enclosed in Appendix A.

Surficial Geology

The (1:25,000 scale) surficial geology map described the soils in the area of the site as being comprised of silty, fluvial veneer that overlies more than 50% of



the map unit with terraced sand and gravel glaciofluvial and morainal (till) deposits where permafrost is prevalent (zFv\sgFGtM-X).

Bedrock Geology

Geology, Ogilvie, Map 711A, by H.Bostock, 1942 *Scale 1:253,440*

Bedrock Geology, YT, G.S.C. Open File 3754, 2001 *Scale 1:1,000,000*

The bedrock maps suggest the region is underlain by green schist to lower amphibolite facis metamorphic rocks of the Yukon-Tanana Terrane.

Topographical Resources

The following topographical maps were reviewed to aid in assessment of the regional topography;

116 B/3 Dawson *Scale 1:50,000*

Yukon Water Placer Atlas

A portion of the *Yukon Water Placer Atlas* which illustrates the regional contour elevations has been included in Figure 1. The maps note that the site lies within a region of relatively low relief within the limits of the Klondike River floodplain. Regionally, higher elevations lie to the south.

2.2 Field Work Program

The field work program was comprised of a site reconnaissance and sampling program.

Site Reconnaissance

A site reconnaissance was conducted on July 19th and 20th to note the field conditions and geological features at the subject property. During this time our observations were documented through a combination of field notes, GPS waypoints and photographs to



note geotechnical points of interest. Our observations have been summarized in Section 3.0, below.

Sampling Program

As access to the site through mechanical means would prove difficult given the vegetation, the sampling program was conducted through hand excavation methodologies. This involved the retention of near surface (< 1.0 meters) soil samples from eight (8) sampling locations (A1 through A8) in order to better characterize the subsurface conditions.

The approximate locations of the sampling locations have been attached as Figure 2.

In general, two soil samples were retained from each sampling location. The first of the two samples was obtained through the use of a shovel from depths of approximately 0.1 to 0.2 meters. The second sample (at each of the sampling locations) was obtained following hand auger advancement from (generally) the bottom (0.1 meters) of the respective sampling locations.

A total of fifteen (15) soil samples were retained during the sampling program. Once retained, they were described on field soil logs and then sealed in air-tight plastic bags in order to allow for laboratory analysis as described in Section 2.3, below.

The depth of auger advancement varied between 0.35 and 0.80 meters. On average, the auger holes were terminated at 0.51 meters due to refusal. The refusal was due to the presence of encountering either a dense granular stratum (in A1, A3 and A5) or else frozen soils (at all other locations).



Soil Logs

During sampling, field soil logs were maintained by the undersigned. This information was utilized along with the laboratory data to compile the Stratigraphic Summary which has been enclosed in Table I.

Photographs

Photos were taken during the work to document the field work program, laboratory soils samples and site conditions.

A selection of these photos have been provided in Appendix B.

2.3 Laboratory Work Program

A laboratory work program was conducted between August 2nd and 12th, 2016 at our Whitehorse laboratory facilities in order to characterize the index properties and conditions of the retained soil samples.

The analysis was comprised of natural moisture content determination and visual laboratory classification of all fifteen (15) retained soil samples. The moisture content analysis was conducted in accordance with ASTM D 2216-92.

Grain size distribution analysis was also conducted on four (4) of the samples (in accordance with ASTM D 422-633) in order to classify the soil utilizing the *Unified Soils Classification System*. A description of the '*Unified Soil Classification System*' has been included in Table I for reference purposes.

The results of the analysis (with the percent of moisture content, fines (silt & clay), sand and gravel by weight) have been presented on the Stratigraphic Summary enclosed in Table I.



3.0 SITE CONDITIONS

3.1 General

The lot is located at Henderson Corner, approximately 23 km south of Dawson City, Yukon on Klondike Highway # 2 as noted in Figure 1. This region has been associated with both historical and more recent agricultural activities. The subject property itself is comprised of historically disturbed land which is currently vacant.

The subject property is approximately $2.478 \pm$ ha in size and is approximately square (154 m by 157 m) in shape.

Access to the sites northwest corner is via a trail which leads from the Klondike Highway # 2 (~ km 690.5 LHS).

3.2 Topography

Variations in the elevations on the subject property are in the order of 2 meters. The higher elevations are concentrated on a central (granular) band which traverses the site from east to west as noted on Figure 2 (yellow outline). This band is approximately 25 meters in width. The bog located south of this region is approximately one meter lower in elevation (excluding local hummocky depressions of up to 0.5 meters). North of the central granular region, although undulating, the local terrain lies in the order of 2 meters below that of the granular region and would be considered low lying.



3.3 Surface Drainage

Although the surface drainage is poorly defined, surface waters would generally flow either towards the north or the south from the central (granular) region where locally higher elevations are present.

Standing water is prevalent throughout the hummocky bog region located in the southern half of the subject property. A drainage ditch is located on/adjacent to the western side of the property. The drainage within the ditch flows to the north until it is blocked by fill located near the northwest corner of the site (as noted in Figure 2).

Portions of the low lying region (located north of the central granular region) may be susceptible to flood events resulting from the Klondike River and spring thaw.

Regionally the surface drainage flows towards the Klondike River located to the north.

3.4 Vegetation

The vegetation varied. The northern half of the lot was treed with a combination of spruce, poplar and willow. The spruce trees were concentrated on a central (granular) band which traversed the lot east-west. The southern half of the site, in the region of the bog, was generally void of trees with the exception of the odd black spruce tree which exhibited stunted growth. Moss and sedges were prevalent throughout the bog area.

Historically, the site and much of the valley region were void of trees as noted in the 1960 and 1977 air photos. These trees would likely have been removed since the time of the Gold Rush to help fuel Dawson. The lack of tree cover would have helped to



promote thaw of the exposed soils in these areas. The depth of thaw would have varied depending upon site specific factors such as the thickness of the organic mat.

3.5 Subsurface Conditions

Stratigraphy

Detailed descriptions of the soil stratigraphy that was encountered have been provided in the Stratigraphic Summary enclosed as Table I.

The soil conditions varied between the three distinct geomorphic regions. The central regions (delineated by the yellow outline in Figure 2 & 4), were comprised of poorly graded sands and sandy gravels which were overlain by approximately 0.2 meters of organics and organic silts. The auger holes advanced in the bog (just south of the central region) noted thicker (0.3 m) organic deposits which overlay frozen ice-rich organic silts and silts. The northern third of the lot was comprised of a 0.2 meter thick layer of organics and organic silt which overlay sandy silts and silty sands. These deposits were noted to be frozen at depths of approximately 0.7 meters.

The grain size distribution analysis conducted on two of the soil samples retained from the granular region classified the material as a gravelly sand (SP) and a gravel with some sand and trace silt (GP). The grain size distribution analysis conducted on a sample retained from the bog classified the material as a silt with some sand (ML). The laboratory analysis of a sample retained from the northern region classified the material as a silty sand (SM).

Stripping Piles

A series of stripping piles were observed along the northern periphery of the granular region as noted in Figure 2. These piles are likely remnants from clearing/stripping operations conducted during construction of the Klondike Highway.



Permafrost

Frozen soils were encountered in five (5) of the eight (8) sampling locations.

The frozen soils were classified in accordance with the '*Classification for Frozen Soils (adapted by Linnell and Kaplar, 1966)*', as either Nbe (well bonded with excess ice) in the southern region of the bog, or else Nbn (well bonded with no visible ice) in the region north of the granular limits. The moisture contents of the frozen soils varied from 25.2 to 256.0 % by weight.

A copy of the classification system utilized for frozen soils has been attached in Table I.

Although the three (3) auger holes advanced within the central (granular) portions of the site encountered thawed soils, permafrost may underlie these soils at depth given its prevalence throughout the site.

Groundwater

The depth to groundwater is unknown. Groundwater flow would likely be to the north-west, towards the Klondike River.



4.0 DISCUSSIONS

Relative to residential development feasibility, there are three distinct regions located within the subject property as noted in Figure 4.

These regions are comprised of;

- a central granular region where residential development would be considered favorable,
- a low lying area (located north of a central granular region), where residential development feasibility would be considered less favorable, and
- a peat bog which is unsuitable for residential development.

The central granular region (which will be suitable to allow for residential development) is in the order of 25 meters wide (\pm) and appears to span the entire width of the property (east-west). While a small region of this granular material may extend north into the low lying region, this (north-south) zone should be considered less favorable for development as it is thinner and may be discontinuous. Additional evaluation would be required to determine whether or not the granular soils will be suitable to allow for construction of a septic field as they may be frozen at depth. The use of a septic holding tank should be anticipated.

Development in the low lying region to the north would be considered less favorable as additional site development would be required (relative to residential development on the central granular region), in order to accommodate the low lying topography, poor drainage and shallow fine grained and frozen nature of the subsoils.

Although the peat bog is considered unsuitable for residential development, it may prove suitable for agricultural purposes if drainage is established and the materials are allowed to thaw. The overlying insulating organics would need to be removed in order to promote thaw of the underlying materials.



5.0 RECOMMENDATIONS

Geotechnical Evaluation

A site specific geotechnical evaluation should be conducted to verify the conditions at any proposed building, road and septic field location prior to design and construction.

Building Foundations

All building structures should be supported by a cribbing and ventilated crawlspace foundation system founded upon an approved granular base.

While the structure and configuration of the granular base will vary, it should in general be comprised of a 1.8 meter thick granular pad constructed upon a geotextile filter fabric placed above the organic mat. The thickness of the granular pad could be decreased in the central granular region depending upon the depth of thaw of the underlying granular soils.

The use of slab-on-grade and/or footing types of foundation systems should not be utilized unless further geotechnical evaluation verifies thawed soils are located within the zone of building load and thermal influence as determined by qualified geotechnical personnel.

Building (and road) elevations in the low lying region would need to be carefully considered to ensure they are not impacted by potential flood events.

Septic System

As permafrost is prevalent throughout the site, septic systems should incorporate a holding tank unless geotechnical findings note the presence of soils which will be suitable for use as accepting soils. Consideration could also be given to importing soils to allow for the construction of a septic field.



Permafrost Disturbance

Care should be taken during clearing operations so as not to disturb the organic mat in regions where roads and buildings are to be constructed. If the insulating organic mat is disturbed in sensitive regions, it should be replaced with an equivalent level of (SM Styrofoam) insulation so as not to disturb the thermal regime. The removal of trees will promote undesirable thaw as shade (and organic mat thickness) will be decreased and so their removal should be carefully considered.

Roads

As the underlying permafrost is sensitive to disturbance, the overlying organic mat should not be disturbed during road construction.

Roads should be constructed upon a minimum of 300 mm of pit run placed on geotextile fabric. As the underlying thermal regime will be disturbed following construction, it may take several years for the road surface to stabilize. Additional granular fill should be utilized to assist in long-term stabilization if disturbance is severe or if the access roads cross the low lying region located north of the central granular region. Once the road has stabilized, it should be capped with 100 mm of 20 mm minus crushed surfacing aggregate.

If possible, access roads to the central granular region should avoid the northern low lying regions. Road construction through the peat bog will not be feasible without the use of significant amounts of geotextile fabric and granular road base and thus should be avoided.

Culvert(s)

A culvert should be installed at the location where the ditch (or local drainage) is blocked and at any other proposed access to the site, to allow for proper regional and site drainage.



Agricultural Assessment

While nearby farming suggests that the glaciofluvial deposits will be suitable for agricultural use, an agricultural assessment would be beneficial to better characterize the organic rich soils. If deemed suitable for agricultural use, the organic mat (which acts as an insulator to the permafrost) should be systematically removed from regions in the bog in order to allow for thaw of the underlying frozen organic rich soils. A series of drainage ditches should be incorporated into the thaw design so as to allow for drainage of the local and regional soils.



6.0 CONCLUSIONS

The soil conditions encountered within central (granular) portions of the lot will allow for construction of a granular pad upon which a residential structure(s) can be constructed utilizing a (PWF) cribbing and ventilated crawlspace foundation system prepared in accordance with the recommendations provided herein.

Structures built upon cribbing foundations are inherently more susceptible to seismic action and so this should be considered during design and construction. Long-term maintenance through periodic re-levelling will be required throughout the life of any structure to accommodate movements caused by fluctuations in the underlying soil volumes as well as thermal and groundwater regimes.

Development within the low lying area located north of the granular region should be carefully considered as this area may be prone to flood events given the local elevations and as frozen fine grained soils are present.

The peat bog located in the southern half of the site will not be suitable for residential (or any) building construction but could be cleared to allow for long-term use of the area for potential agricultural purposes. A drainage system should be incorporated into any plan to thaw these soils which may take in the order of 10 years or more. The actual time it may take for these soils to adequately thaw and become suitable for agricultural use will vary depending upon a number of climate, development and site specific factors.

Erosion control measures will need to be incorporated into any regions where the organic mat is disturbed. A culvert should be installed in the western ditch (and potentially other areas) to promote regional and site drainage.



7.0 LIMITATIONS

This report is intended for the sole use of the *Yukon Government*. No portion of this report may be used as a separate entity; it is intended to be read in its entirety. Any use of this report by a third party is the responsibility of such third party.

It is important to emphasize our reconnaissance was preliminary in nature and was based in part on a random sampling of the subject property. Our recommendations are based upon the subsurface conditions which were encountered at the time of our reconnaissance, current construction techniques and generally accepted engineering practices. Our recommendations have been provided without consideration to the effects of deep and long-term thaw of local and/or regional permafrost which may stem from global warming, new construction/structures or other causes. The content within this report reflects our best judgment in light of the information available to our firm at the time of report preparation. Due to the geomorphological nature of the deposits encountered, interpolations of subsurface conditions between the sample (and other) locations on the site have not been made or been implied. The conditions at this site are dynamic and thus the subsurface conditions will vary or change over time.

The anticipated development conditions have been discussed, but only to the extent that they may influence design decisions. Any references to construction methods contained herein, express our opinion and are not intended to direct contractors on how to carry out construction. Prospective contractors should be aware that the data presented may not be sufficient to assess all factors that may have an effect upon construction.

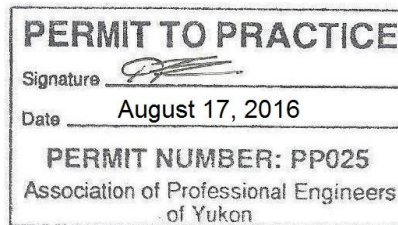
Should unexpected conditions be encountered during construction, our firm should be notified forthwith in order to confirm the suitability of our recommendations. If required, our firm may alter or modify our recommendations at such time.

8.0 CLOSURE

Thank you for allowing our firm to provide you with the above noted reconnaissance. While we trust the information will suit your purposes, please feel free to contact the undersigned if you have any questions.

Respectfully Submitted,

CHILKOOT GEOLOGICAL ENGINEERS LTD.



Tares Dhara, P.Eng.
Senior Geotechnical Engineer

TD/td

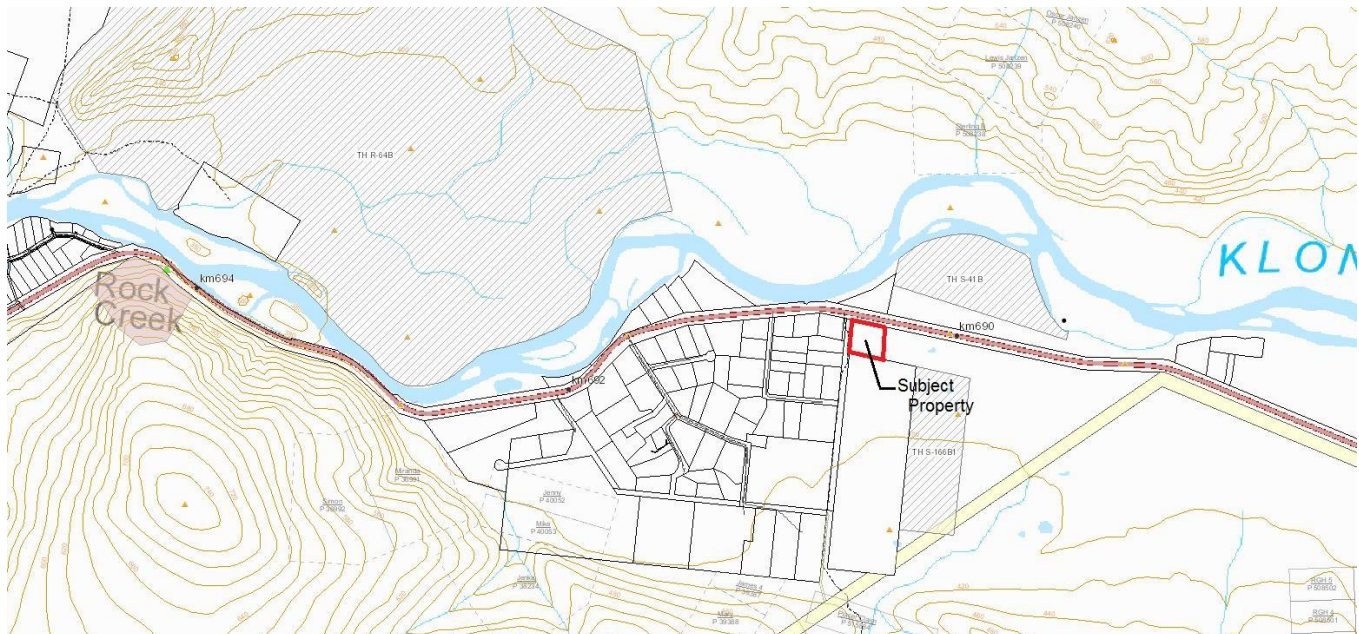


FIGURES 1 - 4



Geotechnical Reconnaissance
Lot 1191, Henderson Corner, 2014-0027 - Dawson, Yukon – 2016

FIGURE 1 – Site Location



Based map modified from Google Earth & YG - Water Placer Atlas
Limits are approximate. Scale varies.

Compiled August 12, 2016 by T.Dhara



Geotechnical Reconnaissance
Lot 1191, Henderson Corner, 2014-0027 - Dawson, Yukon – 2016

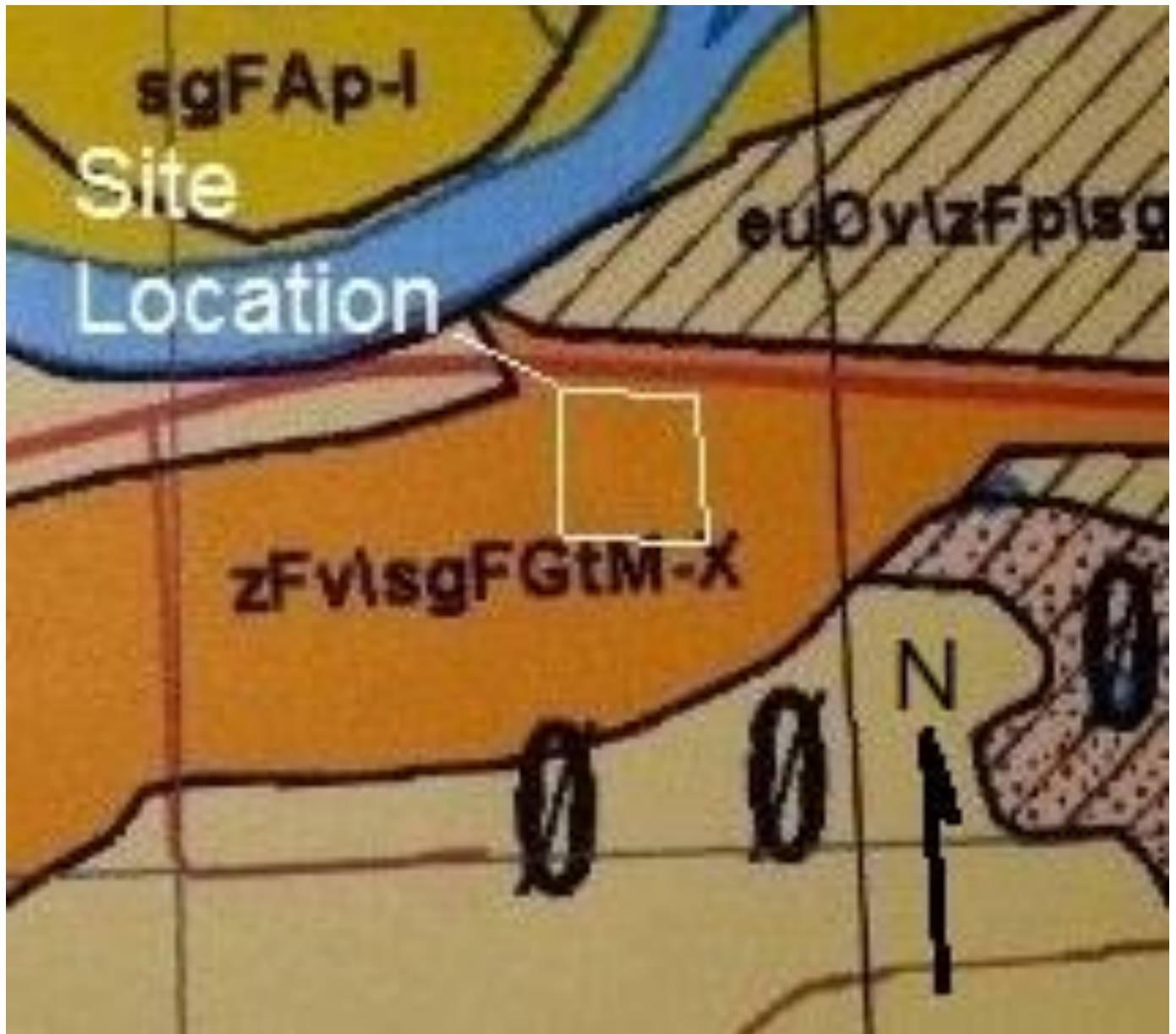
FIGURE 2 – Sampling Locations





Geotechnical Reconnaissance
Lot 1191, Henderson Corner, 2014-0027 - Dawson, Yukon – 2016

FIGURE 3 – Surficial Geology



Based map modified from Surficial Geology of Dawson by K.McKenna & P.Lipovsky
Limits are approximate.

Compiled August 12, 2016 by T.Dhara



Geotechnical Reconnaissance
Lot 1191, Henderson Corner, 2014-0027 - Dawson, Yukon – 2016

FIGURE 4 – Residential Development Feasibility





TABLE I

Stratigraphic Summary

CHILKOOT GEOLOGICAL ENGINEERS LTD.



Geotechnical Reconnaissance
 Lot 1191 - Henderson Corner - 2014-0027 - Dawson, Yukon - 2016
 Table I - Stratigraphic Summary

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
1	NA	0.1	NA	NA	NA	NA	ORG	Moss & Lichen
	1	0.3	16.7	NA	NA	NA	SM	Sand some Silt
	2	0.05+	12.3	NA	NA	NA	GP	Sandy Gravel
	End of Hole	0.45	Edge of Treeline.					Refusal

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
2	NA	0.15	NA	NA	NA	NA	ORG	Moss
	NA	0.15	NA	NA	NA	NA	PEAT	Organics and Rootlets
	3	0.1	265.0	NA	NA	NA	Nbe	Frozen Organic Silt - visible ice
	End of Hole	0.4	In hummocky sedge w/ standing water.					Refusal

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
3	NA	0.1	NA	NA	NA	NA	ORG	Moss & Lichen
	4	0.2	91.4	NA	NA	NA	OL	Organic Silt
	5	0.05+	3.8	7.5	13.2	79.3	GP	Gravel some Sand trace Silt
	End of Hole	0.35	Edge of treeline.					Refusal

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
4	NA	0.15	NA	NA	NA	NA	ORG	Moss
	6	0.15	248.0	NA	NA	NA	PEAT	Organics and Rootlets
	7	0.05+	40.0	88.7	11.3	0.0	Nbe	Frozen Silt some sand - visible ice
	End of Hole	0.35	In hummocky sedge w/ standing water.					Refusal

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
5	NA	0.1	NA	NA	NA	NA	ORG	Moss & Lichen
	NA	0.1	NA	NA	NA	NA	OL	Organic Silt
	8	0.05	19.7	NA	NA	NA	SM	Silty Sand
	9	0.1	29.7	NA	NA	NA	ML	Sandy Silt
	10	0.1+	4.1	3.3	73.6	23.2	SP	Gravelly Sand
	End of Hole	0.45	In treed area.					Refusal

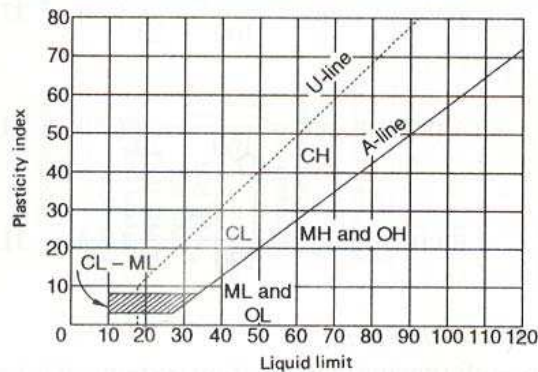
Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
6	NA	0.1	NA	NA	NA	NA	ORG	Moss
	NA	0.1	NA	NA	NA	NA	PEAT	Organics & Organic Silt
	11	0.6	24.0	NA	NA	NA	ML	Sandy Silt
	End of Hole	0.8	Towards Highway Right-of-Way.					Refusal - Possibly Frozen

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
7	NA	0.1	NA	NA	NA	NA	ORG	Moss
	NA	0.1	NA	NA	NA	NA	PEAT	Organics & Organic Silt
	12	0.4	22.4	NA	NA	NA	ML	Sandy Silt
	13	0.1	25.5	36.2	63.8	0	Nbn	Frozen Silty Sand
	End of Hole	0.7	Towards Highway Right-of-Way.					Refusal

Location	Sample	Thickness (m)	Moisture (%)	Fines (%)	Sand (%)	Gravel (%)	USCS/NRC	Description
8	NA	0.1	NA	NA	NA	NA	ORG	Moss
	NA	0.1	NA	NA	NA	NA	PEAT	Organics & Organic Silt
	14	0.3	28.7	NA	NA	NA	ML	Sandy Silt
	15	0.1	26.5	NA	NA	NA	Nbn	Frozen Silty Sand
	End of Hole	0.6	Towards Highway Right-of-Way.					Refusal

Unified Soil Classification System
(ASTM Designation D-2487)

Major division	Group Symbols	Typical Names	Classification Criteria	
Coarse-grained soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW Well-graded gravels and gravel-sand mixtures, little or no fines GP Poorly graded gravels and gravel-sand mixtures, little or no fines GM Silty gravels, gravel-sand-silt mixtures GC Clayey gravels, gravel-sand-clay mixtures	$C_u = D_{60}/D_{10}$ Greater than 4 $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7
		Gravels with fines	SW Well-graded sands and gravelly sands, little or no fines SP Poorly graded sands and gravelly sands, little or no fines SM Silty sands, sand-silt mixtures SC Clayey sands, sand-clay mixtures	$C_u = D_{60}/D_{10}$ Greater than 6 $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7
		Sands More than 50% of coarse fraction passes No. 4 sieve	ML Inorganic silts, very fine sands, rock flour, silty or clayey fine sands CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays OL Organic silts and organic silty clays of low plasticity MH Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts CH Inorganic clays of high plasticity, fat clays OH Organic clays of medium to high plasticity	Classification on basis of percentage of fines Less than 5% Pass No. 200 sieve More than 12% Pass No. 200 sieve 5% to 12% Pass No. 200 sieve GW, GP, SW, SP GM, GC, SM, SC Borderline classification requiring use of dual symbols Check plasticity chart
	Fine-grained soils 50% or more passes No. 200 sieve	Sands with fines		
		Silts and Clays Liquid limit 50% or less		
	Highly organic soils		Pt Peat, muck and other highly organic soils	Fibrous organic matter; will char, burn, or glow



Note: U-line represents approximate upper limit of LL and PI combinations for natural soils

Plasticity chart for the classification of fine-grained soils.
Tests made on fraction finer than No. 40 sieve.

Unified Soil Classification System

Figure 18. UNIFIED SOIL CLASSIFICATION SYSTEM

Table 1.2 Description and classification of frozen soils (adapted from Linnell and Kaplar, 1966)

I: Description of soil phase (independent of frozen state)	Classify soil phase by the unified soil classification system				Classify soil phase by the unified soil classification system				Thaw characteristics
	Major group		Subgroup		Field identification	Pertinent properties of frozen materials which can be measured by physical tests to supplement field identification	Thaw characteristics		
	Description	Designation	Description	Designation					
II: Description of frozen soil	Segregated ice not visible by eye	N	Poorly bonded or friable	NI	Identify by visual examination; to determine presence of excess ice, use procedure under note (3) and hand magnifying lens as necessary; for soils not fully saturated estimate degree of ice saturation (medium, low); note presence of crystals or of ice coatings around larger particles	In-place temperature Density and void ratio a. In frozen state b. After thawing in place Water content (total H ₂ O, including ice) a. Average b. Distribution Strength a. Compressive b. Tensile c. Shear d. Adfreeze Elastic properties Plastic properties Thermal properties Ice crystal structure (using optical instruments) a. Orientation of axes b. Crystal size c. Crystal shape d. Pattern of arrangement	Usually thaw-stable		
			Well bonded	Nb					
	Segregated ice visible by eye (ice 25 mm or less thick)	V	Individual ice crystals or inclusions	Vx	For ice phase, record the following as applicable Location Orientation Thickness Length Spacing Hardness Structure } per part III below Color	Elastic properties Plastic properties Thermal properties Ice crystal structure (using optical instruments) a. Orientation of axes b. Crystal size c. Crystal shape d. Pattern of arrangement	Usually thaw-unstable		
			Ice coatings on particles	Vc					
III: Description of substantial ice strata	Ice greater than 25 mm thick	ICE	Pandom or irregularly oriented ice formations	Vr	Estimate volume of visible segregated ice present as percent of total sample volume	Same as part II above, as applicable, with special emphasis on ice crystal structure			
			Straatified or dismetely oriented ice formations	Vs					
			Ice with soil inclusions	ICE + soil type			Designate material as ice and use descriptive terms as follows, usually one item from each group, as applicable: Hardness: hard, soft (of mass, not of individual crystals) Structure: clear, cloudy, porous, candled, granular, stratified Color: colorless, gray, blue Admixtures: contains few thin silt inclusions		
			Ice without soil inclusions	ICE					

(see notes on p. 32)



APPENDIX A

Selection of Air Photos



Geotechnical Reconnaissance
Lot 1191, Henderson Corner – Dawson City, Yukon – 2015
Appendix A – Selection of Air Photos



1960



1977



1990



2003

Site boundaries are approximate – Not to scale

Compiled August 12, 2016 by T.Dhara



APPENDIX B

Selection of Photos



APPENDIX B – SELECTION OF PHOTOS



Above – Site as viewed from access from Klondike Hwy.



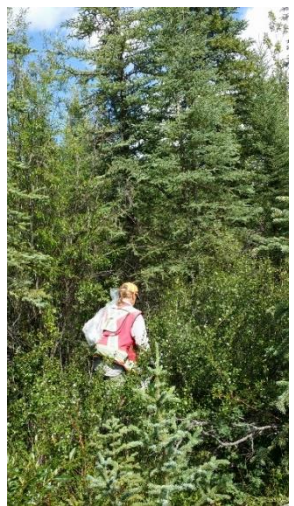
Above – Site conditions at A7.



Above – Site conditions within peat bog.
Facing north towards treed granular area.



Left. Above & Below
Conditions at A2 - Bog



Left – Conditions @ A5
Granular area.

Below Left –
Auguring A8
Below Right – A8

