



**GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6041**

**Geotechnical Database and Descriptions of Permafrost
Monitoring Sites Established 2006-07 in the Central and
Southern Mackenzie Corridor**

**S.L. Smith, J. Chartrand, T.-N. Nguyen, D.W. Riseborough, M. Ednie,
and S. Ye**

2009



Natural Resources
Canada

Ressources naturelles
Canada

Canada



**GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6041**

**Geotechnical Database and Descriptions of Permafrost
Monitoring Sites Established 2006-07 in the Central and
Southern Mackenzie Corridor**

**S.L. Smith, J. Chartrand, T.-N. Nguyen, D.W. Riseborough, M. Ednie,
and S. Ye**

2009

©Her Majesty the Queen in Right of Canada 2009
Available from
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8

Smith, S.L., Chartrand, J., Nguyen, T.N., Riseborough, D.W., Ednie, M. and Ye, S.

2009: Geotechnical database and descriptions of permafrost monitoring sites established 2006-07 in the central and southern Mackenzie Corridor, Geological Survey of Canada, Open File 6041, CD-ROM.

Open files are products that have not gone through the GSC formal publication process.

ABSTRACT

The Geological Survey of Canada of Natural Resources Canada conducted a major field program between 2005 and 2007 to address gaps in baseline environmental information in the Mackenzie Valley associated with proposed transportation and resource development corridors. A total of 43 boreholes were drilled in the Mackenzie corridor south of Fort Good Hope and 33 of these holes were preserved and instrumented with temperature cables. Geotechnical information and initial ground temperature data from these boreholes has been compiled in a relational database presented in MS Access format and as ASCII text files. Graphic presentations of the data are also provided along with information on site characteristics and photographs. The baseline information provided meets the needs of a number of users including those involved in planning northern development, infrastructure design and the regulatory process.

TABLE OF CONTENTS

	Page
Abstract	i
List of figures and tables	iii
1. Introduction	1
2. Site location and general descriptions	2
3. Database structure	7
4. Graphical presentations of borehole logs and initial thermal data	14
5. Summary	15
6. Acknowledgements	15
7. References	16
Appendix	18

LIST OF FIGURES

	Page
1. Location of sites	3
2. Table structure for the database	7

LIST OF TABLES

1. Brief descriptions of sites	5
2. Modified Unified Soil Classification	13

1. INTRODUCTION

Permafrost is an important feature of the Mackenzie Valley landscape that has impacts on both the natural and socio-economic environments of the region. Permafrost and its associated ground ice can influence entire ecosystems through their influence on drainage patterns and ground stability and can also present challenges to northern development. Increased development activity is anticipated in the Mackenzie Valley associated with proposed hydrocarbon extraction and transportation, including construction of a pipeline to carry natural gas from the Mackenzie Delta to northern Alberta. Knowledge of the properties of earth materials including their thermal condition (temperature, active layer thickness, and ground-ice conditions) and their spatial and temporal variation is critical for rational planning of development in northern Canada and for understanding the impact of environmental disturbance and climate change on the permafrost environment.

During the 1970s, extensive geotechnical investigations were conducted in the Mackenzie Valley. Much of this work was associated with investigation and regulatory approval of proposed routes for the Mackenzie Highway and oil and gas pipelines. An initial compilation of publicly available geotechnical borehole data was compiled by Proudfoot and Lawrence (1976) and Lawrence and Proudfoot (1976). Additional information was added to the database in subsequent years including that collected during geotechnical investigations associated with the Norman Wells to Zama oil pipeline. An updated, GIS compatible version of the database was published by Smith et al. (2005). Publicly available information on the ground thermal regime has also been compiled (Smith and Burgess, 2000) including that collected by the GSC as part of an ongoing monitoring program along the Norman Wells pipeline (Smith et al., 2004).

Although much information exists for the Mackenzie corridor, there are extensive regional gaps in our knowledge of the ground thermal regime, particularly in the region north of Norman Wells. Updated information on properties of surficial materials including ground ice conditions is also required to aid design of northern hydrocarbon infrastructure and the associated environmental assessment and design of environmental management and monitoring programs. Gaps in baseline geotechnical and permafrost information were identified in an analysis led by the Department of Indian and Northern Affairs (Gartner Lee Limited, 2003). In 2004, the GSC undertook to address this gap with funding obtained through a Northern Energy Development Memorandum to Cabinet. Fieldwork conducted between 2005 and 2007 was directed toward addressing these gaps through the drilling of several boreholes, the collection of samples to determine geotechnical properties, the preservation of boreholes and the installation of instrumentation for long-term ground-temperature monitoring. In particular, a major gap was addressed between Norman Wells and Fort Good Hope, for which no recent (i.e. in the last decade) information on the ground thermal regime existed.

This Open File provides a digital database with a description of each field site established south of Fort Good Hope, including a description of surficial materials, ground ice conditions, instrumentation installed and initial thermal data. Graphic presentations of the geotechnical borehole logs and initial ground temperature data are also provided. The location of each site is shown on both topographic maps and air photos. Photographs of each site have also been provided to show the general site conditions.

2. SITE LOCATION AND GENERAL DESCRIPTIONS

A total of 43 boreholes were drilled with either a solid or a hollow stem auger in the Mackenzie corridor between Fort Good Hope and the Trout Lake winter road, as shown in Figures 1a and 1b. The location of each site has also been plotted on 1:50000 topographic maps and on air photos acquired in 2004 (scale 1:30000). These can be found in the Appendix. It should be noted that the winter road location may differ between the air photos and the topographic maps presented in the Appendix. The winter road alignment was obtained from 1:2 million scale digital maps which were less precise than the 1:50000 topographic maps and air photos. Also, the winter road has been realigned in some locations since the information for the digital layers was acquired.

Sites were chosen along the winter road, the all weather highway, the Enbridge pipeline right-of-way or other cut lines in order to have easy access during the winter drilling program and also for summer site visits to retrieve thermal data by helicopter or all season road. Sites selected were representative of the terrain and vegetation conditions found throughout the region, similar to the rationale utilized for the establishment of the active-layer monitoring program in the Mackenzie Valley (see for example, Nixon and Taylor, 1994; Nixon et al., 1995) and the thermal monitoring program along the Norman Wells pipeline corridor (Pilon et al. 1989). At some sites, two boreholes were drilled a few tens of metres to a few hundred metres apart to capture the spatial variability and transitions in surficial materials, permafrost and ground ice conditions that may occur over short distances. Brief descriptions of all sites are provided in Table 1. Photographs for each site have also been provided in the Appendix largely to show the characteristics of sites where boreholes were preserved for temperature measurement.

Figure 1a. Location of sites between Fort Good Hope and Norman Wells

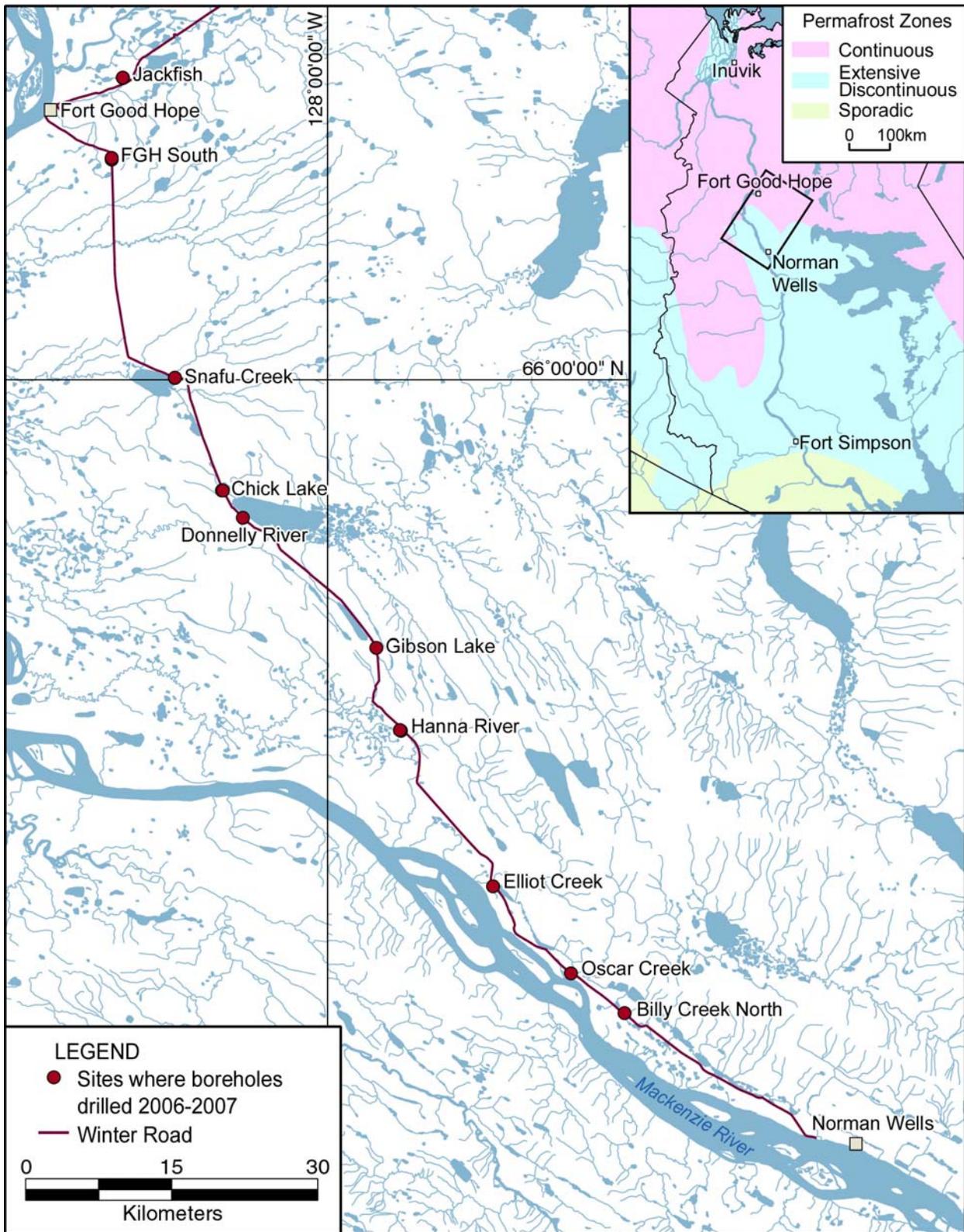


Figure 1b. Location of sites south of Norman Wells. Note that only a winter road exists north of Wrigley; from the Mackenzie Highway to the communities of Trout River and Jean Marie Creek.

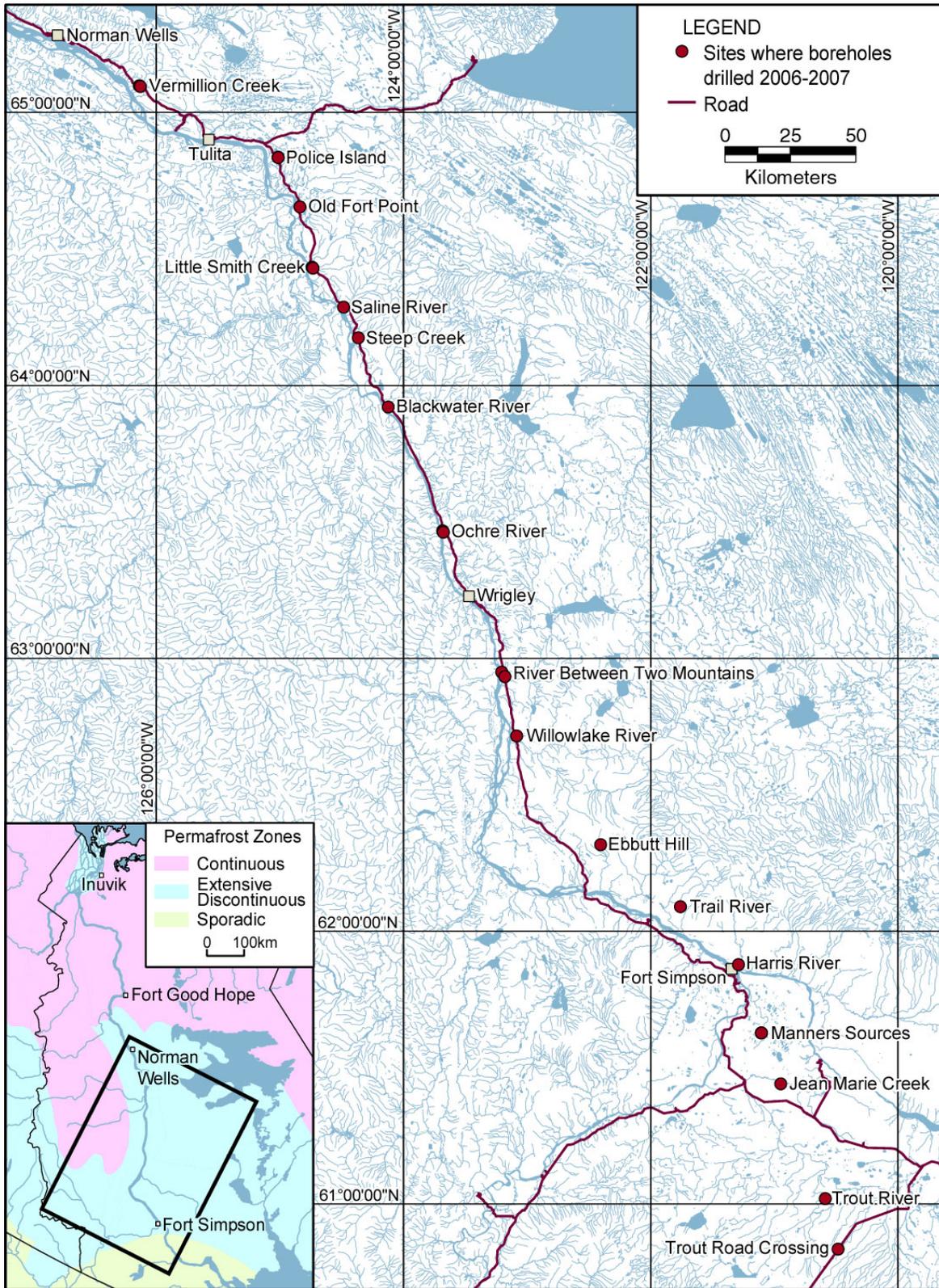


Table 1 – Brief descriptions of sites where boreholes (BH) were drilled and depth of temperature (Temp.) cable.

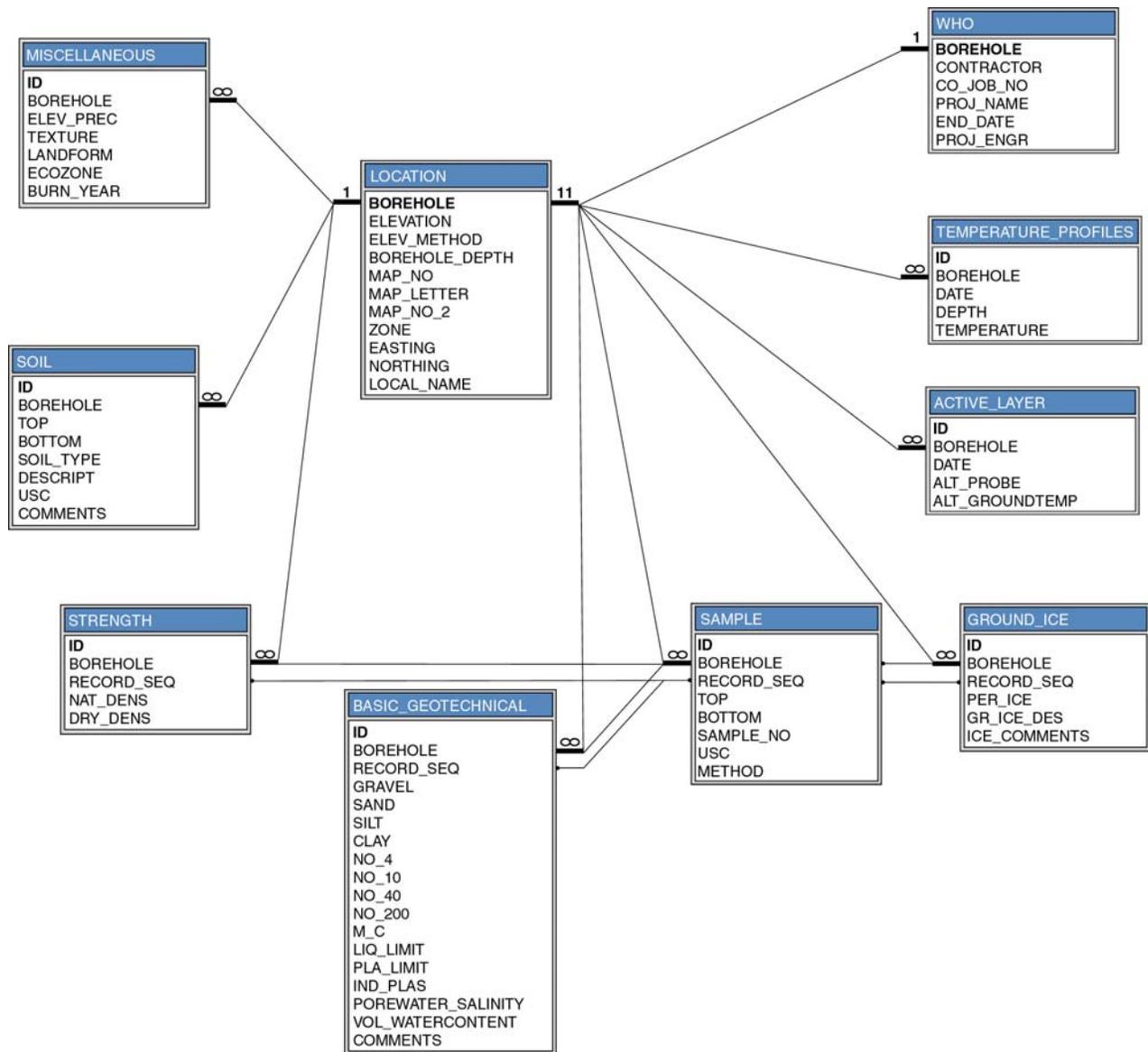
Site name	BH ID	UTM Zone	UTM coordinates	Landform	Vegetation cover	BH Depth	Temp. Cable
Jackfish Creek	JF-01	9W	7351808N 523779E	Moraine plain	Low-lying, open shrubs, black spruce	4.9 m	none
	JF-02	9W	7351772N 523814E	Eolian dune on moraine plain, well drained, high spot	Black spruce forest and moss cover	21.3 m	20 m
Fort Good Hope South	FGHS-01	9W	7343386N 522694E	Hummocky peatland	Dense shrub and open black spruce	10.2 m	8 m
	FGHS-02	9W	7343323N 522699E	Hummocky peatland	Peat plateau, lichen open black spruce	5.1 m	5 m
Snafu Creek	SC-01	9W	7320273N 529474E	Moraine plain	Peat bog, open black spruce forest and lichen cover	19.8	16.8 m
Chick Lake	CL-01	9W	7308482N 532632E	Moraine plain	Peat & organic soil with open black spruce forest and shrubs	21.3 m	20 m
Donnelly River	DR-01	9W	7305468N 537222E	Moraine and fluvial plain	Mixed shrub, deciduous and conifers	<1.5m	none
	DR-02	9W	7305806N 536618E	Moraine and fluvial plain	Mixed shrub, deciduous and conifers	<1.5m	none
Gibson Lake	GL-01	9W	7292195N 550960E	Hummocky moraine plain	Recovering burnt area with peat and shrubs	21.3 m	20 m
Hanna River	HR-01	9W	7283597N 553624E	Lacustrine plain	Boggy burnt area	21.3 m	20 m
Elliot Creek	EC-01	9W	7267151N 563738E	Lacustrine undulating plain, well-drained elevated area	Peat cover on edge of open mature black spruce forest	21.3 m	20 m
	EC-02	9W	7267404N 563712E	Lacustrine alluvial undulating plain	Peat cover on edge of dense mature black spruce forest	12.2 m	9.7 m
Oscar Creek	OC-01	9W	7258009N 572437E	Undulating glacio-lacustrine terrain overlain by alluvial sediments	Peat cover with dense forested birch and black spruce	18.9 m	16 m
	OC-02	9W	7258968N 572068E	Flood plain – alluvial sediments underlain by glacial-lacustrine terrain	Open birch and black spruce forest	<1.5m	none
Billy Creek North	BCN-01	9W	7254350N 578091E	Alluvial and eolian sediments overlying low-lying lacustrine plain	Peat cover with dense forested black spruce and mixed shrubs	19.8 m	15 m
	BCN-02	9W	7254294N 578046E	Alluvial and eolian sediments overlying low-lying lacustrine plain	Open forested, black spruce, mixed shrub	2.3 m	none
Vermillion Creek	VC-01	9W	7222434N 634464E	Moraine plain at approach to water crossing	NW side of Creek, on top of ridge in black spruce forest	8.2 m	8 m
	VC-02	9W	7222160N 634972E	Moraine plain at approach to water crossing	SE side of Creek on plateau in area of burnt black spruce	5.5 m	5 m
Police Island	PI-01	10W	7191493N 404417E	Lacustrine plain	Recovering burn (burnt black spruce forest)	12.9 m	10 m
	PI-02	10W	7191398N 404454E	Lacustrine plain	Unburnt, black spruce forest with moss and lichen ground cover	19.5 m	19.4 m
Old Fort Point	OFP-01	10W	7170979N 412221E	Lacustrine plain	Open mixed spruce, pine deciduous forest adjacent to open low lying fen	20 m	15 m

Little Smith Creek	LS-01	10W	7146259N 416233E	Alluvial flood plain	Open mature black spruce forest	20.6 m	15 m
	LS-02	10W	7145819N 416567E	Glaciofluvial outwash plain	Tamarack, birch, poplar, pine forest transition to spruce	20 m	19.4 m
Saline River	SR-01	10W	7130133N 428109E	Alluvial terrace	Old burnt black spruce forest	2.3 m	none
	SR-02	10W	7129938N 428106E	Glaciofluvial veneer over lacustrine	Burnt black spruce forest	20.4 m	20 m
Steep Creek	Steep-01	10W	7118945N 433241E	Alluvial and colluvial, north facing slope of stream valley (site at edge of right-of-way)	Mixed, white spruce, jackpine, aspen, birch	14 m	8 m
	Steep-02	10W	7117926N 433196E	Alluvial and colluvial, north facing slope of stream valley (site at edge of cleared right-of-way)	Mixed, white spruce, jackpine, aspen, birch	28.3 m	20 m
	Steep-03	10W	7118410N 433207E	Alluvial and colluvial, north facing slope of stream valley (site on edge of wood chip insulated right-of-way)	Mixed, white spruce, jackpine, aspen, birch	20.7m	20 m
Blackwater River	BW-01	10W	7088467N 444851E	Alluvial and glaciofluvial landforms	Flat forested (birch, deciduous) area	0.5m	none
Ochre River	OCR-01	10W	7037588N 465976E	Lacustrine and fluvial terrain	Valley bottom, dense black spruce forest	1.5m	none
	OCR-02	10W	7037012N 466239E	Lacustrine and fluvial terrain	Ridge on south side of river, stunted black spruce forest	2.0 m	none
River Between Two Mountains	RBTM-01	10W	6979706N 489609E	Transition lacustrine to alluvial to moraine terrain	Dense black spruce forest	20.6 m	15 m
	RBTM-02	10W	6977913N 490871E	Transition lacustrine to alluvial to moraine terrain	Dense black spruce forest	12.5 m	10 m
Willowlake River	WLR-01	10W	6953658N 495685E	Alluvial fan	Open mixed forest	3.7 m	3.7 m
Ebbutt Hill	EH-01	10W	6909592N 530836E	Moraine	Dense black spruce, labrador tea and cloudberry-lichen bog	16 m	15 m
Trail River	TR-01	10W	6884733N 564755E	Lacustrine plain and eolian landforms	Black spruce and tamarack forest with understory of sphagnum and feathermoss	12.2 m	10 m
Harris River	HAR-01	10W	6861673N 589929E	Moraine	Predominately birch	16 m	15 m
Manners Sources	MS-01	10W	6834043N 600416E	Eolian inter-dune	Thermokarsted shrub fen	16 m	15 m
	MS-02	10W	6834045N 600488E	Eolian dune crest	Pine forest	16 m	15 m
Jean Marie Creek	JMC-01	10W	6813448N 609445E	Transition alluvial flood plain to organic (fen) over lacustrine plain	Poorly drained shrub fen	8.5 m	5 m
	JMC-02	10W	6813530N 609408E	Transition alluvial flood plain to organic (fen) over lacustrine plain	Sandy ridge with spruce, pine forest	10 m	5 m
Trout River	TroutR	10W	6767353N 630326E	Organic terrain	Peatland with scattered spruce and sphagnum ground cover	7.2 m	5 m
Trout Road Crossing	TRC	10W	6746943N 636730E	Bog dominated moraine plain	Dry peatland vegetation consisting of black spruce, tamarack, feathermoss	12 m	10 m

3. DATABASE STRUCTURE

The relational database file in MS Access format, *NewMackSites05-08.mdb* comprises a series of ten tables that include location information, geotechnical data and other site characteristics. The various tables are linked to a primary table, Location. The relationships between the tables are shown in Figure 2. Each borehole has been given a unique identifier which also acts as the primary key. A description of all tables and the associated fields is found below. Cells have been left blank where no data were available. The individual tables have also been provided as ASCII text files (tab delimited) for import into other database or spreadsheet programs.

Figure 2. Table structure for the database



3.1 Description of database tables and fields

Location: This table contains location information for each borehole.

Borehole - Unique number assigned to the borehole.

Elevation (m) - Elevation above mean sea level.

Elev Method – Method used to determine elevation. The approximate site elevation was either determined utilizing GPS (accuracy 10-40 metres) or from topographic maps.

Borehole Depth (m) - Total depth of the borehole.

Map No - National Topographic System (NTS) primary quadrangle and denotes a 1:1,000,000 series map.

Map Letter - Secondary NTS map designation (1:250,000).

Map No 2 - The third NTS map scale designation (1:50,000).

Zone - UTM zone in which the borehole is located.

Easting (m) - The UTM easting coordinate of the borehole (Datum NAD83).

Northing (m) - The UTM northing coordinate of the borehole (Datum NAD83).

Note: Locations were determined using a Geographic Positioning System (GPS) unit.

Coordinates are based on WGS84 and have a horizontal accuracy of less than 10 meters.

Local Name - Further information on the borehole location.

Who: This table contains information referring back to the original borehole record.

Borehole - Unique number assigned to the borehole.

Contractor - The name of the consultant/contractor who collected the information and/or drilled the boreholes. The Geological Survey of Canada (GSC) engaged two engineering consultant companies, AMEC Earth & Environmental and EBA Engineering Consultants to conduct drilling, sample collection and analysis for the majority of the sites. Drilling for the remaining sites (the most southerly sites in the corridor) was conducted by Geochem Surveys Limited with GSC performing sample collection and analysis. Reports were submitted by EBA (2008) and AMEC (2007) containing the geotechnical information that is presented in the database.

Co Job No - The consultant's job number.

Proj Name - Name or description of the original project.

End Date - The date drilling was completed. The date is given in DD/MMM/YY format.

Proj Engr - Initials of the project engineer.

Sample: This table contains information on the sample including its level in the borehole and the material type.

Borehole - Unique number assigned to the borehole.

Record Seq - The position of the sample in the sequence.

Top (m) - The depth of the top of the sampled interval.

Bottom (m) - The depth of the bottom of the sampled interval.

Sample No - The sample number used in the original report.

USC - Description of the soil, rock or other material. For soils, the modified Unified Soils Classification (USC) System code is given (see Table 2). The USC codes are based on the field descriptions of materials and laboratory results.

Method - The sampling method used. Choices are: *Grab* (grab samples, disturbed), *Core* (CRREL core, undisturbed).

Basic Geotechnical: This table contains basic geotechnical data such as the grain size distribution and Atterberg Limits.

Borehole - Unique number assigned to the borehole.

Record Seq - The position of the sample in the sequence.

Gravel - percent gravel by weight of specimen (greater than #4 size sieve or 4 mm).

Sand - percent sand by weight of specimen (from #4 to #200 size sieve or from 4 to 0.075 mm).

Silt - percent silt by weight of specimen (from #200 to 2 μ sieve or from 0.075 to 0.002 mm).

Clay - percent clay by weight of specimen (less than 2 μ sieve or 0.002 mm).

No 4 - percent of sample passing through the #4 size sieve

No 10 - percent of the sample passing through the #10 size sieve

No 40 - percent of the sample passing through the #40 size sieve

No 200 - percent of the sample passing through the #200 size sieve

M C (%) - The gravimetric moisture content expressed as a percent of the dry weight.

Liq Limit (%) - The Atterberg liquid limit or an estimate of the liquid limit relative to the moisture content (given as % dry weight). The liquid limit is the water content at which soil starts to exhibit plastic behaviour.

Pla Limit (%) - The Atterberg plastic limit which is the water content at which a soil starts to break apart and crumble when rolled. The plastic limit is expressed as moisture content (% dry weight). In a few cases, the symbol "N" is used to indicate that the material is non plastic.

Ind Plas (%) - The index of plasticity (liquid limit - plastic limit). The index of plasticity is the water content range over which soil exhibits plastic behaviour (or the ability of soil to undergo unrecoverable deformation without cracking or crumbling).

Porewater Salinity (PPT) - The total of all mineral constituents dissolved in the specimen porewater, expressed as parts per thousand by weight.

VolWaterContent (%) - The volumetric moisture content expressed as a percent of the soil volume.

Comments- Additional geotechnical comments.

Soil: This table provides information on the borehole lithology.

Borehole - Unique number assigned to the borehole.

Top (m) - The depth of the top of the unit/interval for which the description applies.

Bottom (m) - The depth of the bottom of the unit/interval for which the description applies.

Soil Type - The material type.

Descript - The soil description for each unit/interval.

USC - Unified Soils Classification (USC) System code for the unit/interval (see Table 2).
The code assignment is based on the information provided in the soil type and soil description fields.

Comments - Additional comments/description related to the unit/interval.

Strength: This table contains information on additional geotechnical properties of the samples.

Borehole - Unique number assigned to the borehole.

Record Seq - The position of the sample in the sequence.

Nat Dens (kgm^{-3}) - Density of natural soil sample.

Dry Dens (kgm^{-3}) – Bulk density of the soil sample after drying. Dry density was determined from the natural density.

Ground Ice: This table contains information on ground ice and permafrost characteristics.

Borehole - Unique number assigned to the borehole.

Record Seq - The position of the sample in the sequence.

Per Ice (%) - Estimate of the percentage of visible ice by volume.

Gr Ice Des - Ground ice description using coded classification based on Pihlainen and Johnston (1963).

Code	Ground Ice Description
Unfrozen	Material not frozen
Frozen	Material frozen - type unknown
FX	Material partially frozen - type unknown
N	Ice not visible
NF	Ice not visible - poorly bonded
NB	Ice not visible - well bonded
NBN	Ice not visible - well bonded - no excess ice
NBE	Ice not visible - well bonded - excess ice

V	Visible ice
VX	Visible ice - individual ice crystals or inclusions
VC	Visible ice - ice coating on particles
VR	Visible ice - random or irregular orientations
VS	Visible ice - stratified or oriented ice
ICE	Ice
Blank Space	Permafrost not recorded

Ice Comments - Additional comments about the ground ice.

Miscellaneous: This table contains additional information about the borehole and site characteristics.

Borehole - Unique number assigned to the borehole.

Elev Prec - The precision of the elevation measurement as given by the codes below.

Code Elevation Precision

0	Not recorded
1	Elevation taken from a GPS unit
2	Estimated from 1:50,000 NTS map using contour interval of 25 metres
3	Estimated from 1:50,000 NTS map using contour interval of 50 metres

Texture - Description of the texture of surficial materials.

Landform - Description of the surface morphology.

Ecozone - The classification based on the ecoclimatic regions defined by Ecoregions Working Group (1989). Only two regions are represented in the database, boreal and subarctic.

Burn Year - The year (if any) that the site experienced fire. If a burn has occurred but the year is unknown, "XX" is entered for the last two digits of the year. If no burning has occurred, the field is left blank.

Temperature Profiles: This table gives temperature data referenced to allow the assembly of temperature profiles. If available the late summer/early fall temperature profile is provided as this is close to the time of maximum thaw penetration.

Borehole - Unique number assigned to the borehole.

Date – Date of temperature reading (DD/MMM/YY).

Depth – Depth of sensor, measured in meters.

Temperature – Temperature measured in degrees Celsius.

Active Layer: This table gives thaw depth data.

Borehole - Unique number assigned to the borehole.

Date – Date of temperature reading.

ALT Probe – Depth of thaw (cm), determined by probing (Range is shown in parentheses).
Accuracy is approximately 3 cm.

ALT Groundtemp – Depth of thaw (cm), determined by interpolation of temperature data.
Accuracy is approximately 30 cm.

Table 2 – Modified Unified Soil Classification (USC).

Major Divisions		Group Symbol	Typical names
Coarse-grained soils (more than half of material is larger than #200 sieve size)	Gravels (more than half of coarse fraction is larger than #4 sieve size)	Clean Gravels	GW Well graded gravels, gravel-sand mixtures, <5% fines
			GP Poorly graded gravels, gravel-sand mixtures, <5% fines
		Dirty Gravels	GM Silty gravels, gravel-sand- silt mixtures >12%fines
			GC Clayey gravels, gravel-sand-clay mixtures, >12% fines
	Sands (more than half of coarse fraction is smaller than #4 sieve size)	Clean Sands	SW Well-graded sands, gravelly sands, <5% fines
			SP Poorly-graded sands, or gravelly sands, <5% fines
		Dirty Sands	SM Silty sands, sand-silt mixtures, >12% fines
			SC Clayey sands, sand-clay mixtures, >12% fines
Fine-grained soils (more than half of material is smaller than #200 sieve size)	Silts and clays (liquid limit <50)	ML	Inorganic silts and very fine sands, rock flour silty sands of slight plasticity
		CL* W _L <30	Inorganic clays of low plasticity, gravelly, sandy, or silty clays, lean clays
		CI* 30<W _L <50	Inorganic clays of medium plasticity silty clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and clays (liquid limit >50)	MH	Inorganic silts, micaceous or diatomaceous, fine sandy or silty soils
		CH	Inorganic clays of high plasticity
		OH	Organic clays of high plasticity
Highly organic soils	Pt	Peat and other highly organic soils	

3.2 Database Quality

The geotechnical data presented in the database were collected by three different field crews. While all personnel utilized similar manuals and guidelines, some variation in the field descriptions provided by the different individuals responsible for logging the core is expected. In addition, three different facilities were utilized to conduct the laboratory analyses. To the best of our knowledge, the standards and procedures utilized in the laboratory analyses ensure that all data is of similar and high quality. We acknowledge however that errors may occur in the recording of information and transfer to the digital database; checks have been done to ensure that these errors have been minimized.

4. GRAPHICAL PRESENTATIONS OF BOREHOLE LOGS AND INITIAL THERMAL DATA

Graphical presentations of borehole logs and the initial thermal data in the digital database are presented in the Appendix to this report. Borehole logs are included for all sites for which adequate data were obtained.

Temperature cables were installed in 33 boreholes. Temperature cables could not be installed in all boreholes due to collapse of some boreholes or because refusal was met at such shallow depths (less than 3 to 4 m) that cable installation was impractical. Temperature cables were installed mainly in February-March 2007 and data loggers were connected to all cables. At a few sites, temperature cables were installed in August or September 2007. Manual readings were recorded during site visits in August or September 2007 and 2008. Where possible, the late summer/early fall ground temperature in 2007 or 2008 has been recorded in the database as this will give some indication of the maximum thaw penetration (although the ground may continue to warm at depth beyond this period). Where it was not possible to obtain a manual reading, the data from the data logger were utilized. Graphical presentations of these ground temperature profiles are provided in the Appendix. Further details on the ground thermal regime are provided in other publications such as Smith et al. (2008). This data will be disseminated through the Canadian Permafrost Monitoring Network website (canpfnetwork.com), along with data collected at these sites in the future.

5. SUMMARY

A relational database of geotechnical and thermal information for boreholes established in 2006-07 in the Mackenzie corridor south of Fort Good Hope has been provided. The database provides new baseline information on geotechnical and ground thermal conditions along potential transportation and resource development corridors. This data compilation supplements existing baseline data available for the region. In particular, new data are available to characterize the ground thermal conditions in areas where little recent information existed such as north of Norman Wells. This information meets the needs of a number of users including those involved in planning northern development, infrastructure design (such as pipelines) and regulatory agencies.

6. ACKNOWLEDGEMENTS

Support for this project was provided by Natural Resources Canada, the Northern Energy Development Memorandum to Cabinet, and the Program for Energy Research and Development. The field drilling program was conducted by EBA Engineering Consultants, AMEC Earth and Environmental and Geochem Surveys Ltd. Support provided by Enbridge (NW) Pipelines Ltd. for drilling and site establishment at Steep Creek is appreciated. The support provided by the communities in the Sahtu Settlement Region and the Deh Cho region is greatly appreciated, including the traditional knowledge that aided site selection, the provision of environmental monitors, and other logistical support. N. Couture provided helpful comments on the manuscript.

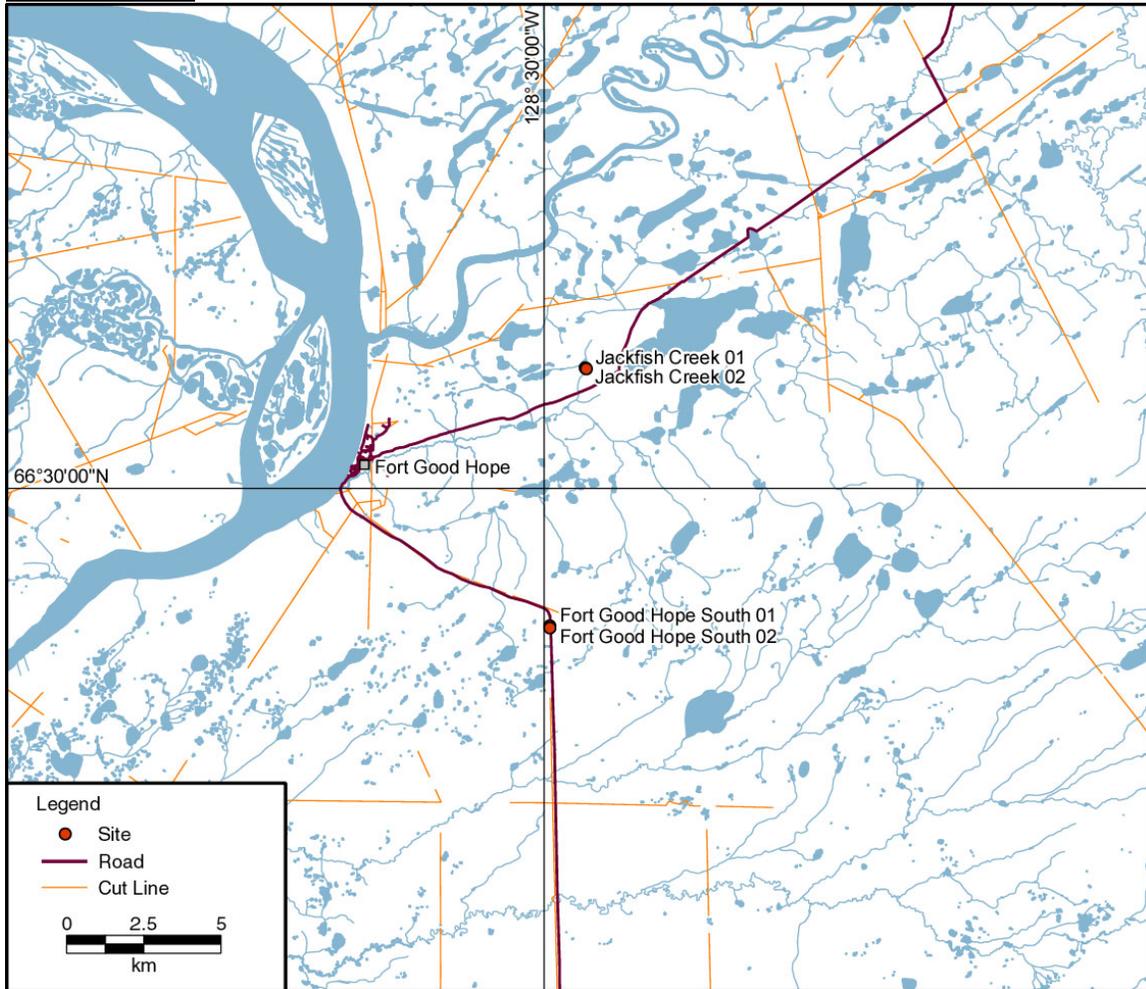
7. REFERENCES

- AMEC Earth & Environmental, 2007. Winter 2007 Geotechnical drilling and instrumentation installation. Report submitted to Geological Survey of Canada, March 2007.
- EBA Engineering Consultants, 2008. Collection of geotechnical data Norman Wells to Fort Good Hope. Report submitted to Geological Survey of Canada, February 2008.
- Ecoregions Working Group, 1989. Ecoclimatic regions of Canada, Ecological Land Classifications Series No. 23, Environment Canada, p. 118.
- Gartner Lee Limited, 2003. Identification of the biophysical information and research gaps associated with hydrocarbon exploration development and transmission in the Mackenzie Valley, action plan. Report prepared for the Department of Indian Affairs and Northern Development, the Government of the Northwest Territories, and the Environmental Studies Research funds, June 2003, Gartner Lee Limited.
- Lawrence, D.E., and Proudfoot, D.A., 1976. Mackenzie Valley geotechnical data bank - hard copy, Geological Survey of Canada Open Files 421 to 425.
- Nixon, F.M., and Taylor, A.E. 1994. Active layer monitoring in natural environments, Mackenzie Valley, Northwest Territories, Geological Survey of Canada Current Research, 1994-B: 27-34.
- Nixon, F.M., Taylor, A.E., Allen, V.S., and Wright, F. 1995. Active layer monitoring in natural environments, lower Mackenzie Valley, Northwest Territories, Geological Survey of Canada Current Research, 1996-B: 27-34.
- Pihlainen, J.A. and Johnston, G.H. 1963. Guide to a field description of permafrost, National Research Council Technical Memorandum 79, 23 p.
- Pilon, J.A., Burgess, M.M., Judge, A.S., Allen, V.S., MacInnes, K.L., Harry, D.G., Tarnocai, C., and Baker, H. 1989. Norman Wells to Zama pipeline permafrost and terrain research and monitoring program: site establishment report, Geological Survey of Canada Open File 2044.
- Proudfoot, D.A., and Lawrence, D.E. 1976. Mackenzie Valley geotechnical data bank, tape description manual, Geological Survey of Canada Open File 350.
- Smith, S., and Burgess, M.M. 2000. Ground temperature database for northern Canada, Geological Survey of Canada Open File 3954.
- Smith, S.L., Burgess, M.M., Riseborough, D., Coultish, T., and Chartrand, J. 2004. Digital Summary Database of Permafrost and Thermal Conditions – Norman Wells Pipeline Study Sites, Geological Survey of Canada Open File 4635.
- Smith, S.L., Burgess, M.M., Chartrand, J., and Lawrence, D.E. 2005. Digital borehole geotechnical database for the Mackenzie Valley/Delta region, Geological Survey of Canada Open File 4924.
- Smith, S.L., Nguyen, T.N., Riseborough, D.W., Ednie, M., Ye, S. and Chartrand, J. 2008. Preliminary ground thermal data for permafrost monitoring sites established in 2007

between Fort Good Hope and Norman Wells, Northwest Territories, Geological Survey of
Canada Current Research 2008-20, 9 p.

APPENDIX

Jackfish Creek



Jackfish Creek



Jackfish Creek

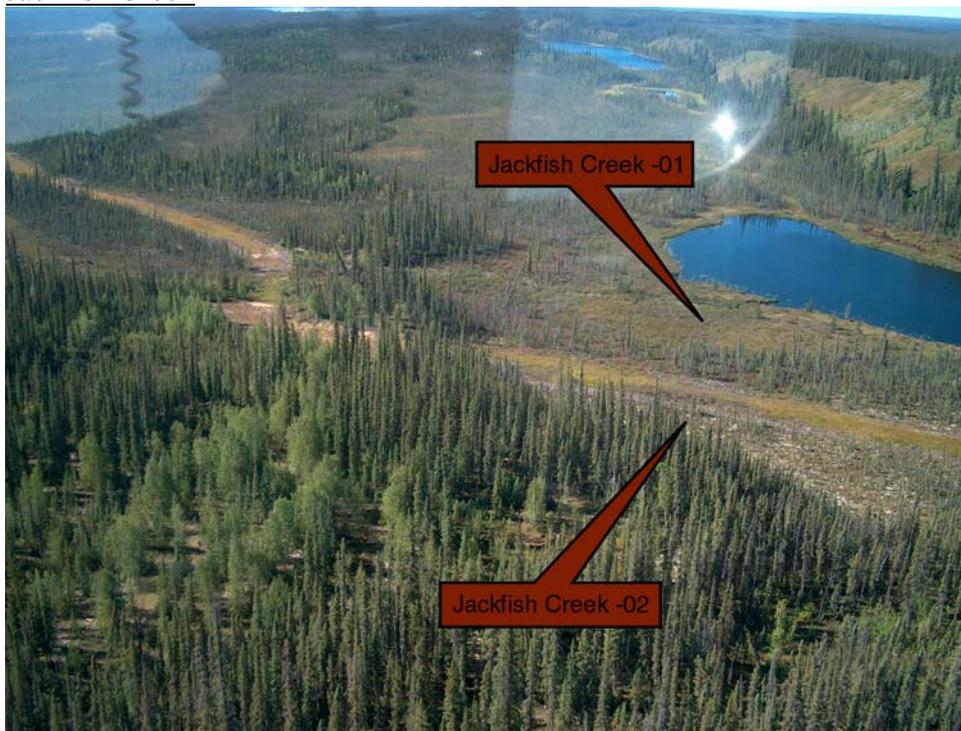


Photo taken Aug 2006



Photo taken Sep 2007

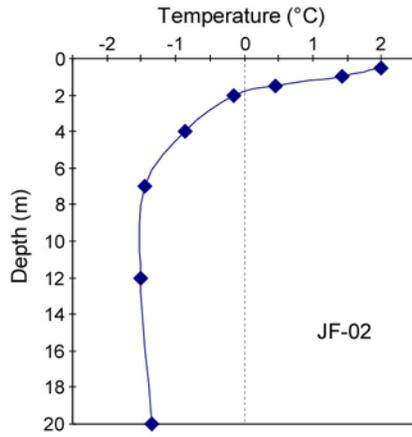
Jackfish Creek

Borehole No: JF-01		Northing: 7351808		Easting: 523779		Zone: 9								
Borehole Depth: 4.9		Location: Jackfish Creek 01				Date: 7-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Peat: Roots, rootlets, moss, twigs, medium brown.												
1		Sand: Some silt, trace clay, slightly cohesive, dark grey.	Frozen - Vx, up to 20%											
2		Stopped drilling with standard augers due to excessive sloughing. Continued with hollow stem augers.	Unfrozen											
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Jackfish Creek

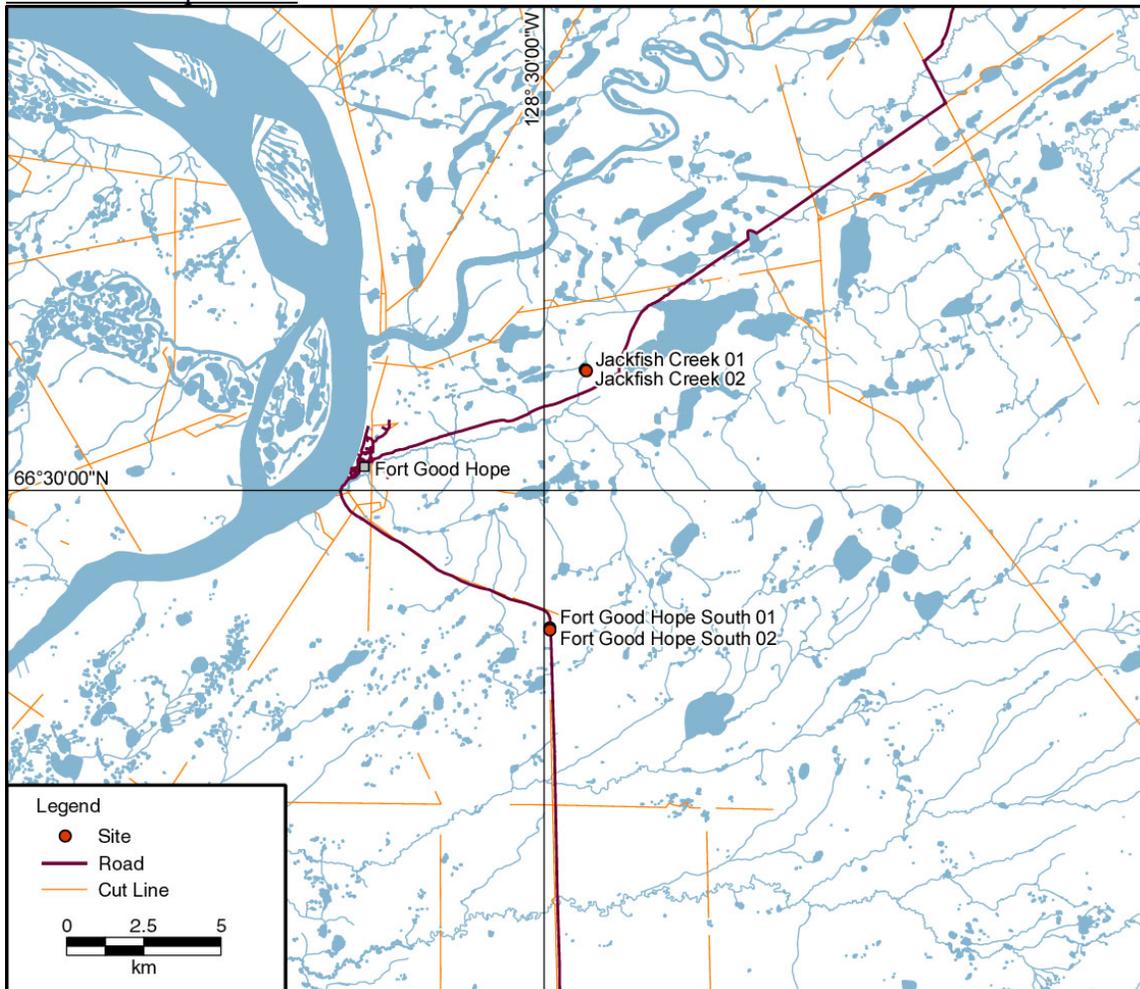
Borehole No: JF-02		Northing: 7351772		Easting: 523814		Zone: 9											
Borehole Depth: 21.3		Location: Jackfish Creek 02				Date: 8-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Topsoil: Some peat, roots, wood chips, black.	Frozen - NF														
1		Sand: Medium grained, dry, oxidized, medium reddish brown.		•													
2		Sand: Silty, trace clay, medium grey.		•													
3				•													
4		Sand: Becoming darker grey.	Nbn	•													
5				•													
6				•													
7				•													
8				•													
9		Silt and Sand: Trace clay, dark grey.		•													
10				•													
11				•													
12				•													
13				•													
14				•													
15				•													
16		Sand: Some silt, trace clay, medium brown.	Nf and Nbn	•													
17				•													
18				•													
19			Nf	•													
20				•													
21				•													
22																	

Jackfish Creek

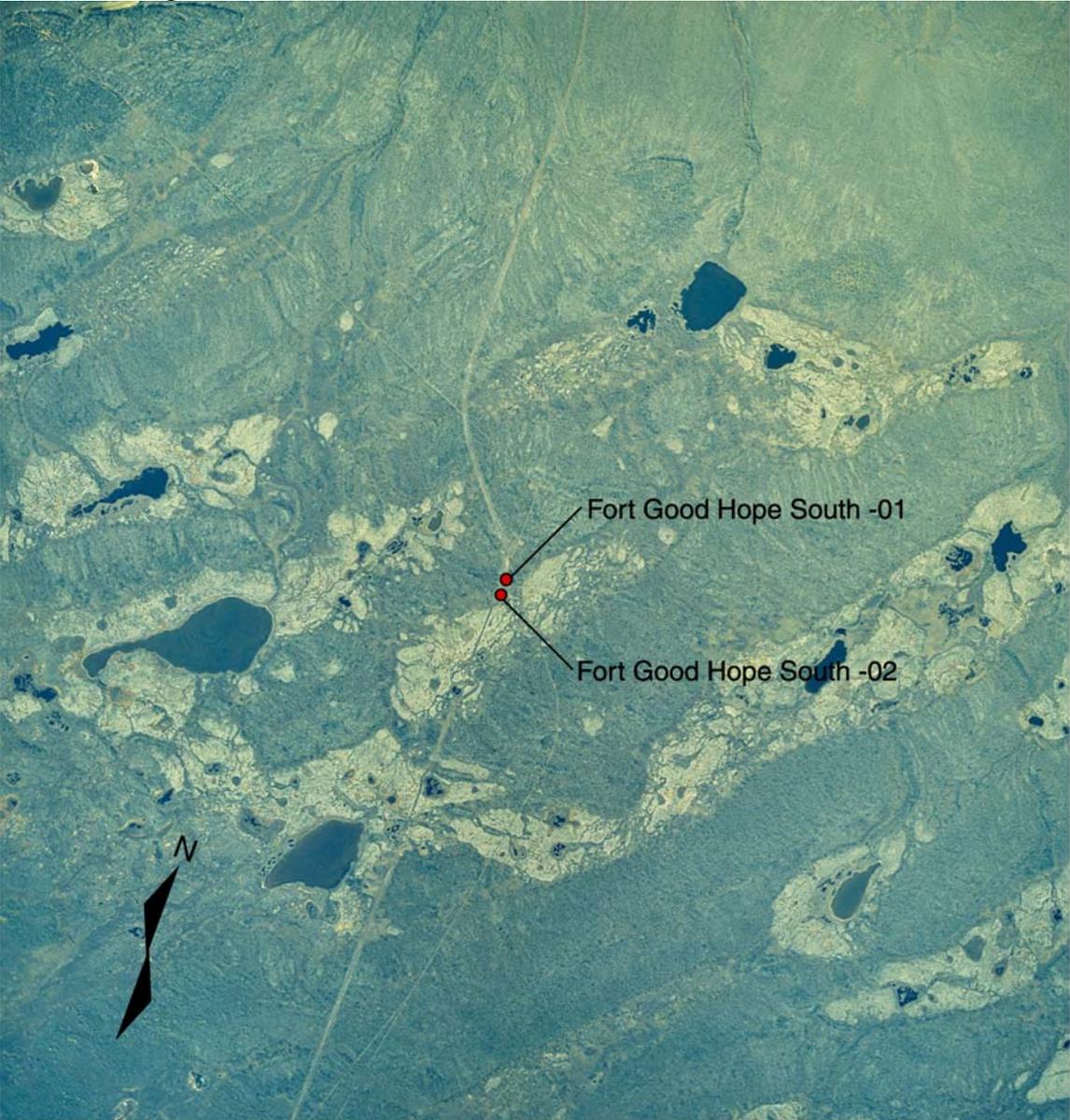


September 23 2008 data

Fort Good Hope South



Fort Good Hope South



Fort Good Hope South

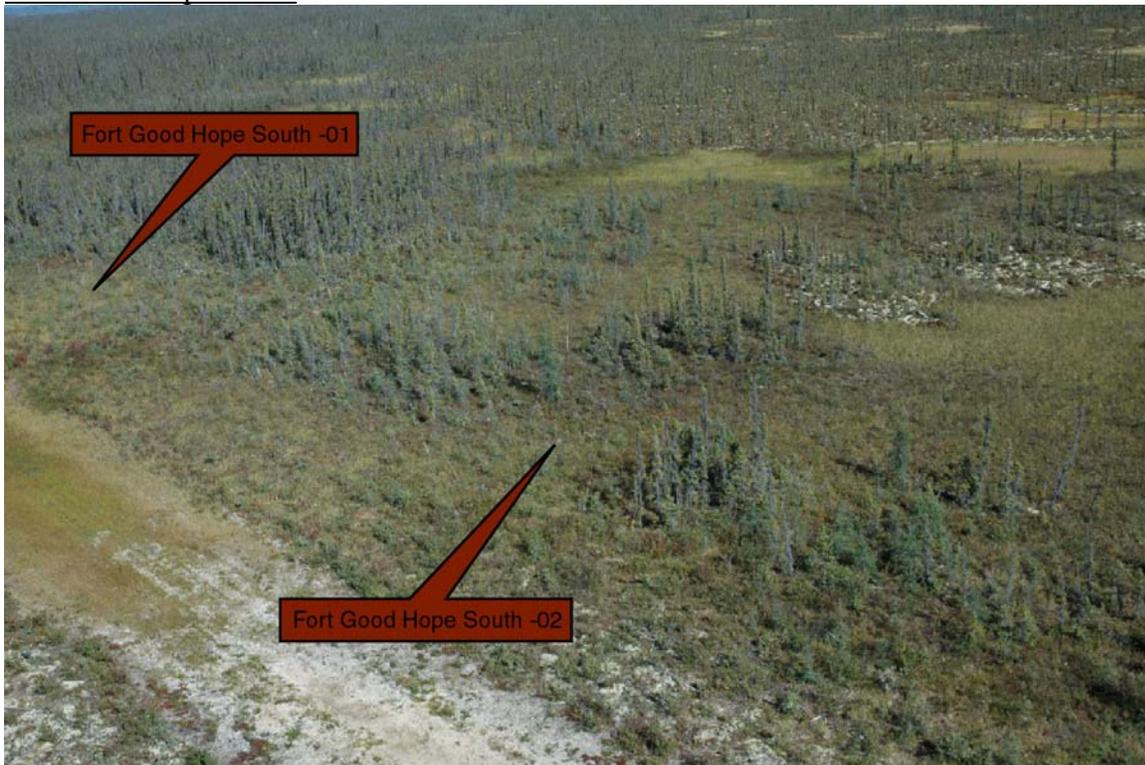


Photo taken Aug 2006



Photo taken Sep 2007

Fort Good Hope South



Photo taken Sep 2007



Photo taken Sep 2007

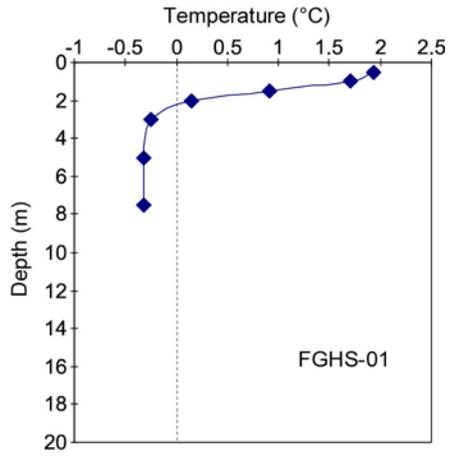
Fort Good Hope South

Borehole No: FGHS-01		Northing: 7343386		Easting: 522694		Zone: 9							
Borehole Depth: 10.2		Location: Fort Good Hope South 01				Date: 9-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Peat: Roots, rootlets, wood chips, moss, fibrous, dark brown.	Frozen - Nbn										
1		Clay: Trace peat, roots, medium grey.	Unfrozen										
2		Clay: Silty, sandy, trace to some gravel (rounded to angular, up to 50 mm diameter), dark grey.											
3		Clay: Stiff, medium plastic.											
4													
5		Clay: Silty, sandy, gravelly (rounded to angular, up to 10 mm diameter).											
6													
7													
8		Clay: Silty, sandy, some gravel (rounded to angular, up to 25 mm diameter), stiff, medium plastic.											
9													
10		Refusal on possible bedrock.											
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													

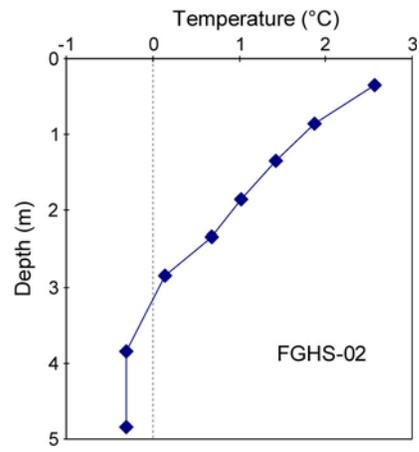
Fort Good Hope South

Borehole No: FGHS-02		Northing: 7343323		Easting: 522699		Zone: 9									
Borehole Depth: 5.1		Location: Fort Good Hope South 02				Date: 9-Mar-07									
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)							
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel				
0		Peat: Roots, rootlets, wood chips, moss, fibrous, dark brown.	Frozen - Nbn												
1		Clay (Till): Silty, sandy, some gravel (rounded to sub-angular, up to 25 mm diameter), medium plastic, stiff, dark grey.	Unfrozen												
2															
3															
4															
5		Refusal on possible bedrock.													
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															

Fort Good Hope South

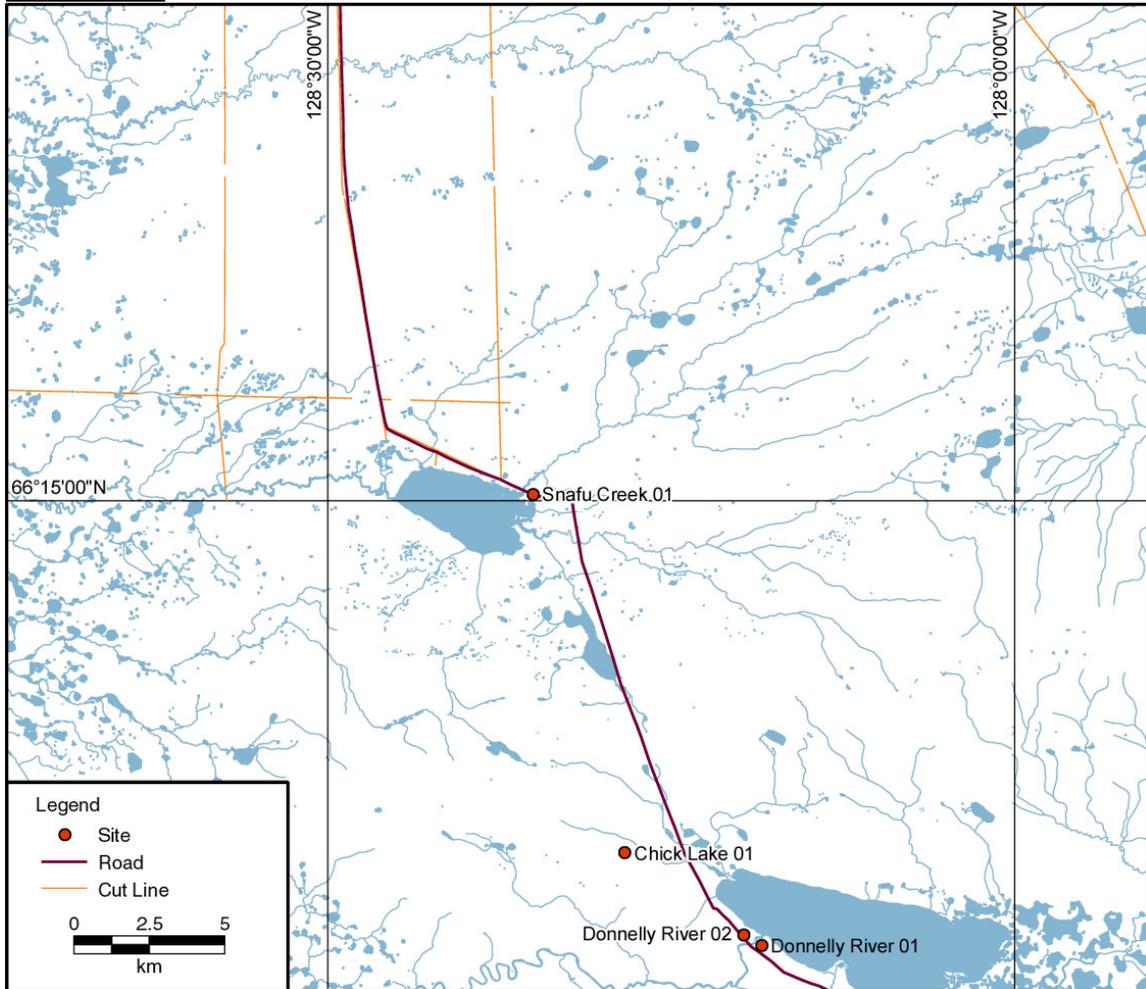


September 24 2007 data



September 23 2008 data

Snafu Creek



Snafu Creek



Snafu Creek



Photo taken Sep 2007

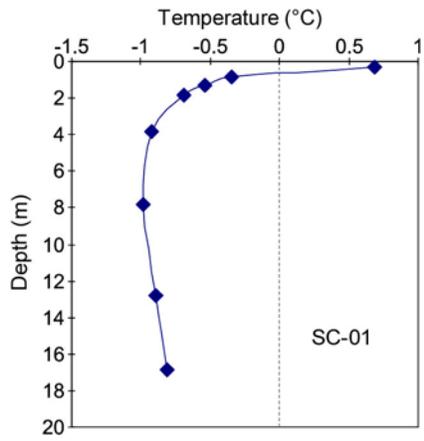


Photo taken Sep 2007

Snafu Creek

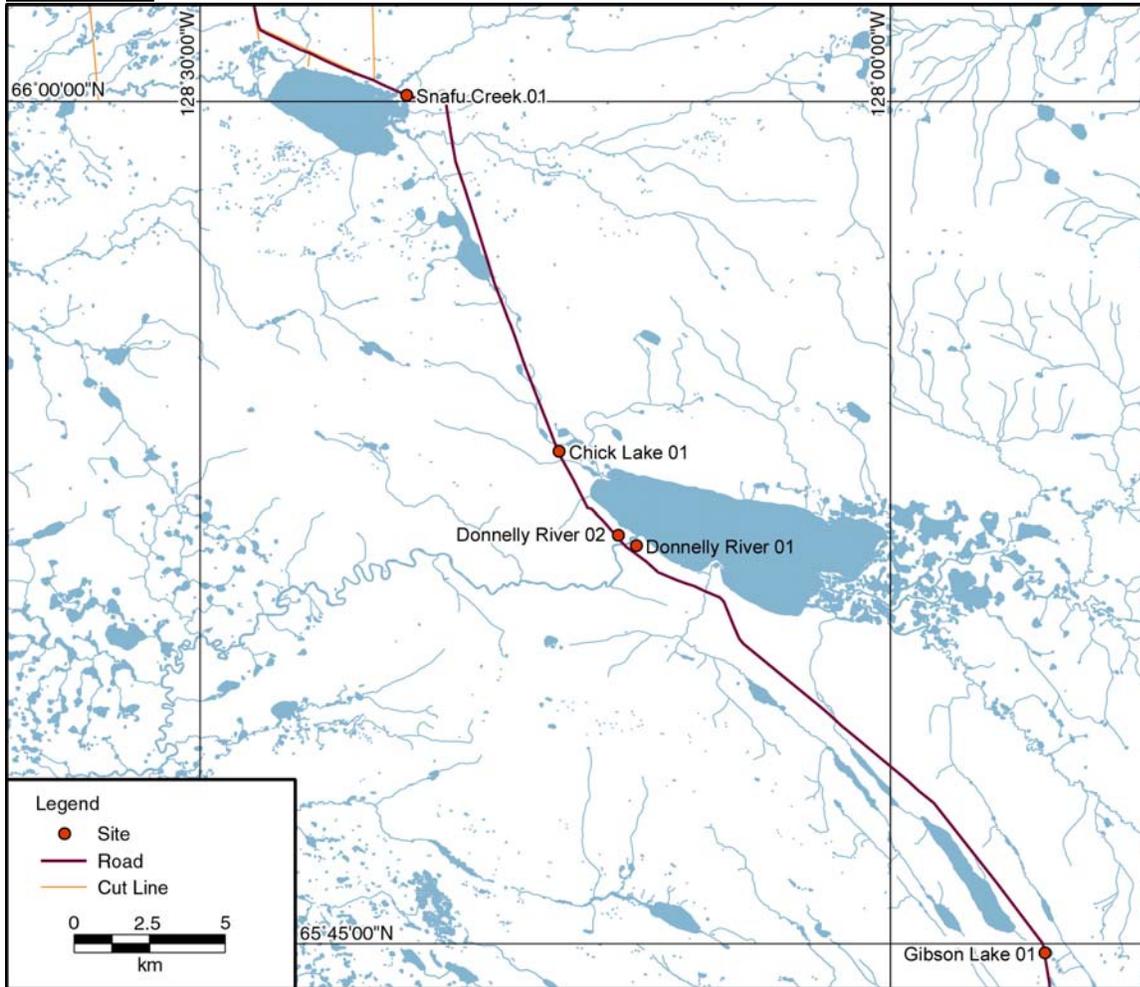
Borehole No: SC-01		Northing: 7320273		Easting: 529474		Zone: 9							
Borehole Depth: 19.8		Location: Snafu Creek 01				Date: 10-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Peat: Roots, moss, fibrous organic material, strong organic odour, medium brown.	Frozen - Vx 20 to 30%			905.60							
1													
2		Sand and Silt (Till): Some gravel (angular to rounded up to 25 mm diameter), trace clay, light to medium brown.				266.20	1874.00						
3			Unfrozen										
4													
5													
6		Sand and Silt (Till): Becoming clayey											
7													
8		Clay (Till): Silty, some sand, trace gravel (angular to rounded up 50 mm diameter), light to medium brown.	Frozen - Vx 1 to 2%										
9													
10													
11		Clay (Till): Silty, trace sand.											
12			Nbn										
13													
14													
15													
16			Nf										
17		Shale: Dark grey, dry dusty cuttings.											
18													
19													
20													
21													
22													

Snafu Creek

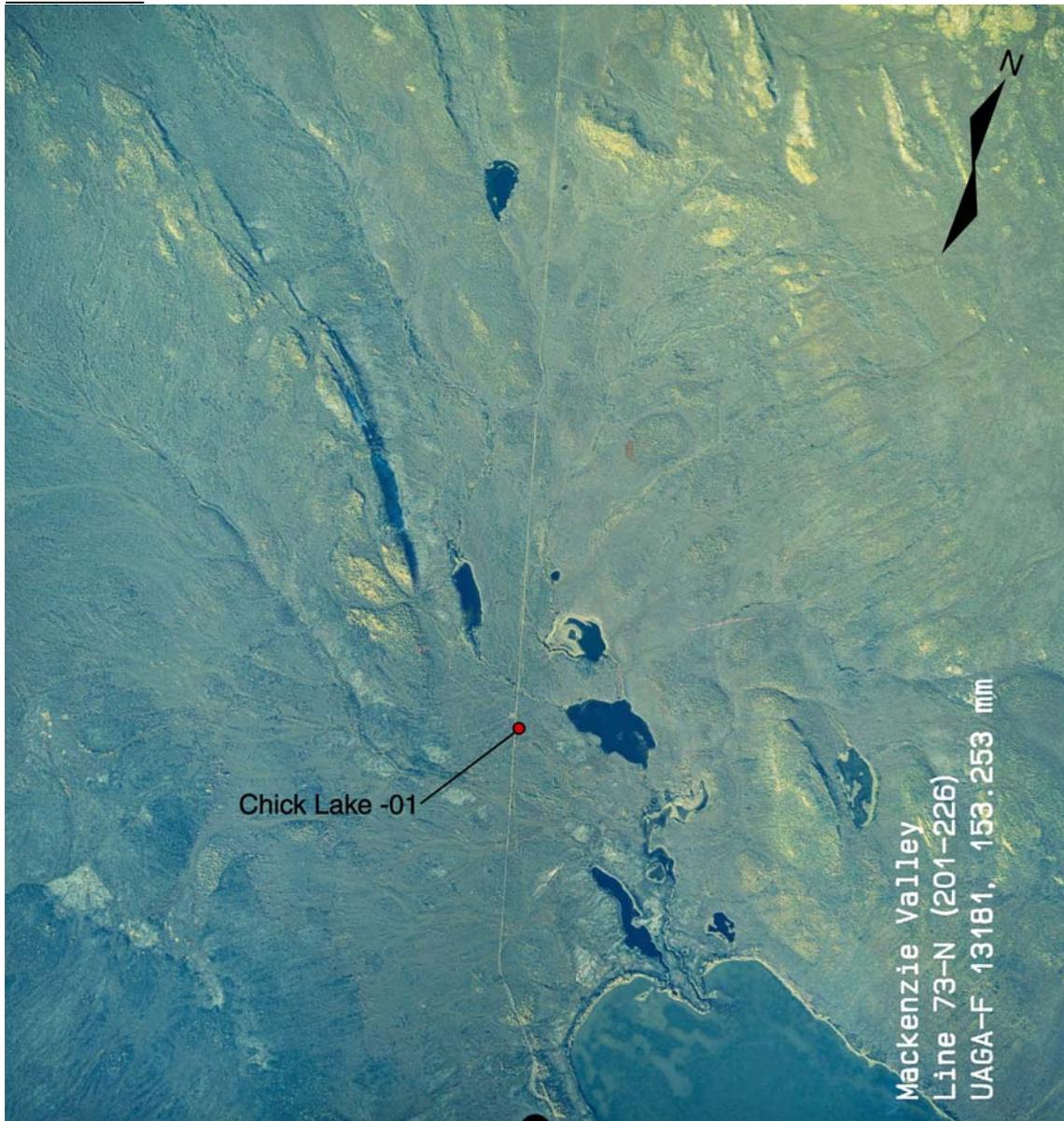


September 24 2007 data

Chick Lake



Chick Lake



Chick Lake



Photo taken Sep 2007



Photo taken Sep 2007

Chick Lake



Photo taken Sep 2007

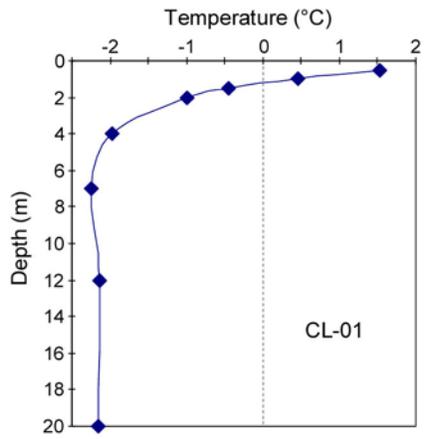


Photo taken Sep 2008

Chick Lake

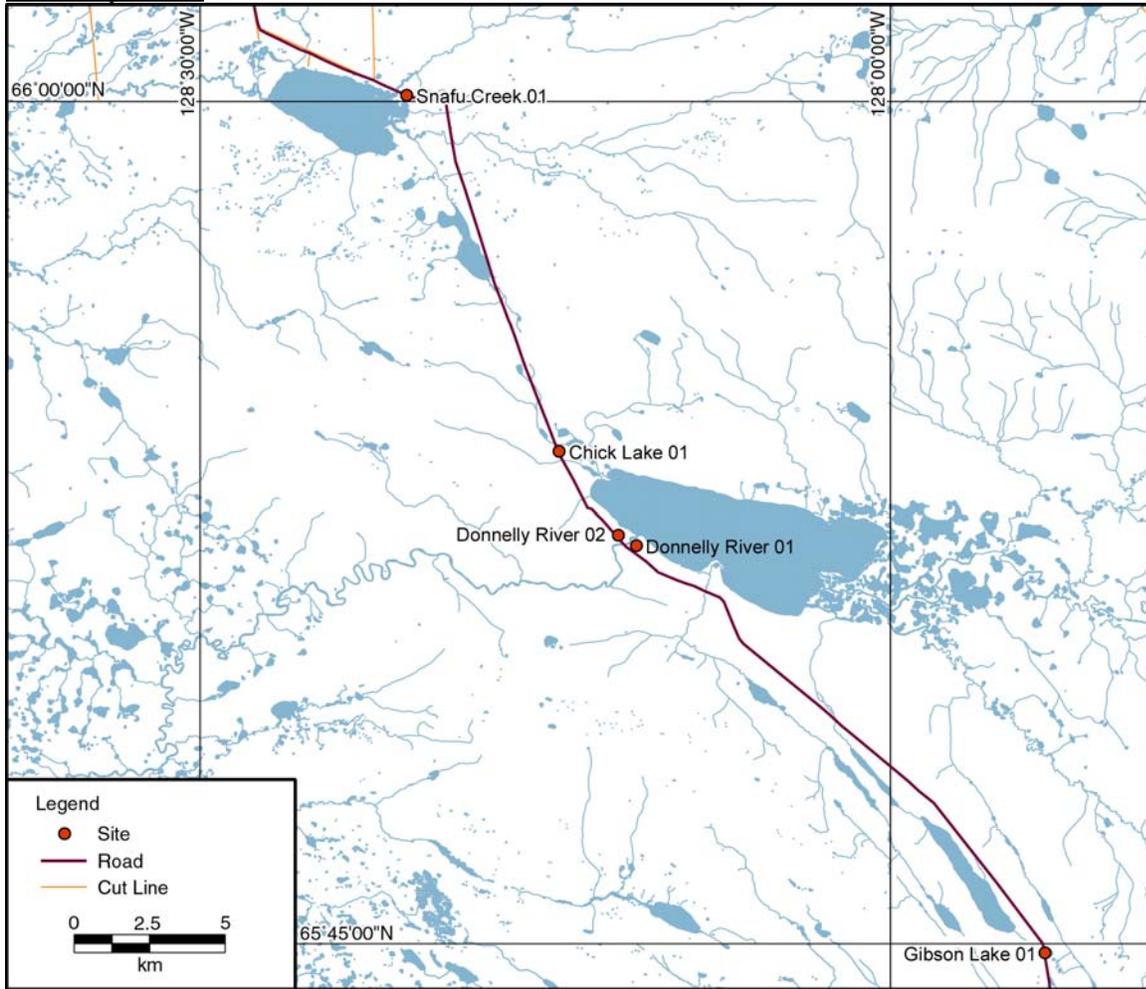
Borehole No: CL-01		Northing: 7308482		Easting: 532632		Zone: 9								
Borehole Depth: 21.3		Location: Chick Lake 01				Date: 10-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Peat: Roots, fibrous organic material, roots, wood chips and moss, reddish medium brown.	Frozen - Vx - 25 to 30 %				1570.00							
1		Clay: And organic material, roots, wood chips, medium to dark grey.					1472.00							
2		Clay: Silty, trace sand, high plastic, dark grey.												
3							150.40							
4							104.90							
5							1284.00							
6														
7														
8														
9														
10			Ice rich zones Vx up to 60% spaced approximately 1 to 1.5 m apart, non ice-rich zones Vx 5 to 10%											
11														
12														
13			Ice rich zones Vx up to 25-35% spaced approximately 1 to 1.5 m apart											
14		Clay: Laminated layers of lighter and darker clay.	Ice rich zones Vx up to 10-20% spaced approximately 1 to 1.5 m apart											
15							1696.00							
16														
17														
18			Ice rich zones Vx up to 30 to 50% spaced approximately 1 to 1.5 m apart, non ice-rich zones Vx 10 to 15%											
19		Clay: Silty, trace sand, trace gravel (angular to rounded, up to 15 mm diameter).												
20														
21			Ice rich zones Vx up to 40 to 50% spaced approximately 1 to 1.5 m apart, non ice-rich											
22														

Chick Lake



September 24 2007 data

Donnelly River



Donnelly River



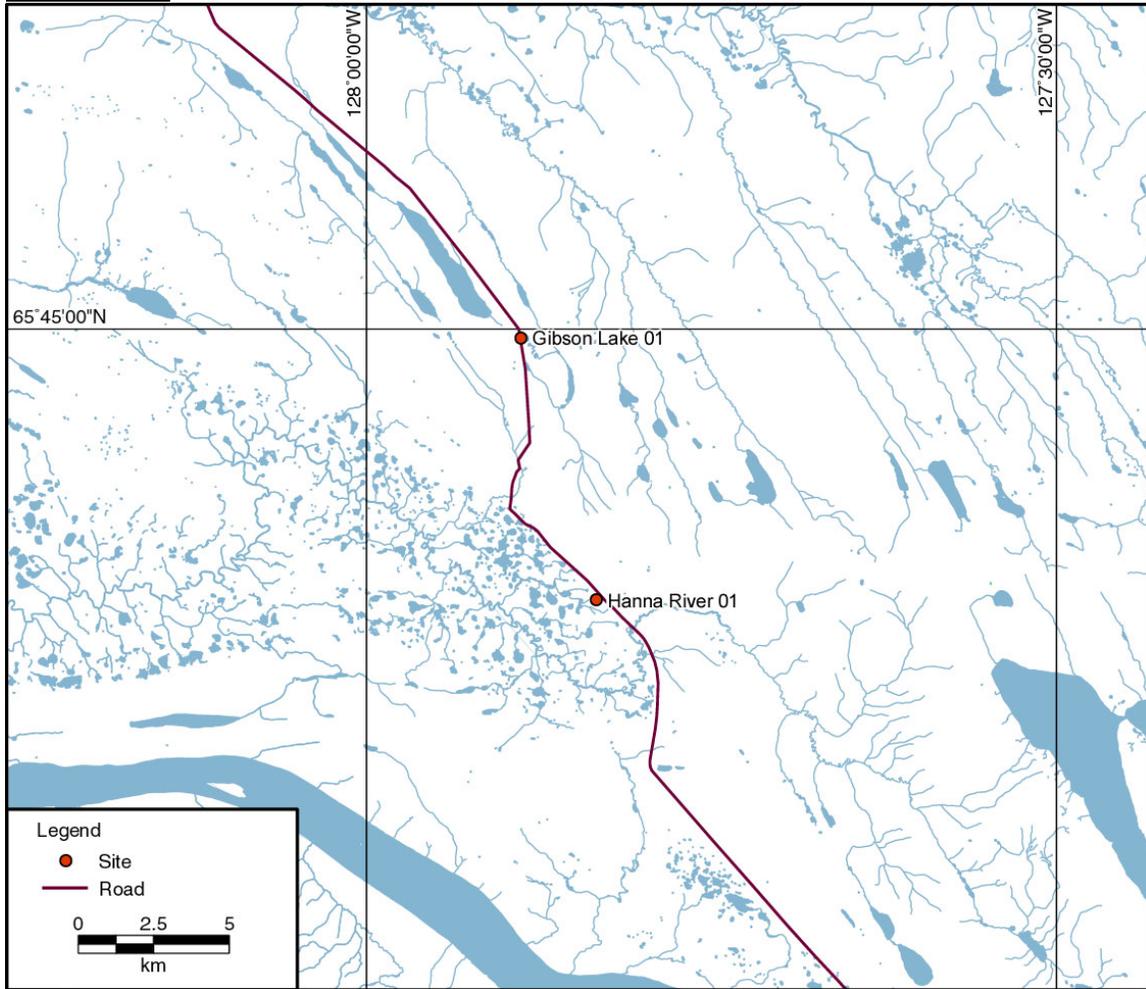
Donnelly River

Borehole No: DR-01		Northing: 7305468		Easting: 537222		Zone: 9							
Borehole Depth: <1.5		Location: Donnelly River 01				Date: 11-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Refusal met before reaching 1.5m depth											
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													

Donnelly River

Borehole No: DR-02		Northing: 7305806		Easting: 536618		Zone: 9											
Borehole Depth: <1.5		Location: Donnelly River 02				Date: 11-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Refusal met before reaching 1.5m depth															
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Gibson Lake



Gibson Lake



Gibson Lake

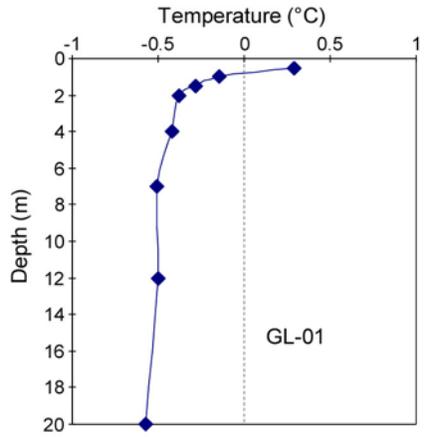


Photo taken Sep 2007

Gibson Lake

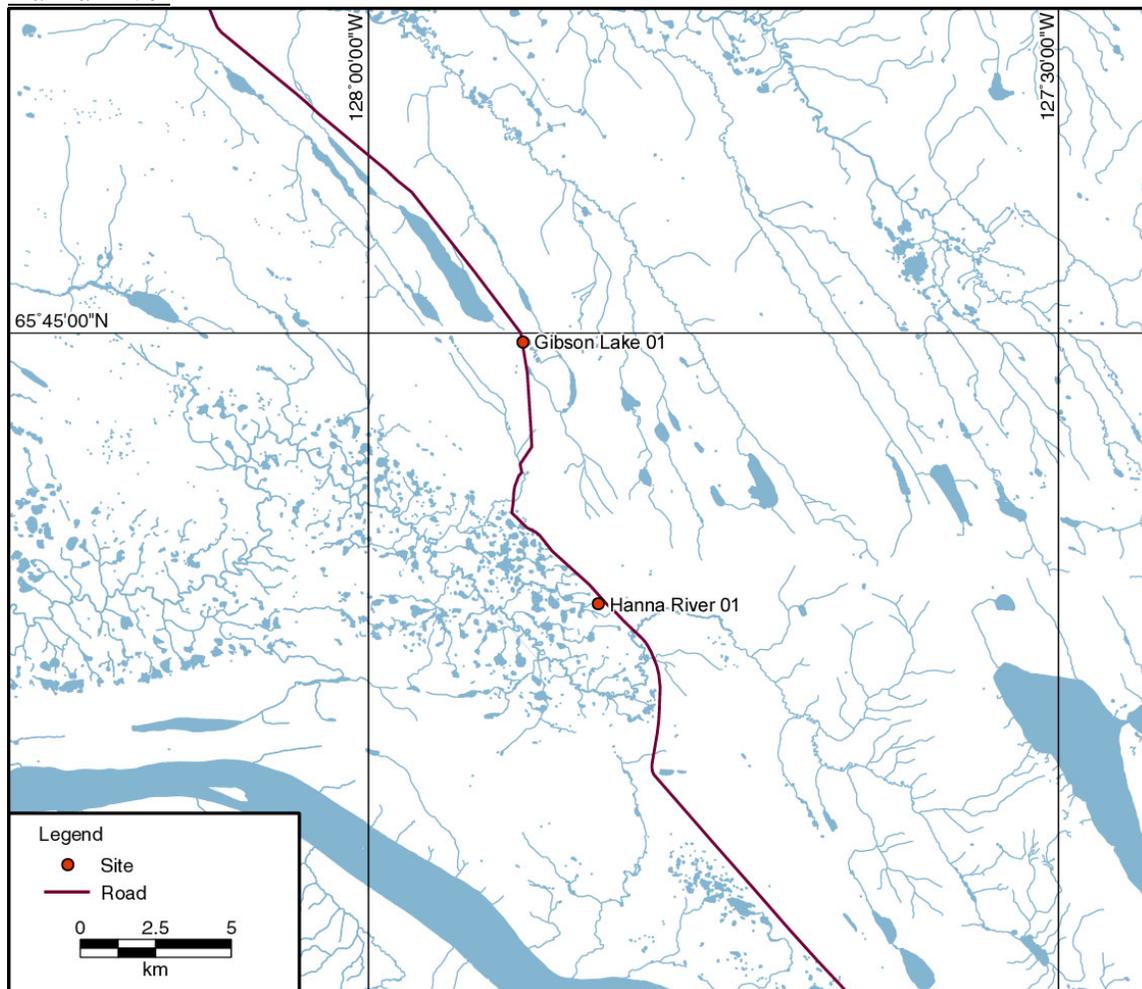
Borehole No: GL-01		Northing: 7292195		Easting: 550960		Zone: 9											
Borehole Depth: 21.3		Location: Gibson Lake 01				Date: 5-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Topsoil: Roots, rootlets, twigs, black.	Frozen -Vx-10% and Nbn														
1		Clay: Trace gravel, trace silt, dark grey.															
2		Clay: Silty, trace sand to sandy, trace gravel (rounded to sub-rounded, up to 50 mm diameter), dark grey.	Vx -10 to 15%				1786.00										
3																	
4																	
5																	
6																	
7			Vx - less than 5%														
8																	
9																	
10																	
11																	
12																	
13			Vx - 5 to 10%														
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Gibson Lake

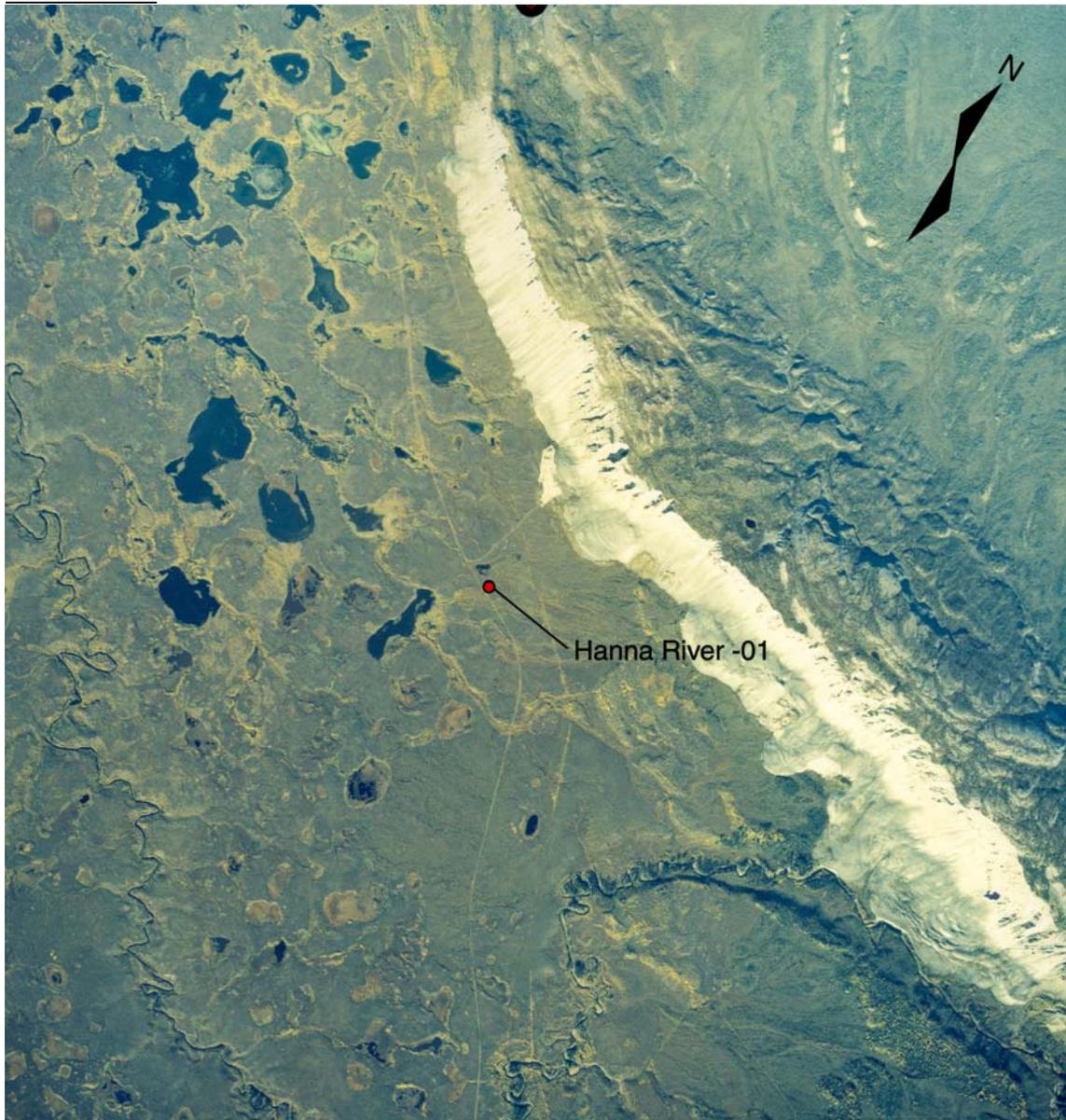


September 24 2007 data

Hanna River



Hanna River



Hanna River



Photo taken Aug2006

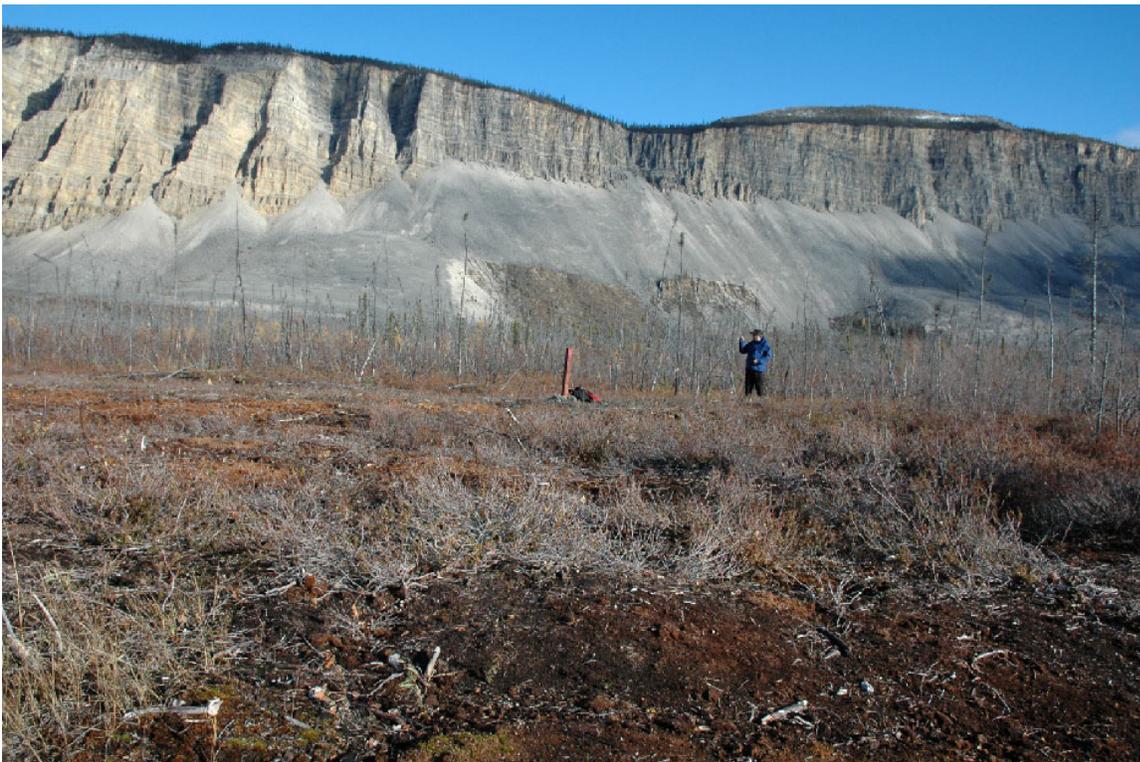


Photo taken Sep 2007

Hanna River

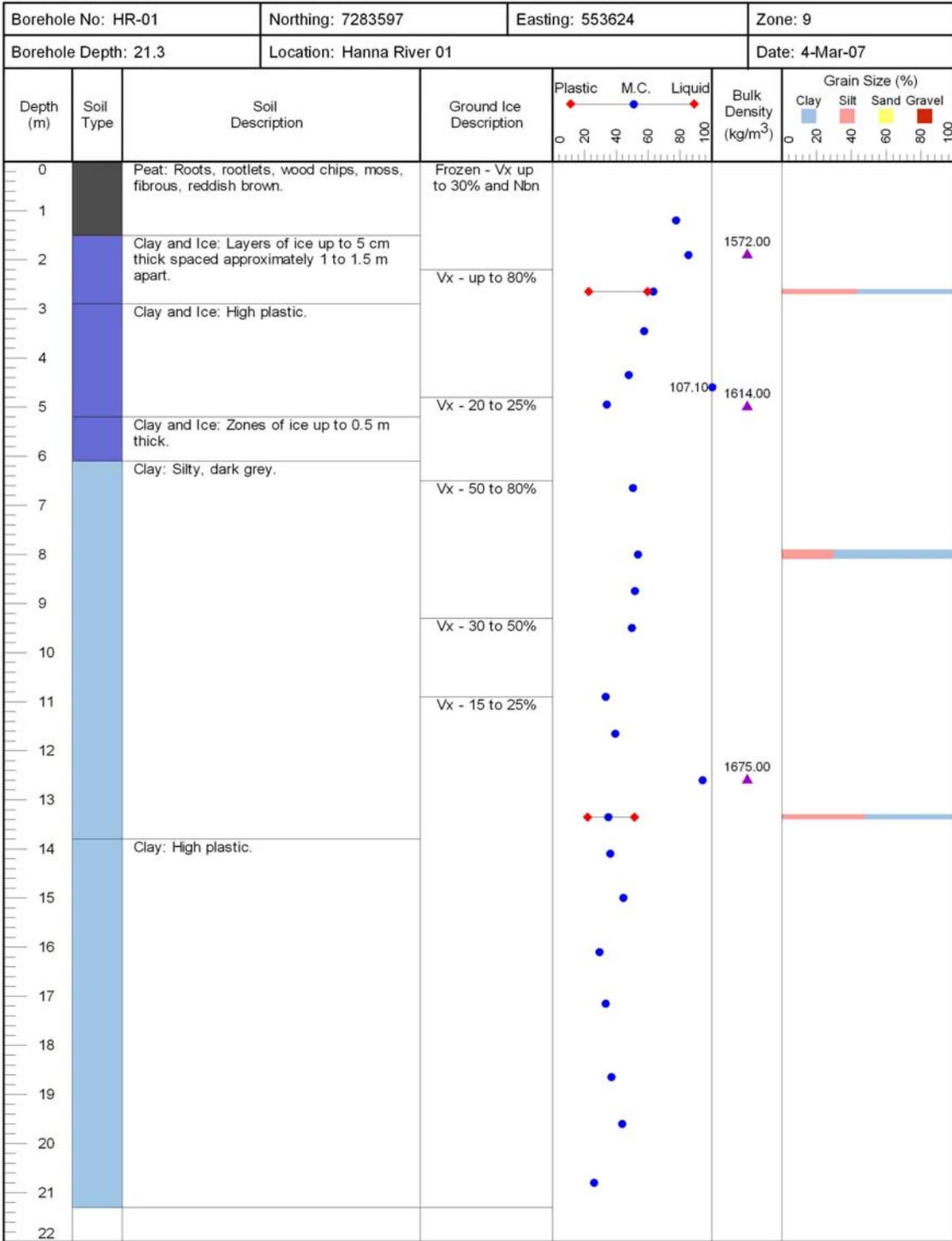


Photo taken Sep 2007

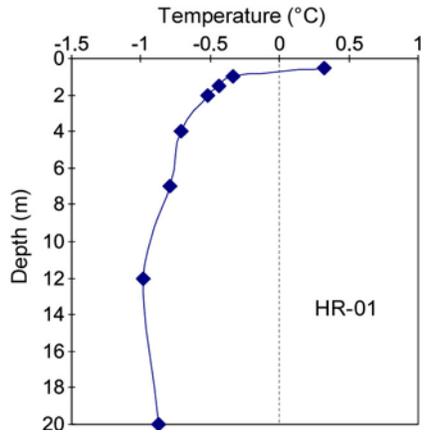


Photo taken Sep 2008

Hanna River

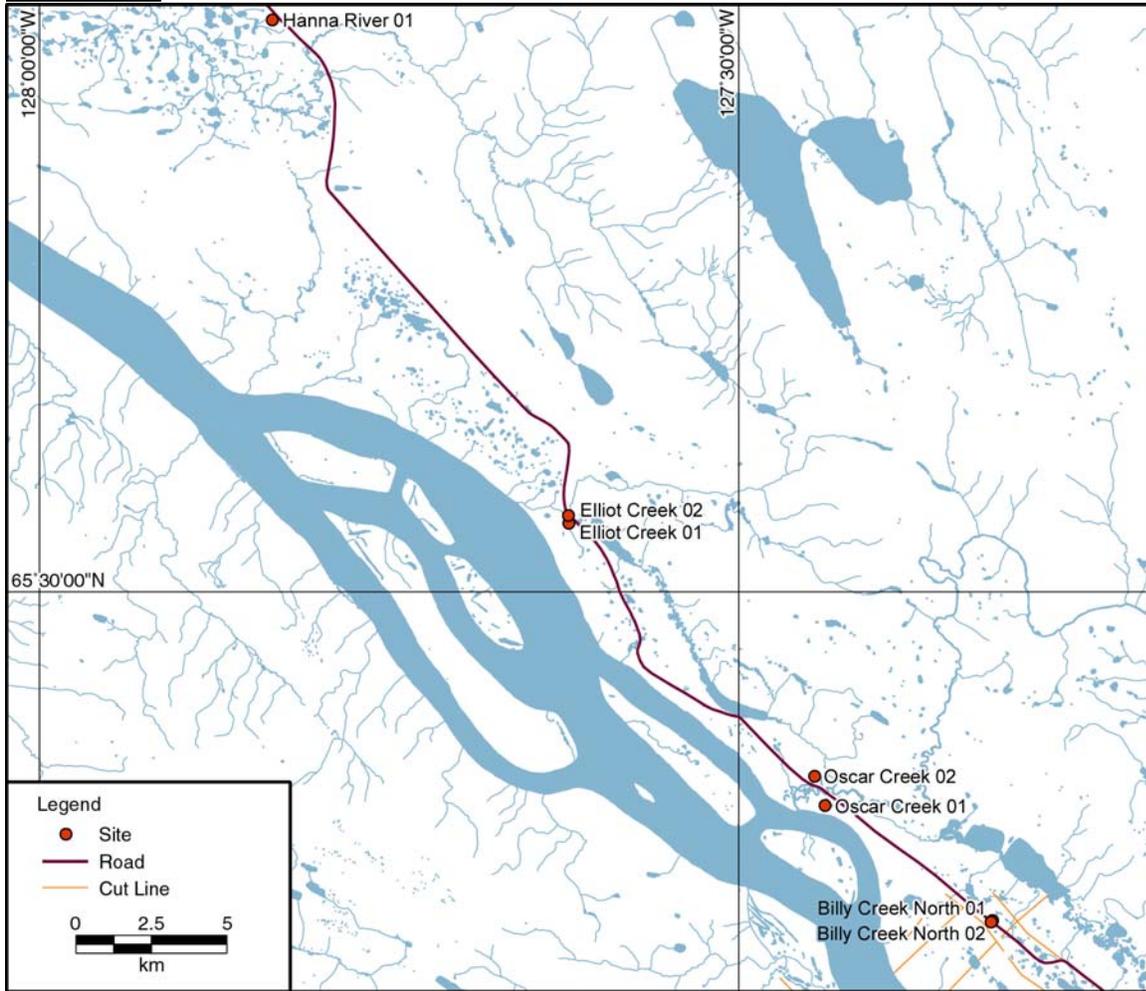


Hanna River

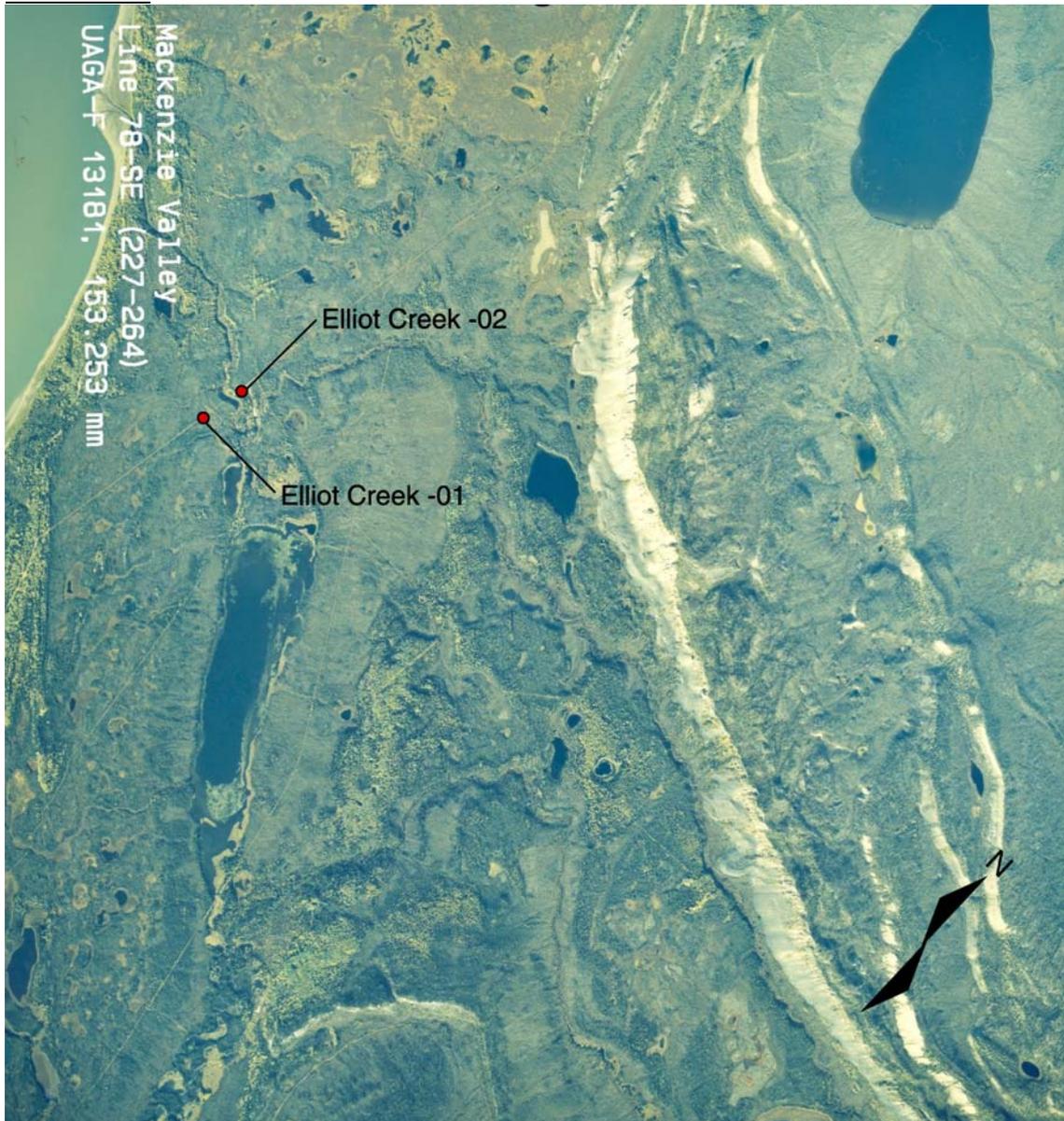


September 24 2007 data

Elliot Creek



Elliot Creek



Elliot Creek



Photo taken Aug 2006



Photo taken Sep 2008

Elliot Creek

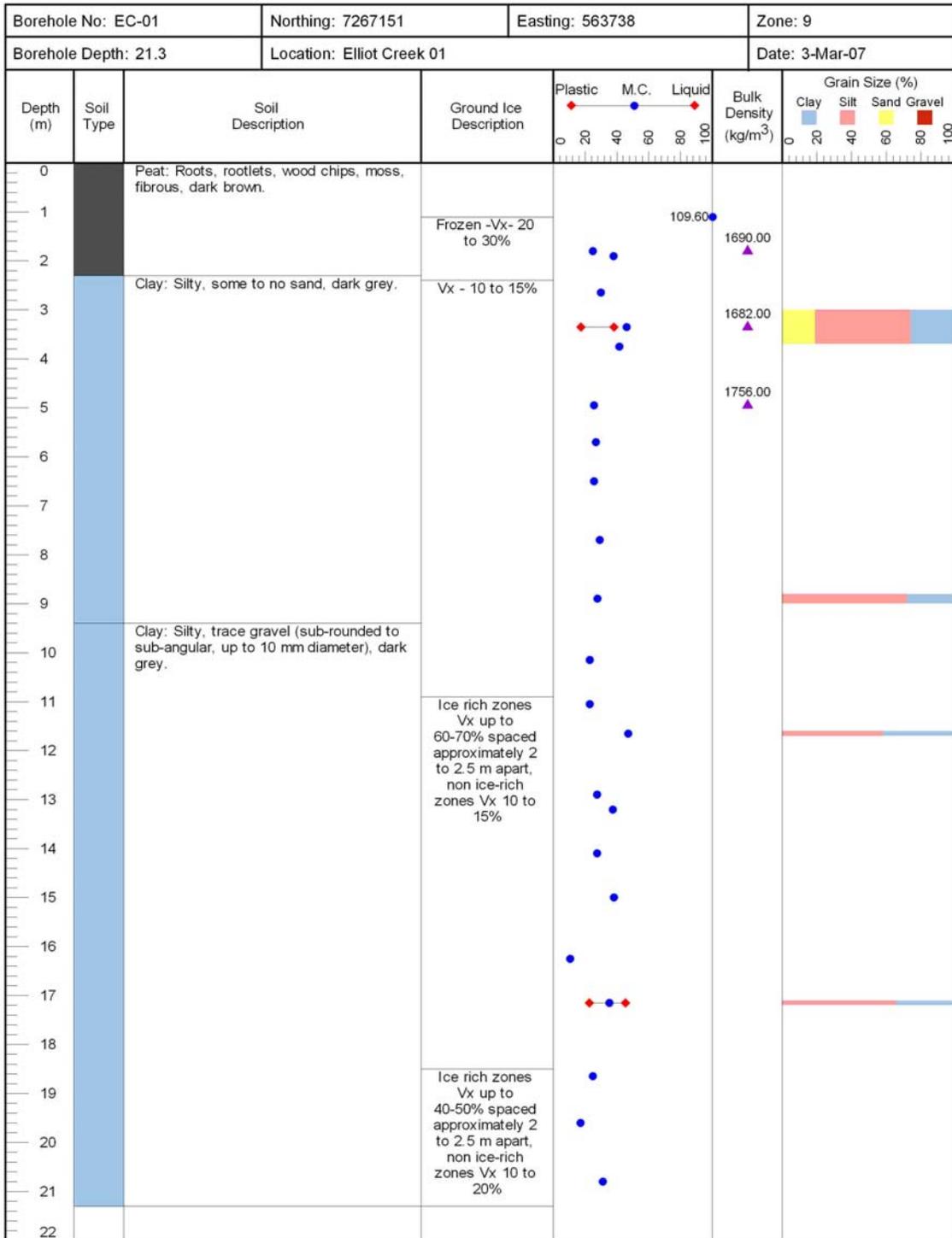


Photo taken Sep 2008



Photo taken Sep 2008

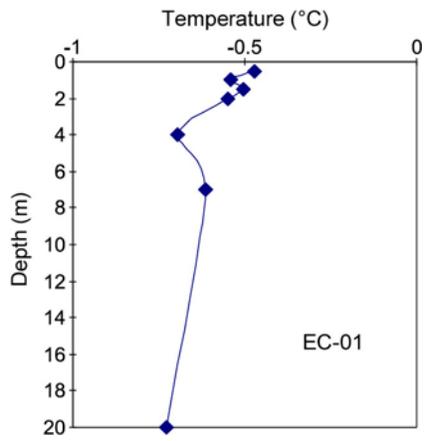
Elliot Creek



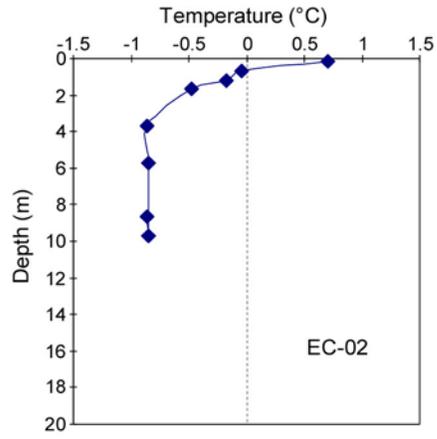
Elliot Creek

Borehole No: EC-02		Northing: 7267404		Easting: 563712		Zone: 9								
Borehole Depth: 12.2		Location: Elliot Creek 02				Date: 12-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic	M.C.	Liquid	Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Peat: Roots, rootlets, wood chips, moss, fibrous, reddish brown.	Frozen - Nbn											
1		Silt: Clayey, some sand, trace peat and grass roots, dark grey.												
2														
3		Peat: Fibrous organic material, trace shells, black.	Vx - 20%											
4		Sand and Gravel: (rounded to sub-rounded, up to 25 mm), trace clay, trace silt, medium brown.												
5		Sand: Gravelly (rounded to sub-rounded, up to 75 mm), some silt/clays, medium brown.												
6		Clay: Some to no gravel (rounded to sub-rounded, up to 25 mm), some silt in laminated layers up to 0.5 cm thick, trace sand, medium to dark grey.	Vx - 10%											
7			Unfrozen											
8			Frozen - Vx 10 to 15%											
9														
10		Sand and Gravel: (rounded to sub-rounded, up to 25 mm), trace clay, trace silt, moist, light brown.												
11														
12		Sand and Gravel: Silt content increasing.												
13		Refusal on inferred boulders and cobbles.												
14														
15														
16														
17														
18														
19														
20														
21														
22														

Elliot Creek

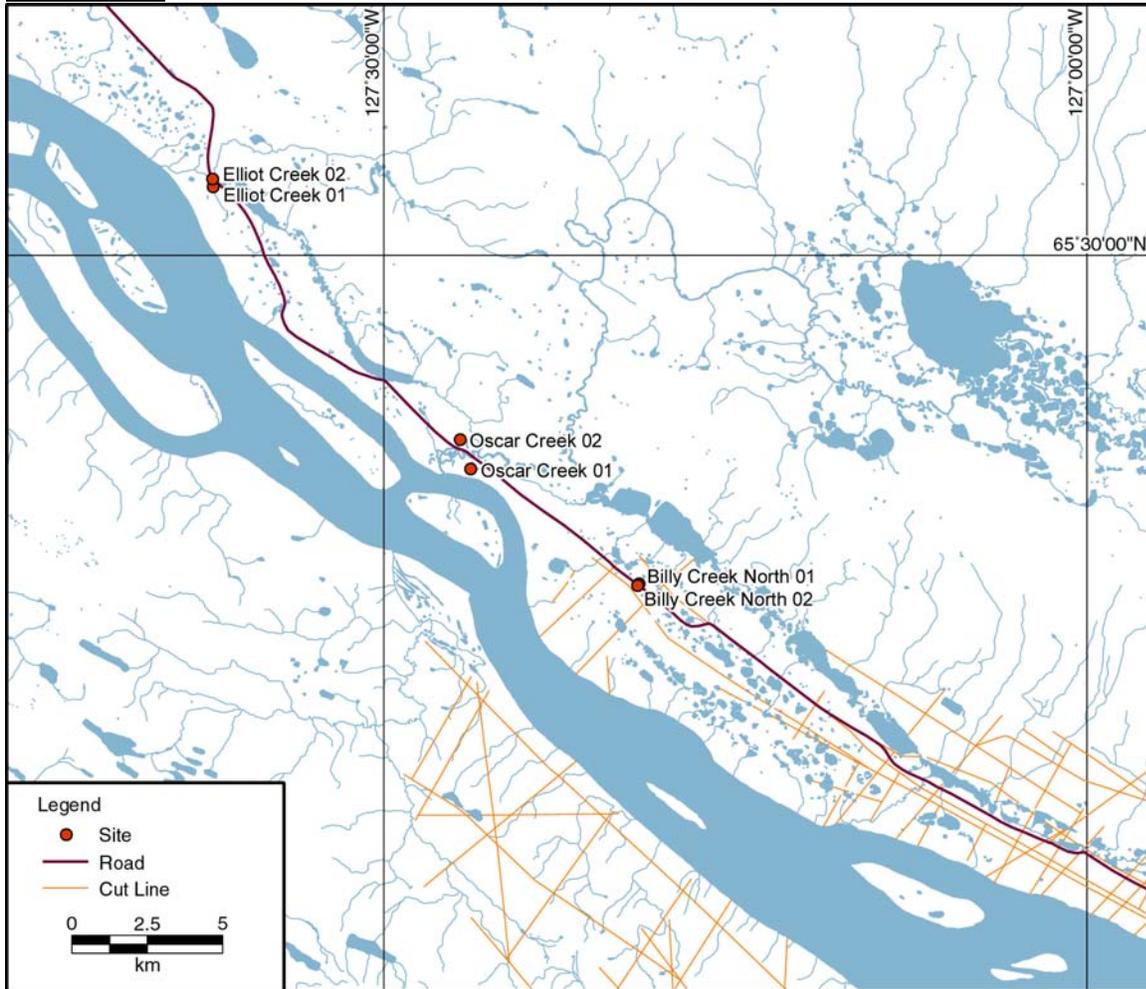


September 24 2007 data



September 24 2007 data

Oscar Creek



Oscar Creek



Oscar Creek



Photo taken Sep 2007



Photo taken Sep 2007

Oscar Creek



Photo taken Sep 2008



Photo taken Sep 2008

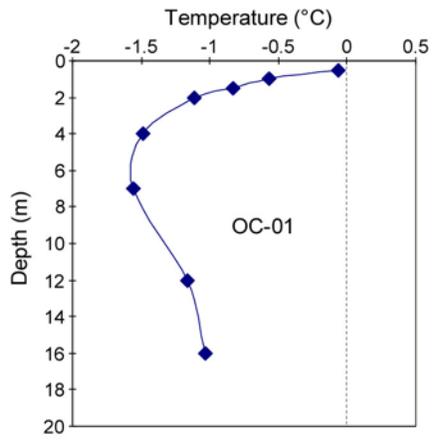
Oscar Creek

Borehole No: OC-01		Northing: 7258009		Easting: 572437		Zone: 9												
Borehole Depth: 18.9		Location: Oscar Creek 01				Date: 3-Mar-07												
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)										
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel							
0		Peat: Roots, rootlets, wood chips, moss, fibrous, dark brown.	Frozen - Vx, Vr - 15 to 20%															
1		Clay: Silty, trace to some sand, trace organics and roots, medium plastic, dark grey.																
2			Vx - 15 to 20%				1234.00											
3																		
4		Clay and Silt: Trace gravel (rounded to sub-rounded, up to 10 mm diameter), medium grey.	Nbn				1689.00											
5		Sand: Gravelly (rounded to sub-rounded, up to 10 mm diameter), some silt/clay, medium greyish brown.	Unfrozen				1595.00											
6																		
7		Clay: Silty, trace sand, dark grey																
8																		
9																		
10																		
11		Clay: Trace gravel (rounded to sub-rounded, up to 10 mm diameter), medium cohesive, dark grey.																
12		Sand and Gravel: (rounded to sub-angular, up to 25 mm diameter), some silt/clay, medium brown.																
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		

Oscar Creek

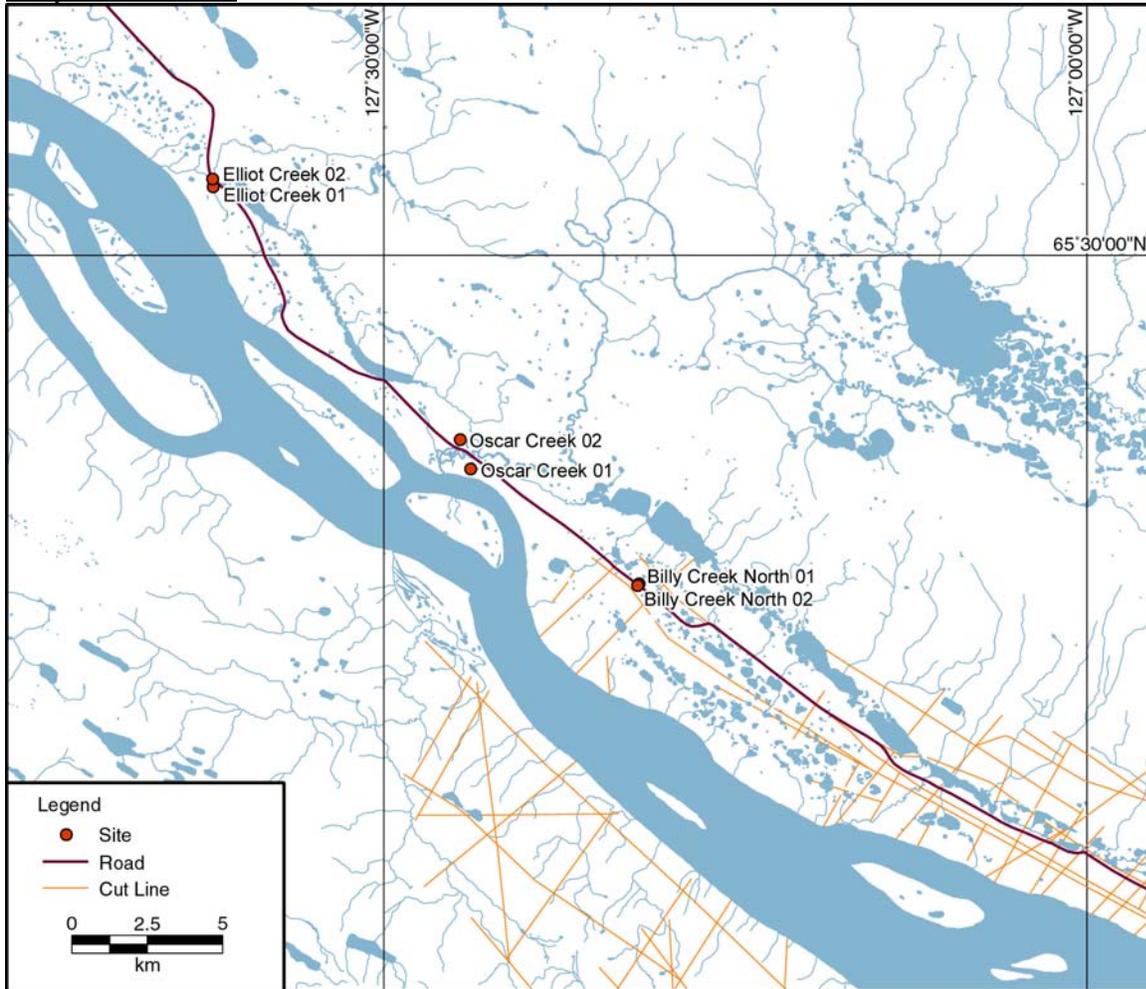
Borehole No: OC-02		Northing: 7258968		Easting: 572068		Zone: 9							
Borehole Depth: <1.5		Location: Oscar Creek 02				Date: 13-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Refusal met before reaching 1.5m depth											
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													

Oscar Creek

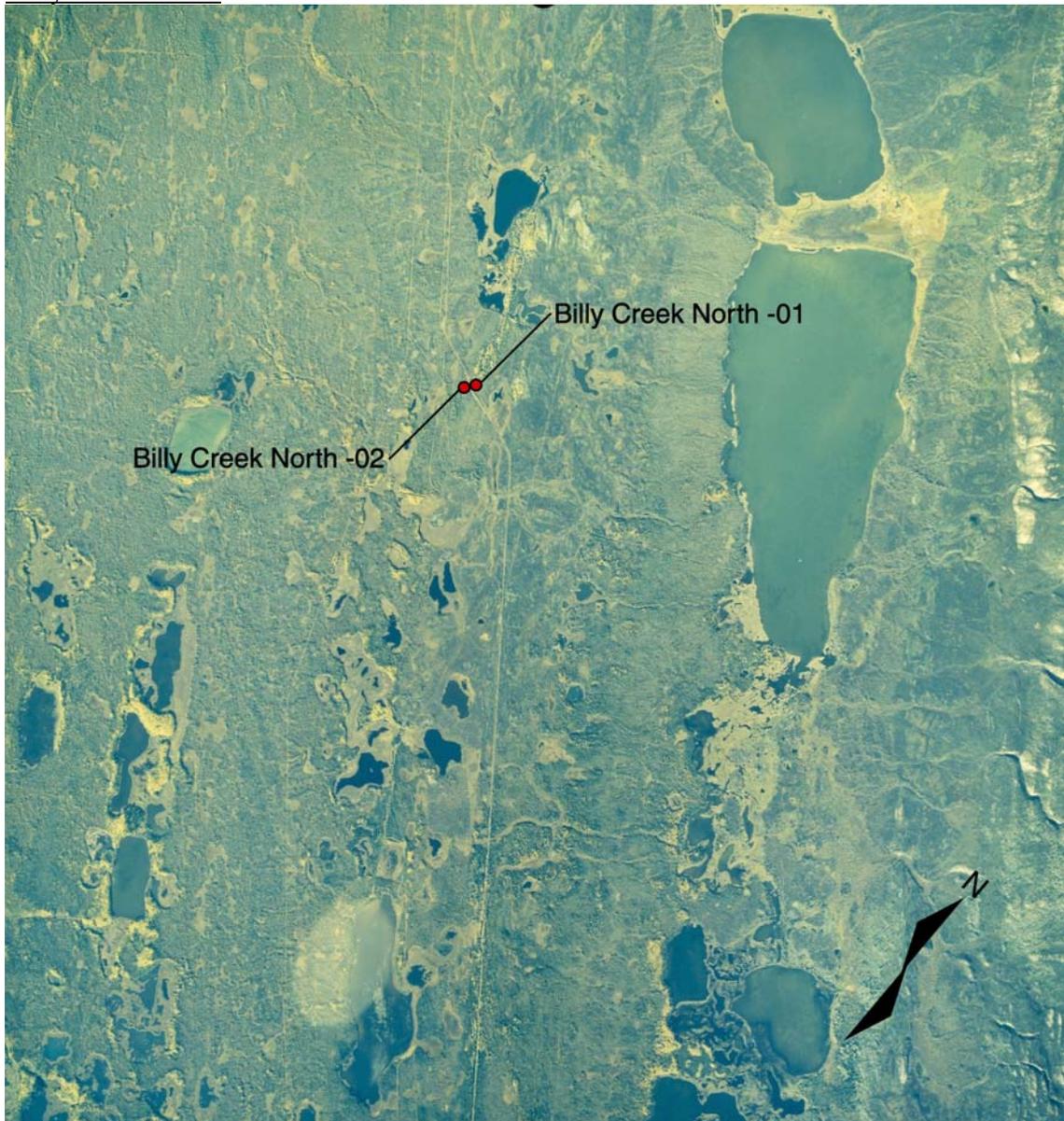


September 24 2007 data

Billy Creek North



Billy Creek North



Billy Creek North



Photo taken Sep 2008



Photo taken Sep 2007

Billy Creek North

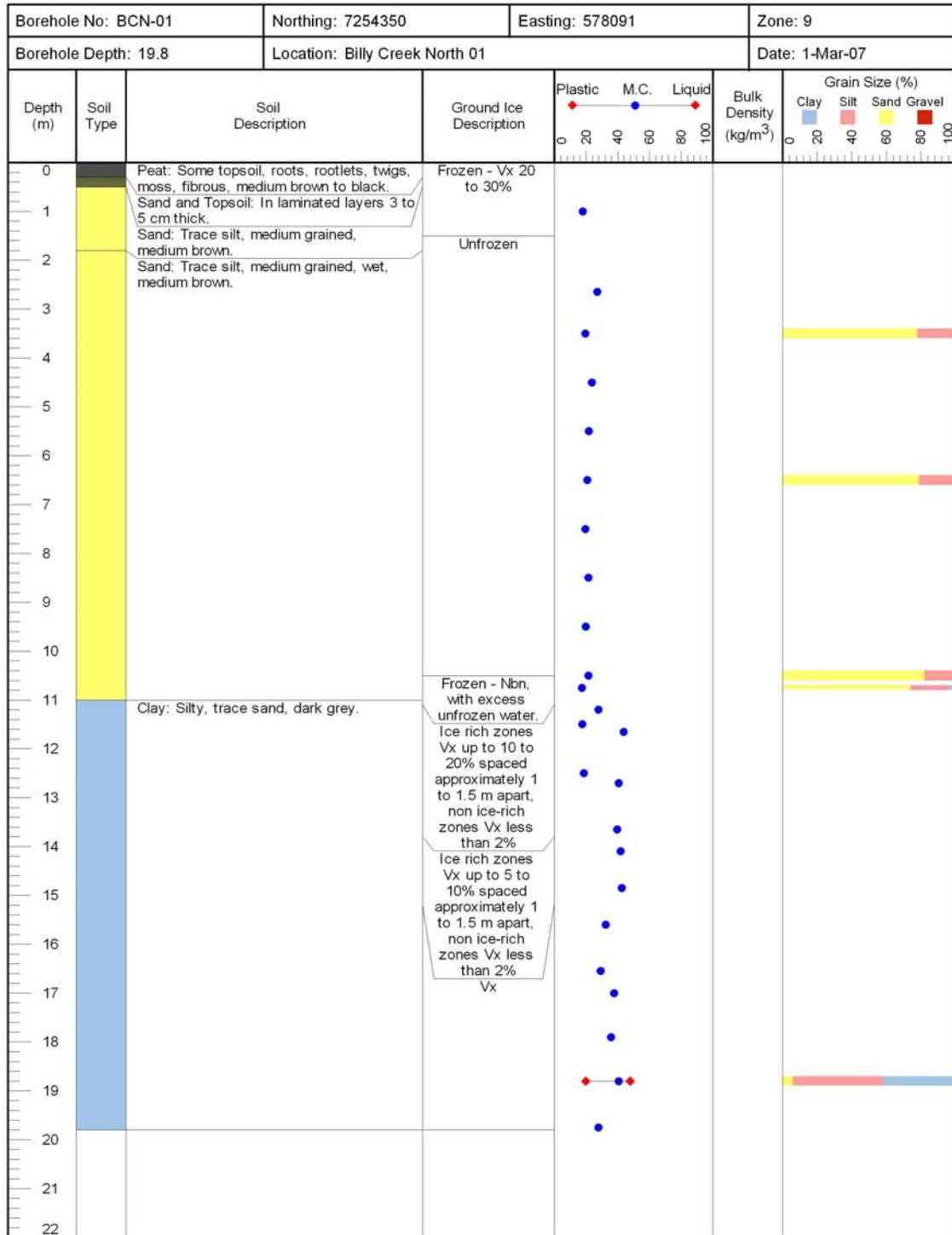


Photo taken Sep 2008



Photo taken Sep 2007

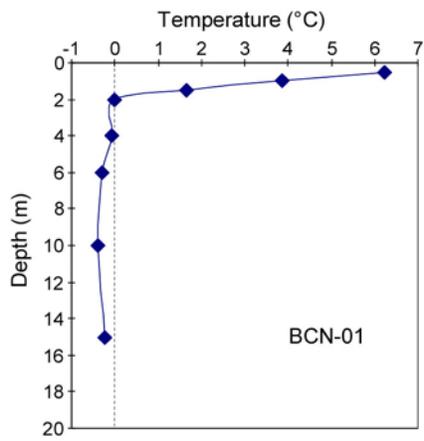
Billy Creek North



Billy Creek North

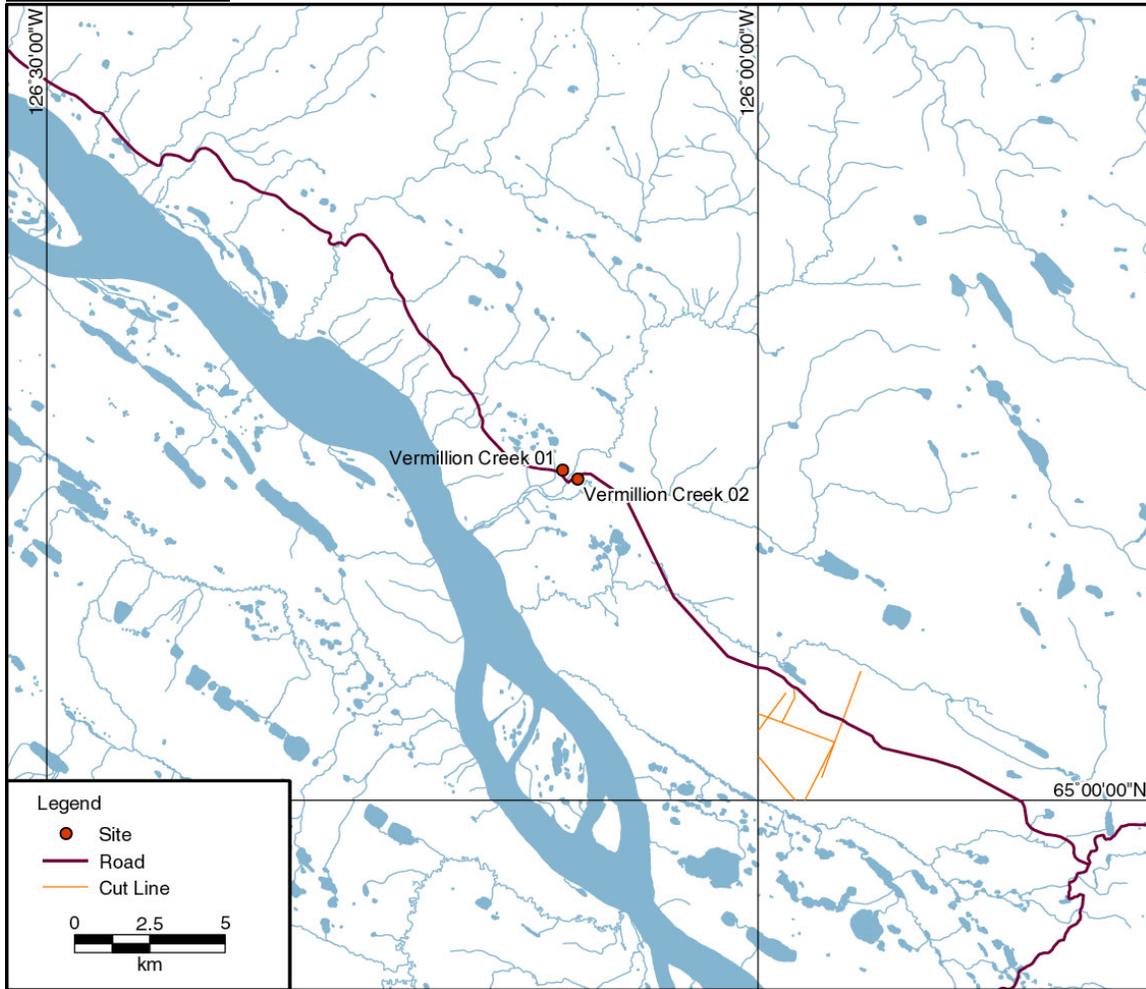
Borehole No: BCN-02		Northing: 7254294		Easting: 578046		Zone: 9											
Borehole Depth: 2.3		Location: Billy Creek North 02				Date: 13-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Refusal met at 2.3m depth															
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Billy Creek North

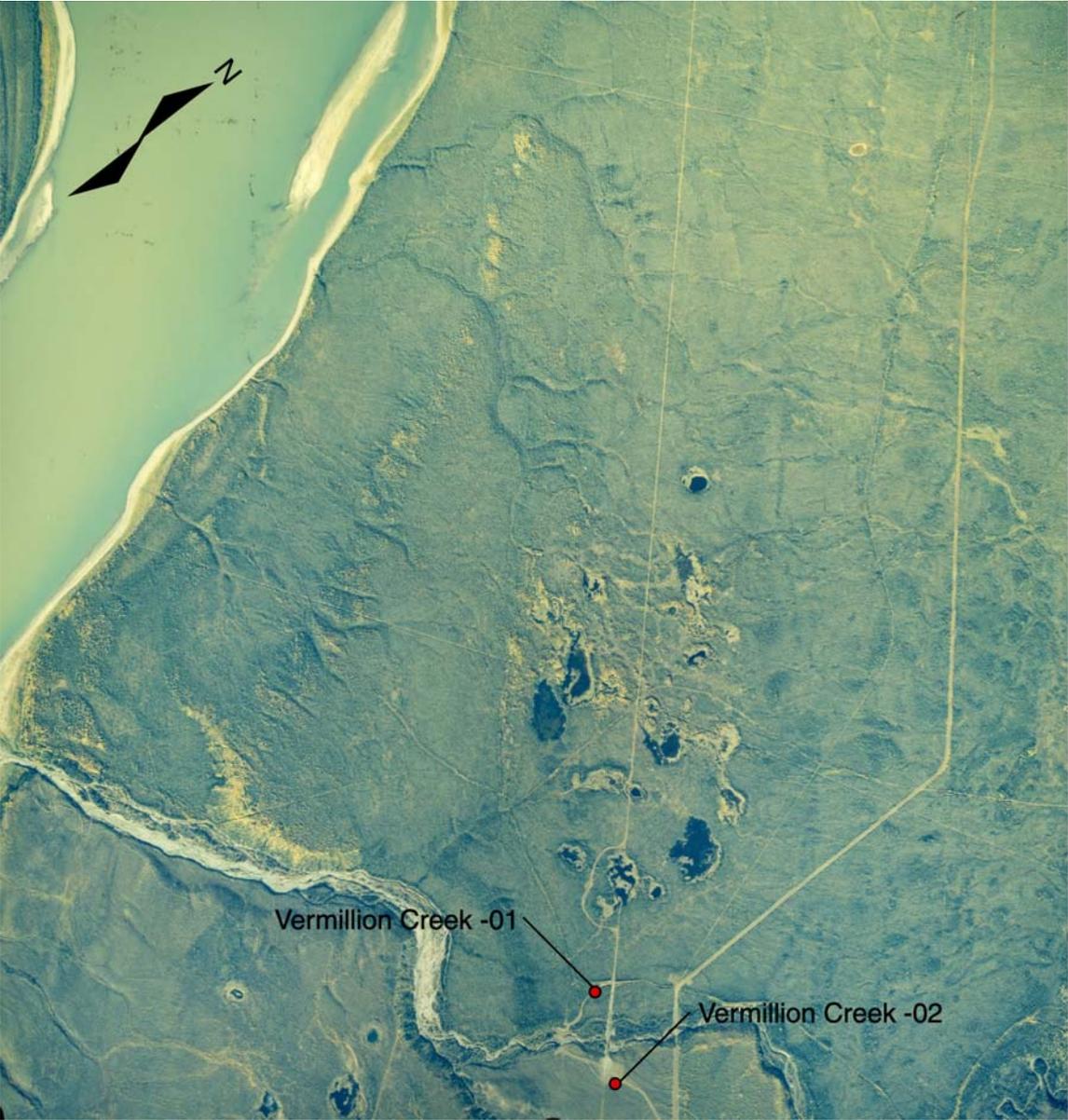


August 11 2007 data

Vermillion Creek



Vermillion Creek



Vermillion Creek



Photo taken Sep 2007



Photo taken Sep 2007

Vermillion Creek



Photo taken Sep 2007



Photo taken Sep 2007

Vermillion Creek

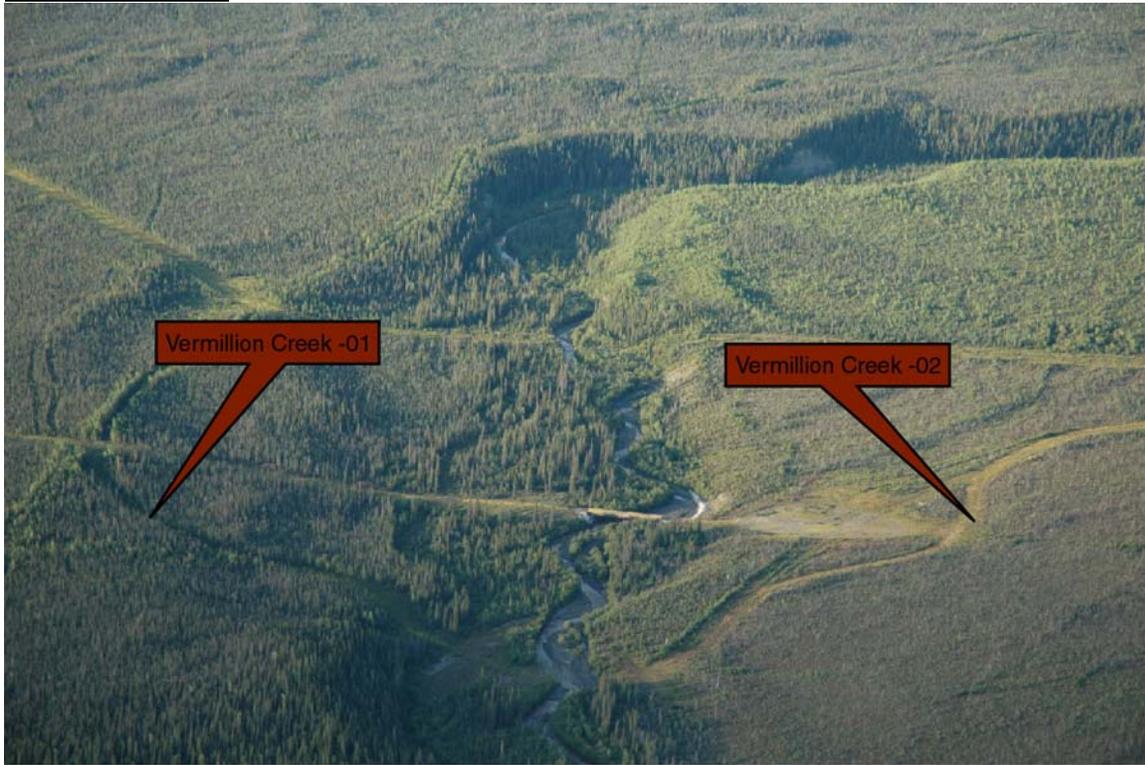


Photo taken Aug 2006

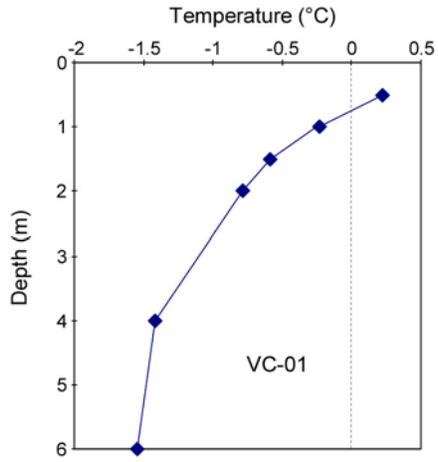
Vermillion Creek

Borehole No: VC-01		Northing: 7222434		Easting: 634464		Zone: 9								
Borehole Depth: 8.2		Location: Vermillion Creek 01				Date: 14-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Peat: Roots, rootlets, wood chips, moss, fibrous, reddish brown.	Frozen - Vx 25%											
1		Clay: Trace to some roots, rootlets, wood chips etc, medium brown.	Vx less than 5%											
2		Clay: Silty, trace to some gravel (rounded to sub-rounded, up to 25 mm diameter), dark grey.												
3		Clay: Silty, dark grey.												
4														
5			Ice rich zones Vx up to 40 to 50% spaced approximately 1 to 1.5 m apart, non ice-rich zones Vx less than 5%											
6														
7														
8														
9		Refusal on inferred boulders and cobbles.												
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

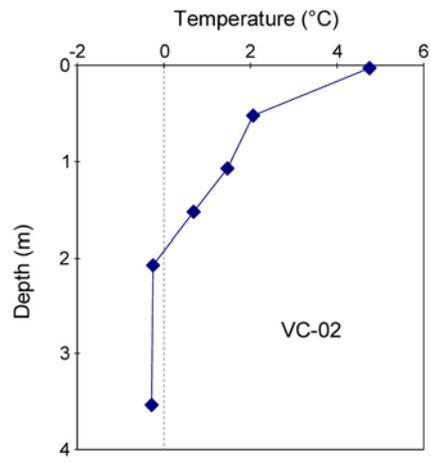
Vermillion Creek

Borehole No: VC-02		Northing: 7222160		Easting: 634972		Zone: 9												
Borehole Depth: 5.5		Location: Vermillion Creek 02				Date: 14-Mar-07												
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)										
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel				
0		Peat: Roots, rootlets, wood chips, moss, fibrous, reddish brown.	Frozen - Vx - 25-30%				117.40											
1																		
2		Clay: Silty, some gravel, trace to some sand, dark grey.	Vx - Less than 5%															
3			Vx - 5 to 15%															
4																		
5																		
6		Refusal on inferred boulders and cobbles.																
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		

Vermillion Creek

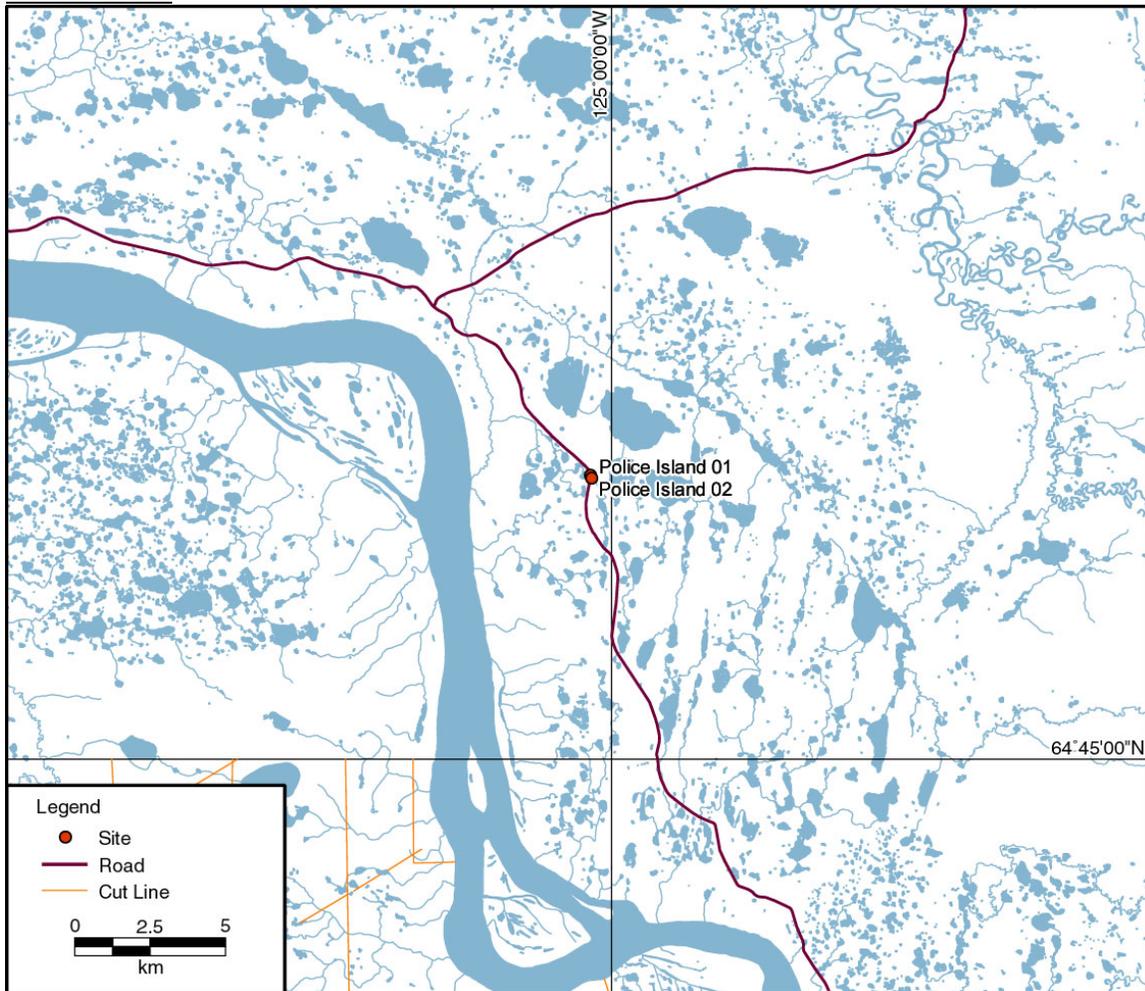


September 29 2007 data

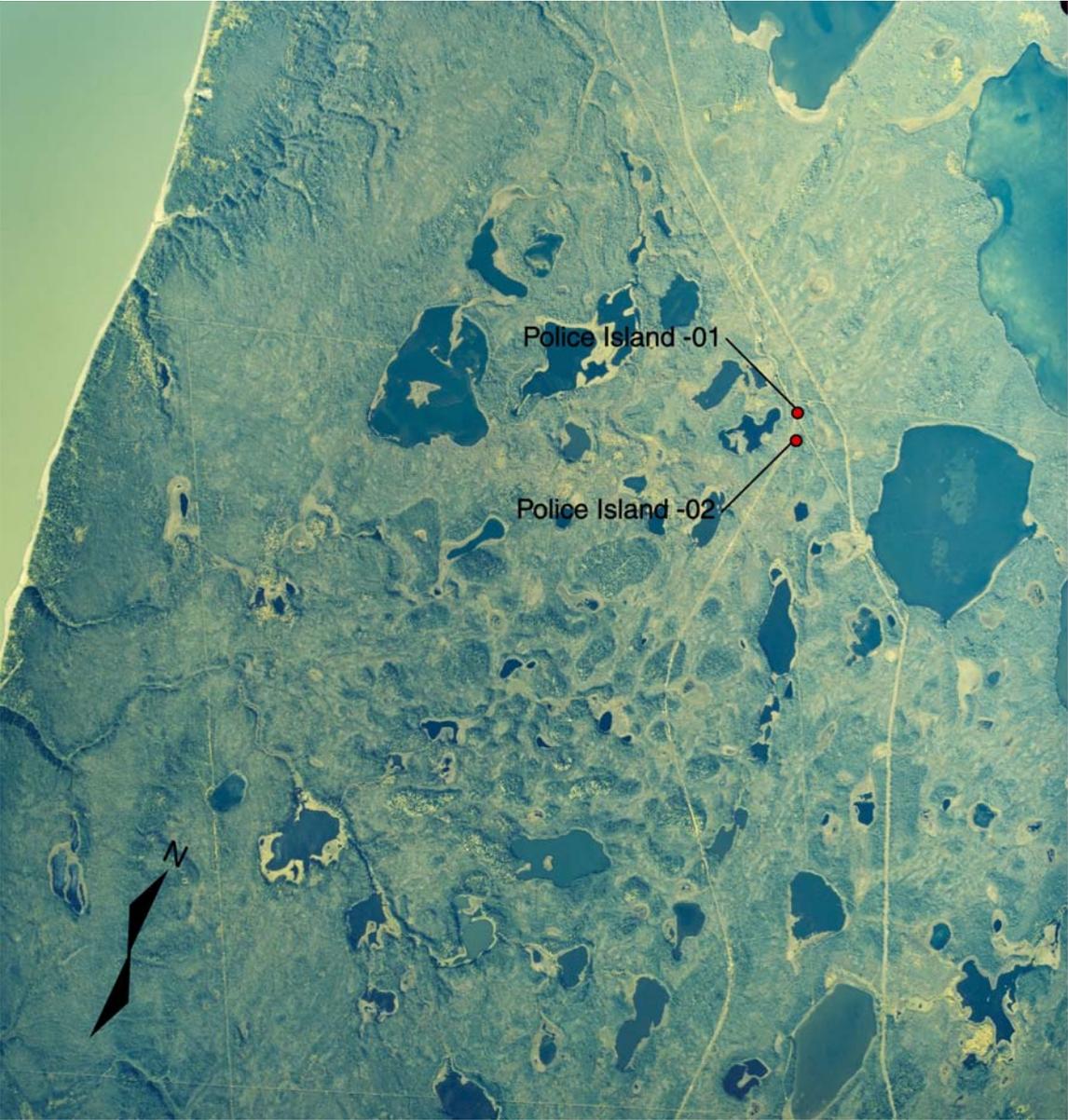


September 29 2008 data

Police Island



Police Island



Police Island



Photo taken Aug 2007



Photo taken Aug 2007

Police Island



Photo taken Aug 2008

Police Island



Photo taken Aug 2007

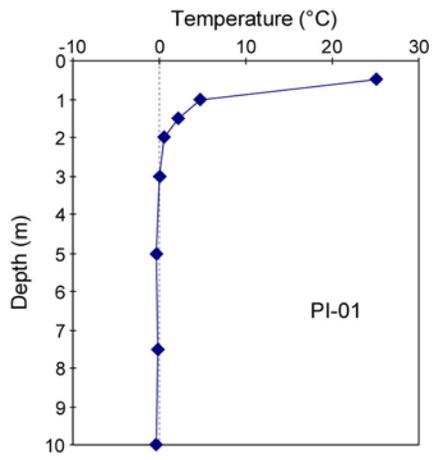
Police Island

Borehole No: PI-01		Northing: 7191493		Easting: 404417		Zone: 10							
Borehole Depth: 12.9		Location: Police Island 01				Date: 6-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Peat: Fibrous.											
		Clay: Silty, brown, sandy, low plastic.											
1		Sand: Silty, fine, saturated, brown, unfrozen, firm.	Nbn										
			UF		•								
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													

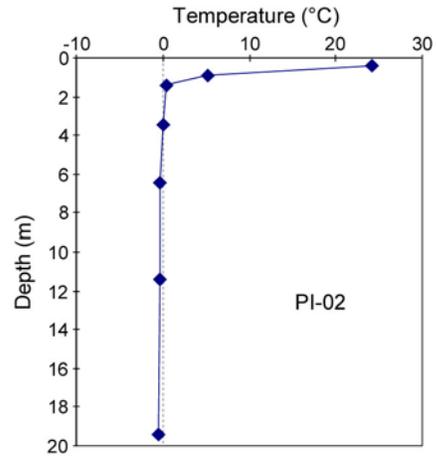
Police Island

Borehole No: PI-02		Northing: 7191398		Easting: 404454		Zone: 10											
Borehole Depth: 19.5		Location: Police Island 02				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Clay: Silty, low plastic, brown to grey, sand lenses.															
1		Sand: Silty, fine, wet to saturated.															
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13		Sand: Fine to coarse, trace gravel to 20 mm sizes.	Nbn														
14																	
15																	
16																	
17		Clay: Silty, trace sand, medium plastic, grey.	Vr-Vs														
18																	
19		Sand: Fine to medium.															
20			Nbn														
21																	
22																	

Police Island

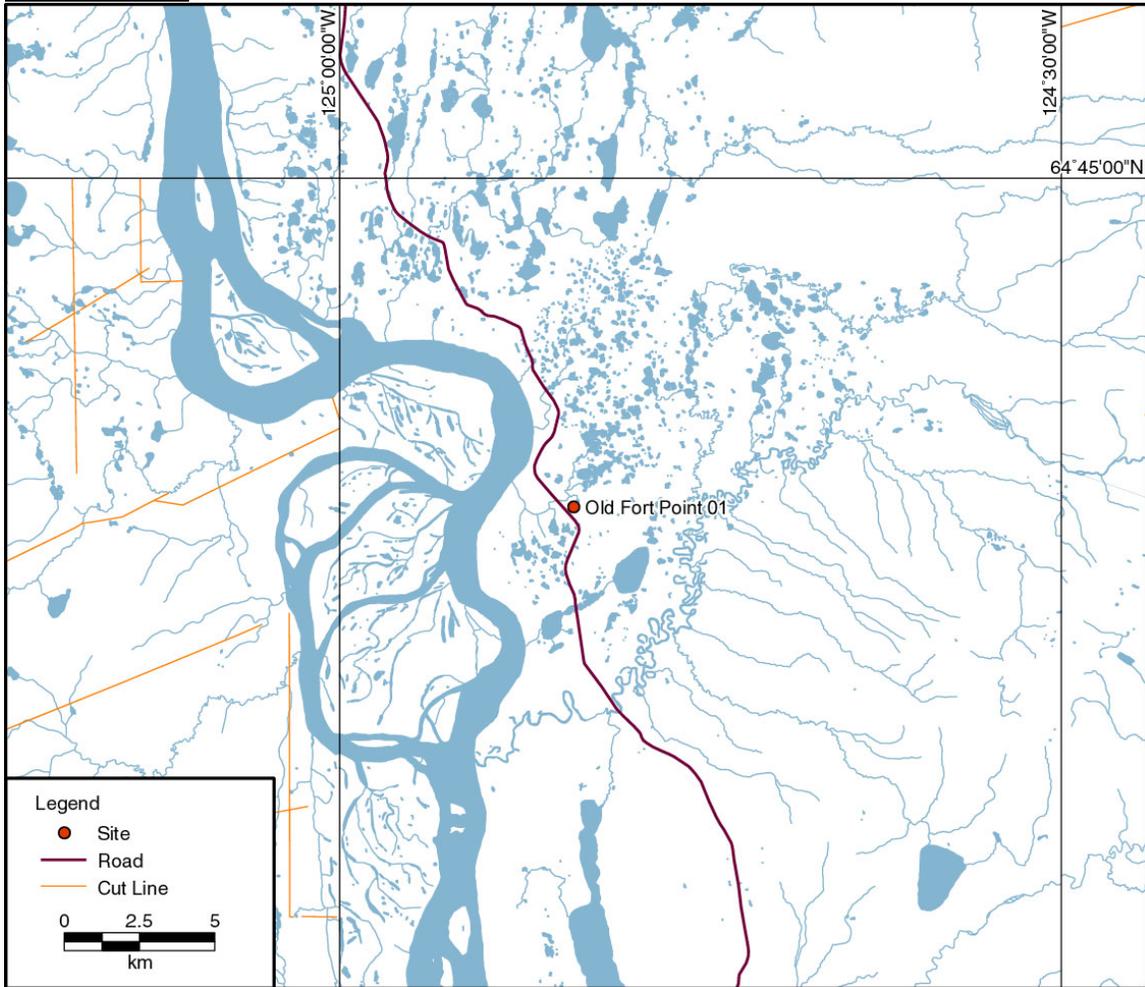


August 17 2007 data



August 17 2007 data

Old Fort Point



Old Fort Point



Old Fort Point



Photo taken Aug 2007



Photo taken Aug 2007

Old Fort Point



Photo taken Aug 2007

Old Fort Point

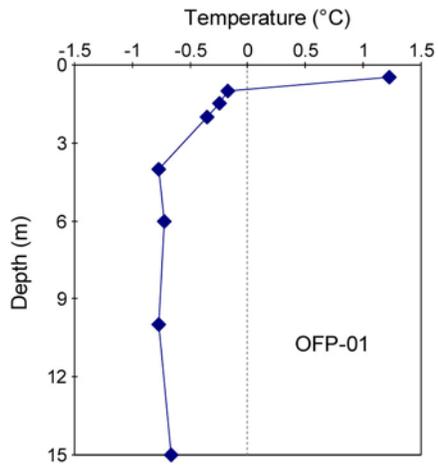


Photo taken Aug 2007

Old Fort Point

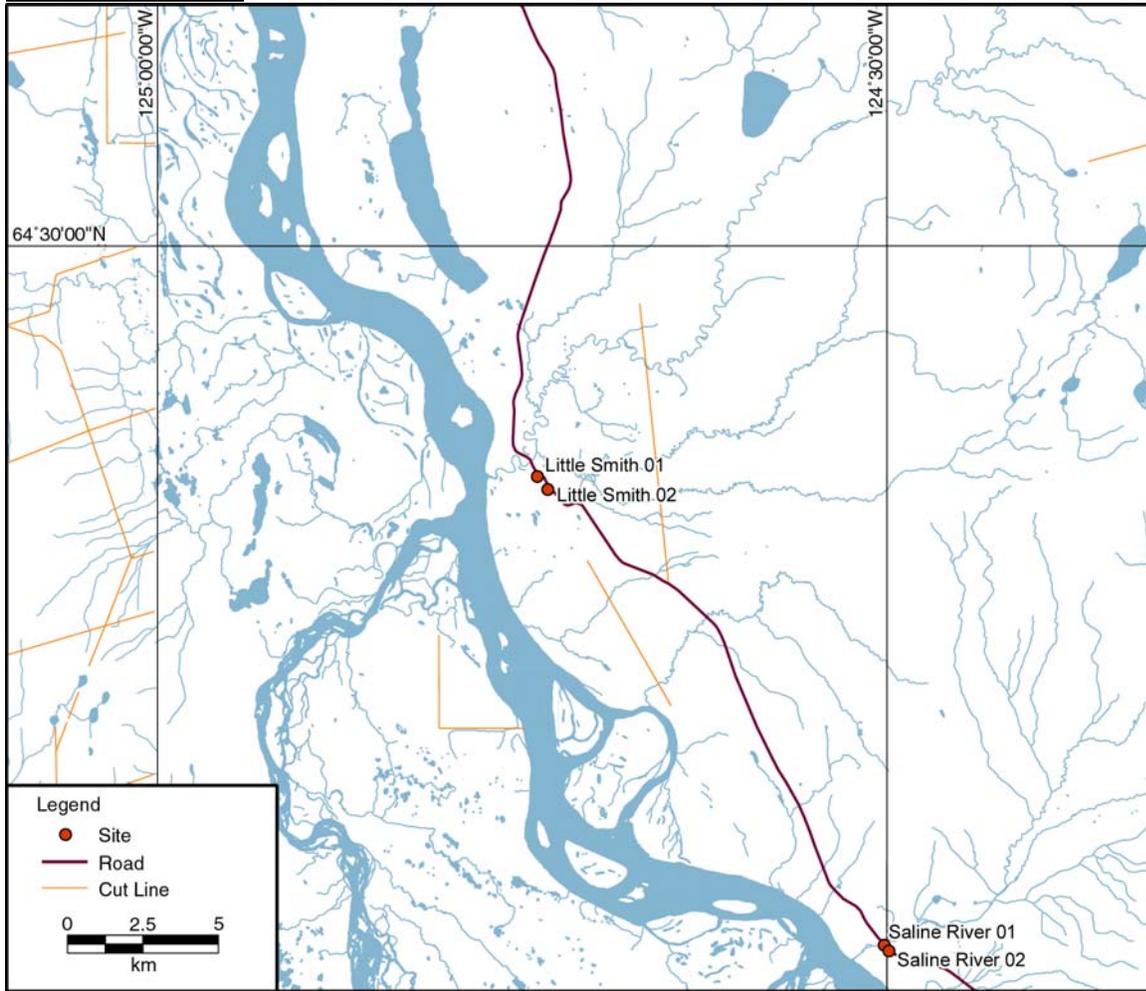
Borehole No: OFP-01		Northing: 7170979		Easting: 412221		Zone: 10								
Borehole Depth: 20		Location: Old Fort Point 01				Date: 6-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Peat: Organic soil. Sand: Silty, fine to medium, brown.	Nbn											
1														
2		Sand: Silty, fine, brown.	Nbn											
3		Clay: Silty, trace sand, low to medium plasticity, grey to brown. Clay: Sand lenses in clay.	Vs-Vr, no excess ice Vs-Vr, zones of 30% excess ice											
4														
5														
6		Clay: Non plastic.												
7														
8														
9														
10														
11														
12														
13														
14														
15		Ice and clay.												
16		Clay: Silty, trace sand, low to medium plasticity.												
17														
18														
19														
20														
21														
22														

Old Fort Point



August 17 2007 data

Little Smith Creek



Little Smith Creek



Little Smith Creek



Photo taken Aug 2007



Photo taken Sep 2007

Little Smith Creek



Photo taken Aug 2007



Photo taken Sep 2007

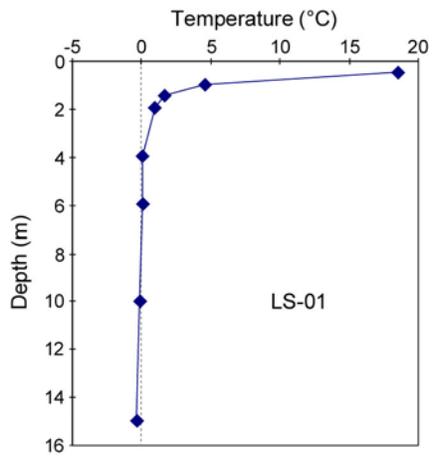
Little Smith Creek

Borehole No: LS-01		Northing: 7146259		Easting: 416233		Zone: 10											
Borehole Depth: 20.6		Location: Little Smith 01				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Clay: Silty, low plastic, organic inclusions, soft, saturated, unfrozen.															
1		Sand: Silty, fine, loose, brown.															
2		Gravel: Some sand, gravel to cobble size, trace to little fines, brown, free water.															
3																	
4		Clay: Silty, sandy, some gravel, stiff to very stiff, grey, moist.															
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

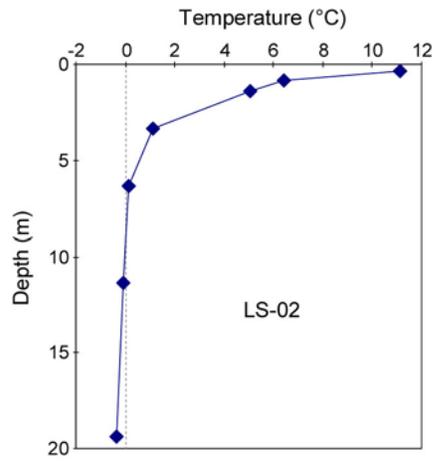
Little Smith Creek

Borehole No: LS-02		Northing: 7145819		Easting: 416567		Zone: 10								
Borehole Depth: 20		Location: Little Smith 02				Date: 6-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Organics. Gravel: Some sand, trace fines. Clay: Silty, medium plastic, very stiff, brown, moist.												
1														
2														
3														
4														
5														
6														
7														
8														
9		Silt: Clayey, trace fine sand, low plastic.	Nbn											
10														
11		Clay: Silty, little sand, trace gravel, medium plastic, brown, moist.	Vr ice											
12														
13														
14														
15														
16			Vr ice											
17														
18														
19														
20														
21														
22														

Little Smith Creek

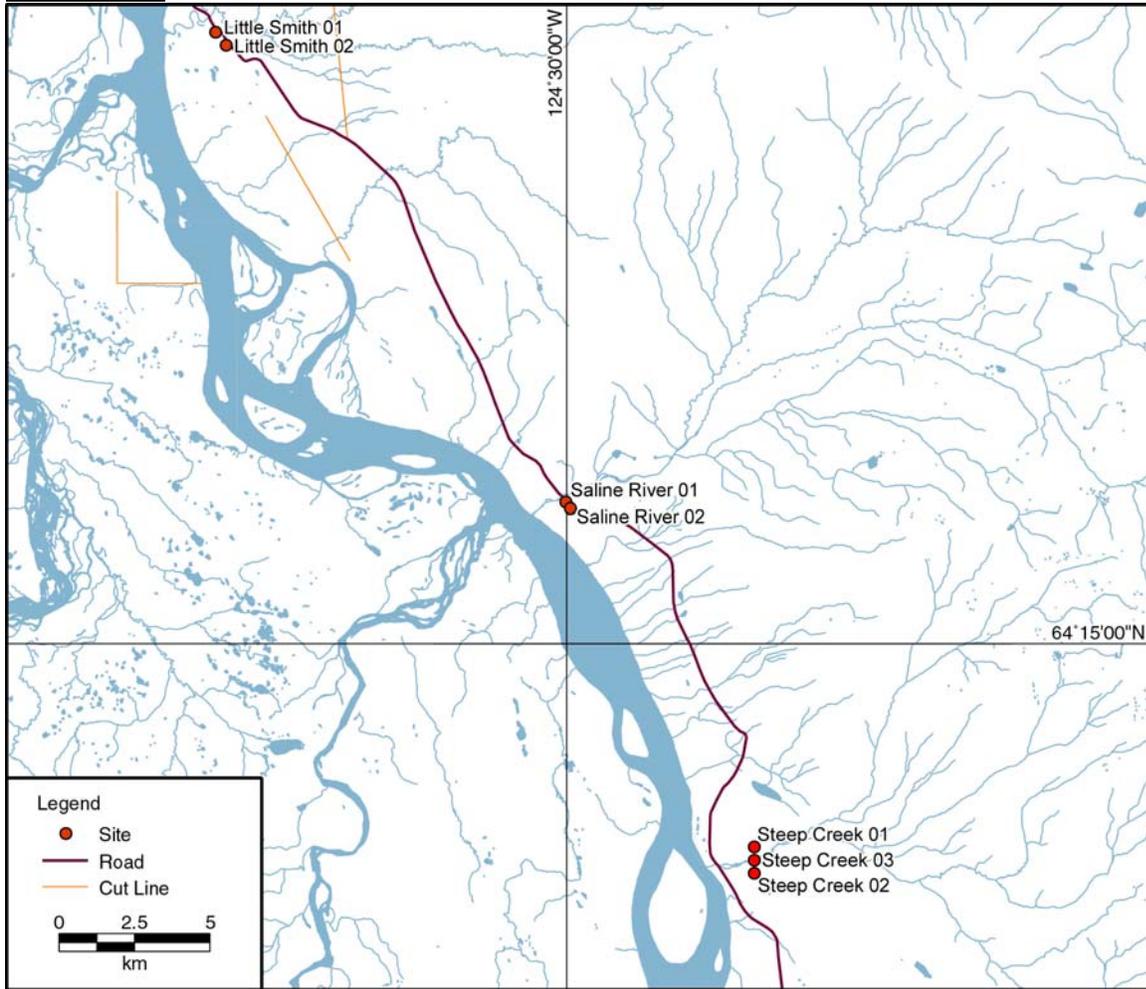


August 17 2007 data

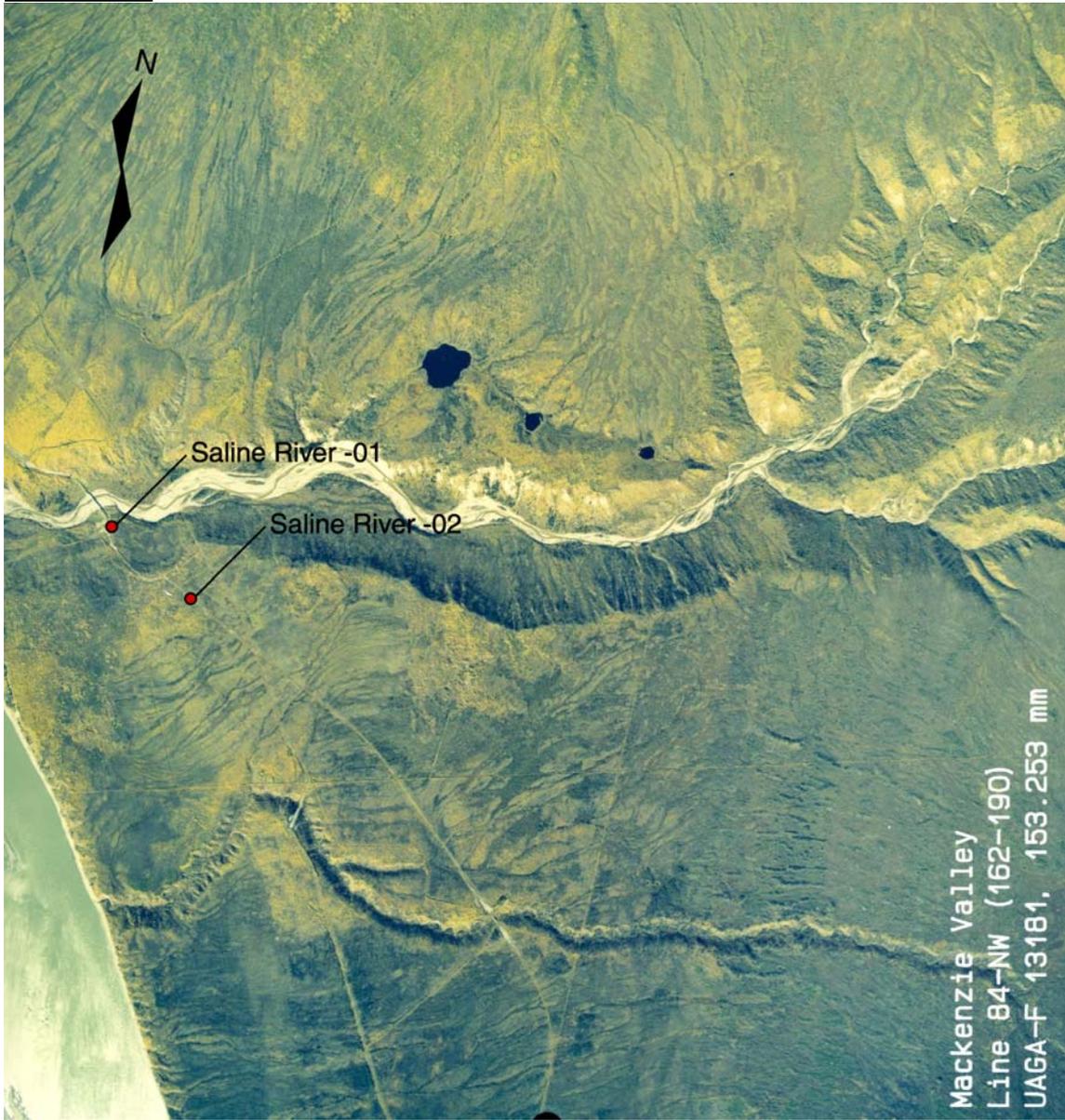


August 17 2007 data

Saline River



Saline River



Saline River



Photo taken Aug 2007



Photo taken Aug 2007

Saline River



Photo taken Aug 2008

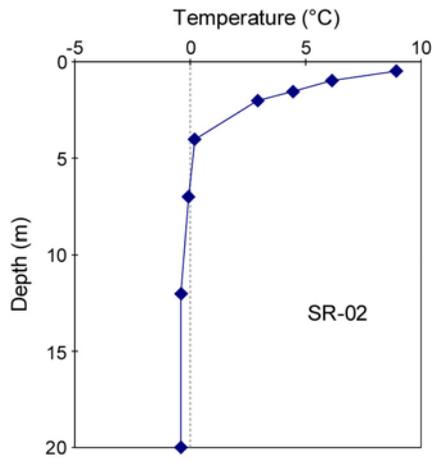
Saline River

Borehole No: SR-01		Northing: 7037588		Easting: 465976		Zone: 10								
Borehole Depth: 2.3		Location: Saline River 01				Date: 6-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Peat: Organic soil - brown.												
1		Gravel: To cobble sizes, little sand, traces fines, dry.												
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Saline River

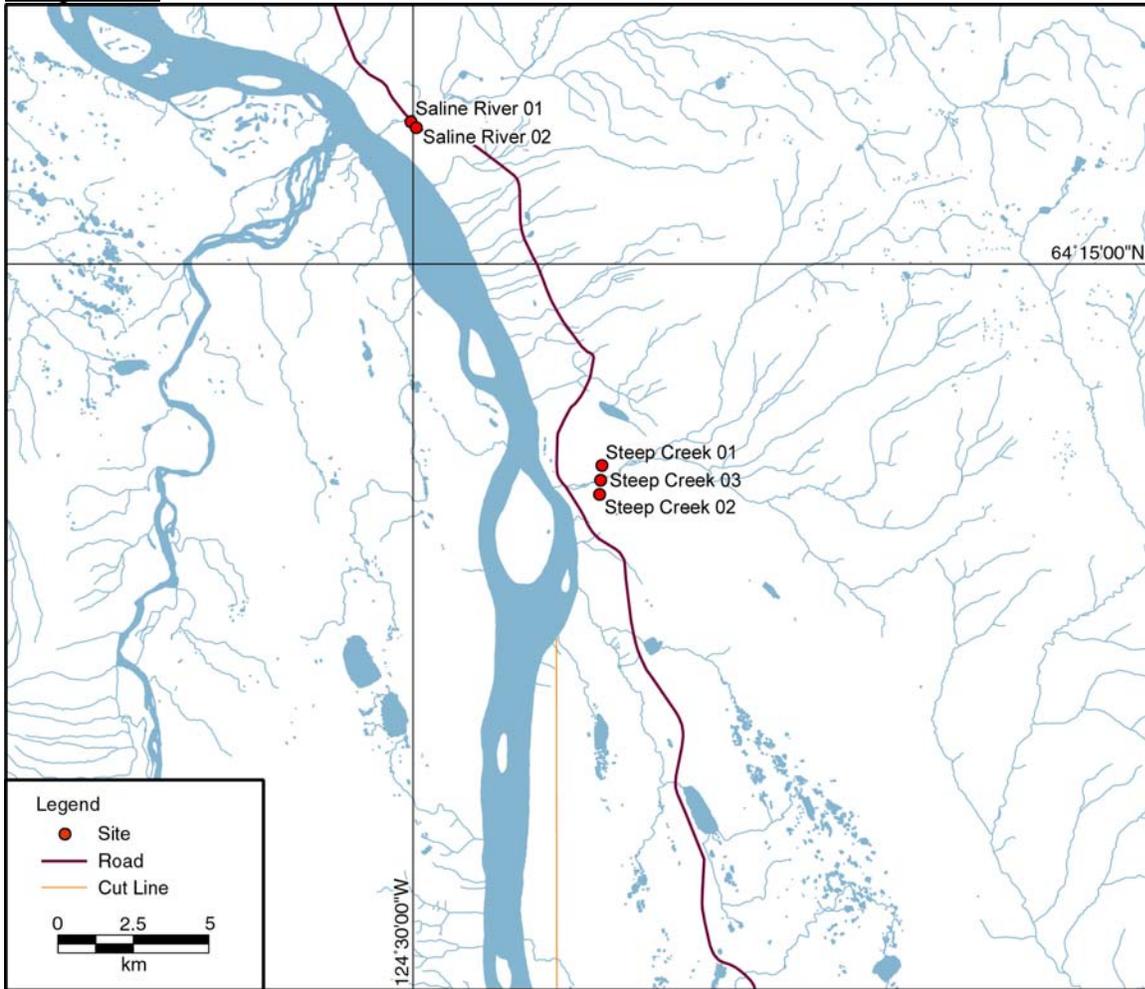
Borehole No: SR-02		Northing: 7129938		Easting: 428106		Zone: 10							
Borehole Depth: 20.4		Location: Saline River 02				Date: 6-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Organics.											
1		Gravel: Fine grained, some sand, little fines, brown.	Vx										
2		Clay: Silty, some sand, trace gravel, low to medium plastic, brown.	Vf										
3													
4													
5													
6		Clay: Silt, medium plastic, grey.	Nbn										
7			Vr in Nbn										
8													
9													
10													
11													
12			Vr										
13													
14													
15													
16			Vr										
17													
18													
19													
20													
21													
22													

Saline River



August 17 2007 data

Steep Creek



Steep Creek



Steep Creek



Photo taken Aug 2006



Photo taken Sep 2006

Steep Creek



Photo taken Sep 2007



Photo taken Aug 2006

Steep Creek

Borehole No: Steep-01		Northing: 7118945		Easting: 433241		Zone: 10								
Borehole Depth: 14		Location: Steep Creek 1 Base of Slope				Date: 14-Feb-06								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Clay: Some rounded gravel, some partly decomposed organics, low to medium plastic, very soft, dark grey, moist.												
1														
2		Clay: Gravely, some cobble, low plastic, very soft, dark grey, moist. Gravel and cobble are rounded.												
3		Cobbles and Boulders: Trace clay, trace sand, wet, rounded.												
4														
5														
6														
7		Cobbles: Some rounded gravel, trace sand, trace low plastic clay, wet, rounded.												
8		Clay: Gravely (rounded), low plastic, very soft, dark grey, very wet.												
9														
10														
11														
12														
13		Clay: Gravely, silty, low plastic, very soft, dark grey, very wet.												
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														

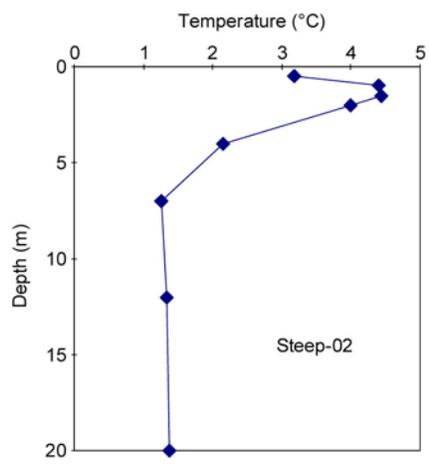
Steep Creek

Borehole No: Steep-02		Northing: 7117926		Easting: 433196		Zone: 10							
Borehole Depth: 28.3		Location: Steep Creek 2 Crest of Slope				Date: 10-Feb-06							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Gravel: Sandy, clayey, rounded, brown, dry.											
1		Clay: Trace gravel, ice crystals, medium plastic, soft, dark grey, damp.											
2		Clay: Trace gravel, medium plastic, firm, dark grey.											
3		Clay: Trace gravel, medium plastic, firm, dark grey, moist.											
4													
5													
6													
7													
8		Clay: Some gravel, medium plastic, firm, dark grey, moist.											
9													
10													
11		Gravel: Sandy, clayey, grey to brown, wet.											
12		Sand: Clayey, some gravel, very loose, brown, wet.											
13													
14		Sand: Trace to some gravel, sandy clay, low plastic, very loose, grey, wet.											
15		Clay: Some gravel, travel sand, low plastic, firm, dark grey, moist.											
16													
17		Clay: Sandy, gravelly, low plastic, firm, dark grey, moist.											
18													
19													
20		Clay: Sandy, gravelly, low plastic, firm, dark grey, damp.											
21													
22													
23		Clay: Sandy, gravelly, trace cobble, low plastic, firm, dark grey, damp.											
24													
25		Clay: Sandy, gravelly, some cobble, low plastic, firm, dark grey, wet.											
26		Clay: Sandy, gravelly, some cobble, low plastic, firm, dark grey, very wet.											
27													
28													
29													
30													

Steep Creek

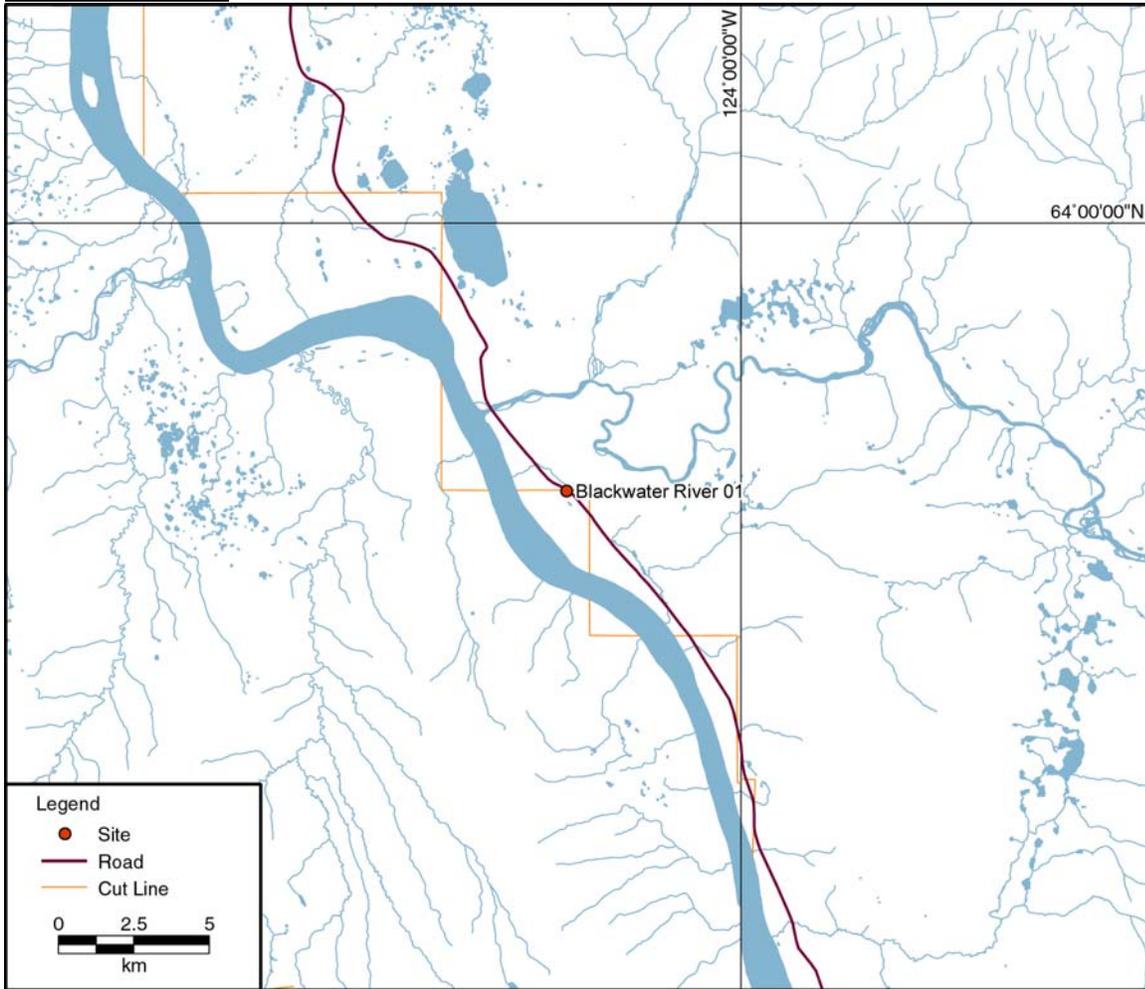
Borehole No: Steep-03		Northing: 7118410		Easting: 433207		Zone: 10								
Borehole Depth: 20.7		Location: Steep Creek 3 Midslope				Date: 12-Oct-06								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Woodchips.												
1		Sand: Gravelly (rounded), some low plastic clay, trace organics, dark brown, moist to damp.												
2														
3														
4														
5				Visible ice crystals										
6		Clay: Gravelly (rounded), some rounded cobbles, trace sand, medium plastic, firm, dark grey, moist.												
7														
8														
9														
10														
11		Clay: Low plastic.												
12														
13														
14														
15														
16		Clay: Medium plastic.												
17														
18														
19														
20														
21		Clay: Low plastic.												
22														
23														
24														
25														
26														
27														
28														
29														
30														

Steep Creek



September 29 2008 data

Blackwater River



Blackwater River



Blackwater River



Photo taken May 2006

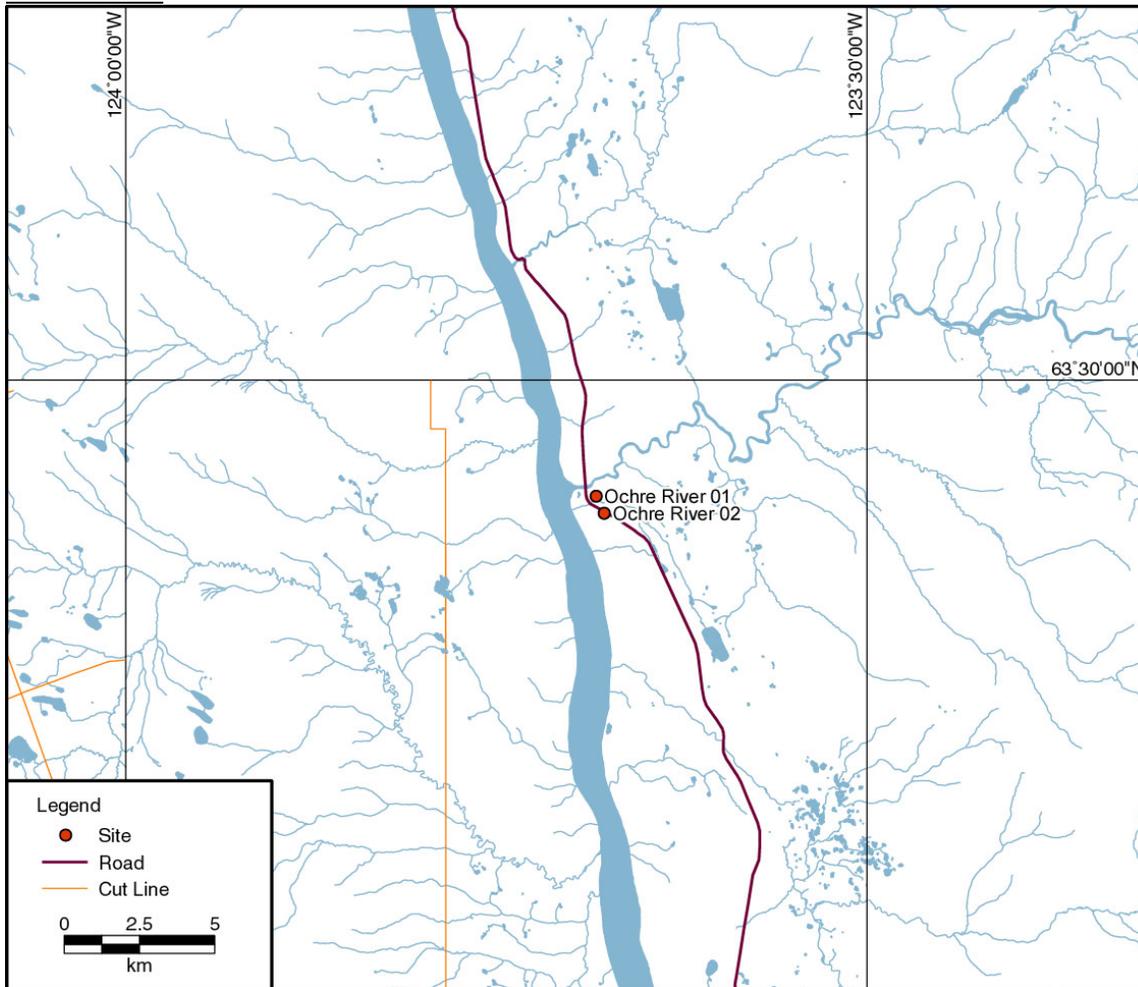


Photo taken May 2006

Blackwater River

Borehole No: BW-01		Northing: 7088467		Easting: 444851		Zone: 10											
Borehole Depth: 0.5		Location: Blackwater River 01				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Sand: Some fines, brown. Gravel.															
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Ochre River



Ochre River



Ochre River

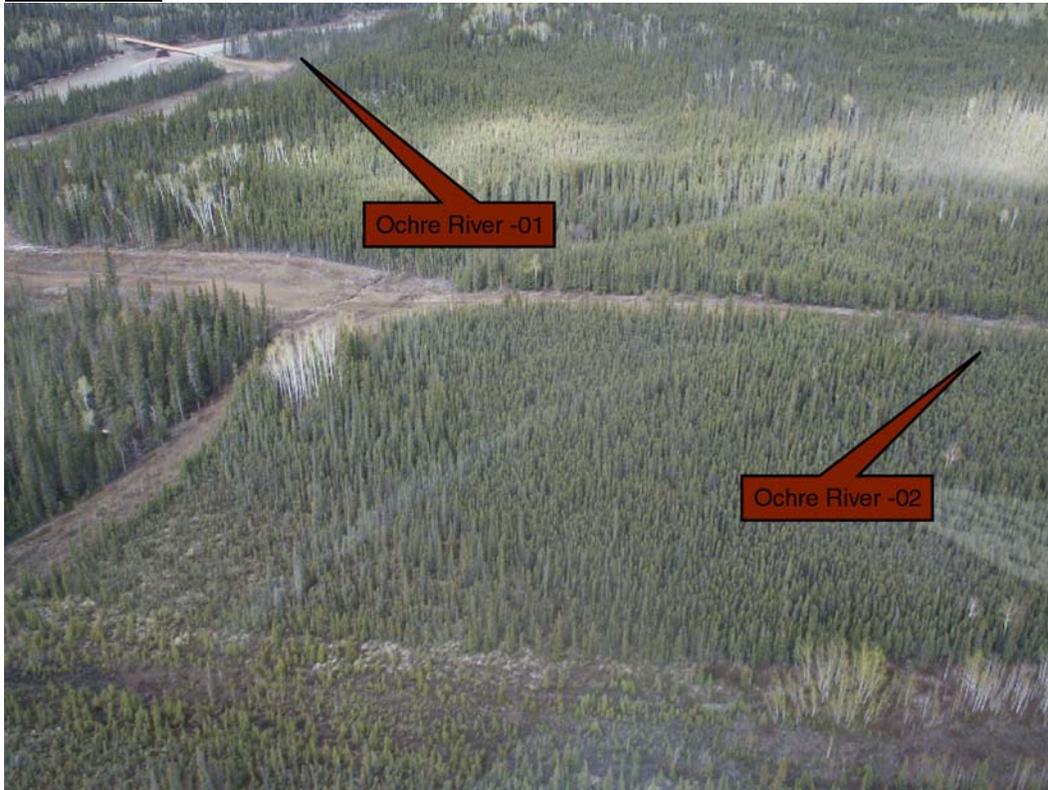


Photo taken May 2006



Photo taken May 2006

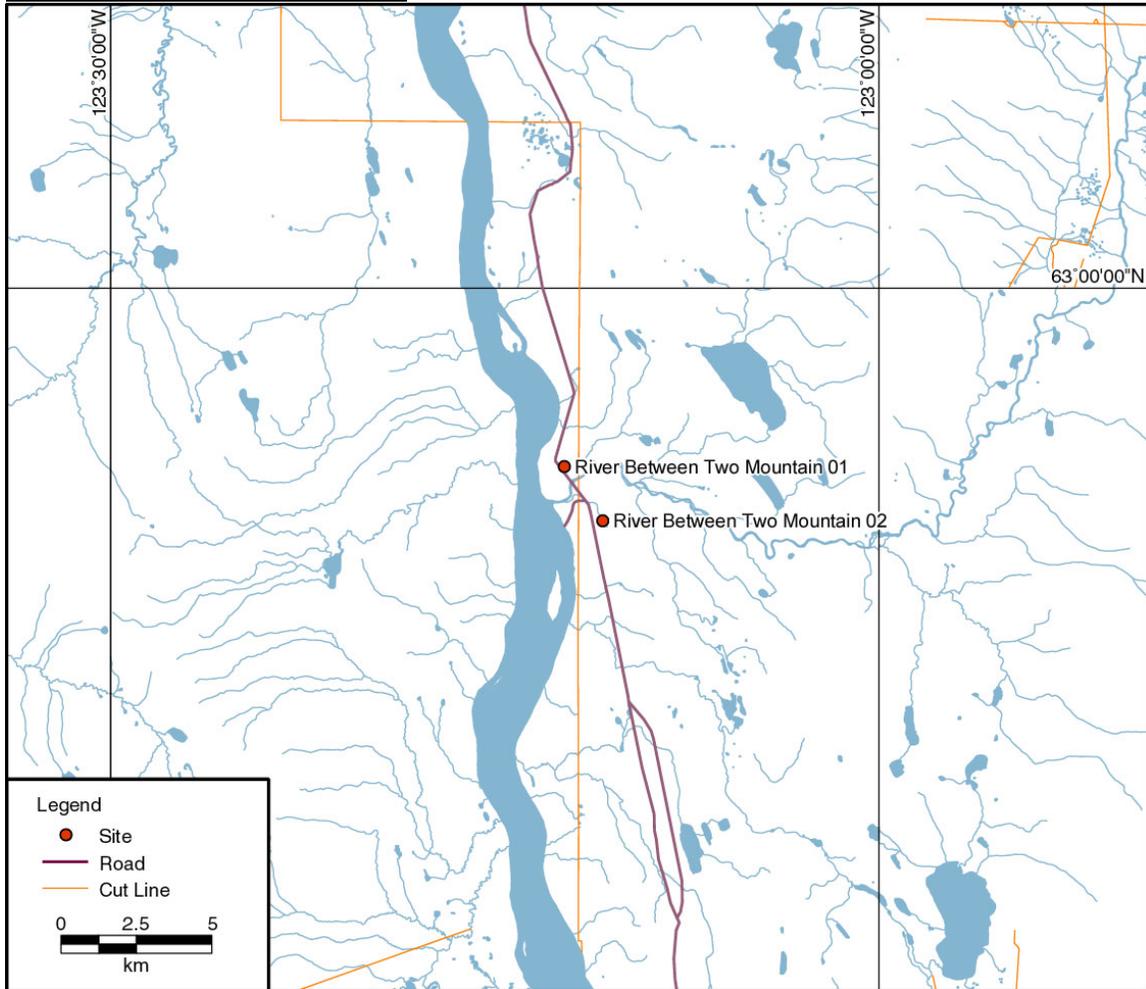
Ochre River

Borehole No: OCR-01		Northing: 7037588		Easting: 465976		Zone: 10											
Borehole Depth: 1.5		Location: Ochre River 01				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel						
0		Peat: Organic soil.															
1		Clay: Silty, low plastic, grey to brown.				132.40											
2		Gravel: To cobble sizes, some sand, little fines.															
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Ochre River

Borehole No: OCR-02		Northing: 7037012		Easting: 466239		Zone: 10							
Borehole Depth: 2		Location: Ochre River 02				Date: 6-Mar-07							
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)					
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel		
0		Peat.											
		Organics.											
1		Clay: Silty, little sand, low to medium plastic, brown.	Vr-Vs, no excess ice										
2		Gravel: Cobbles.											
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													

River Between Two Mountains



River Between Two Mountains



River Between Two Mountains

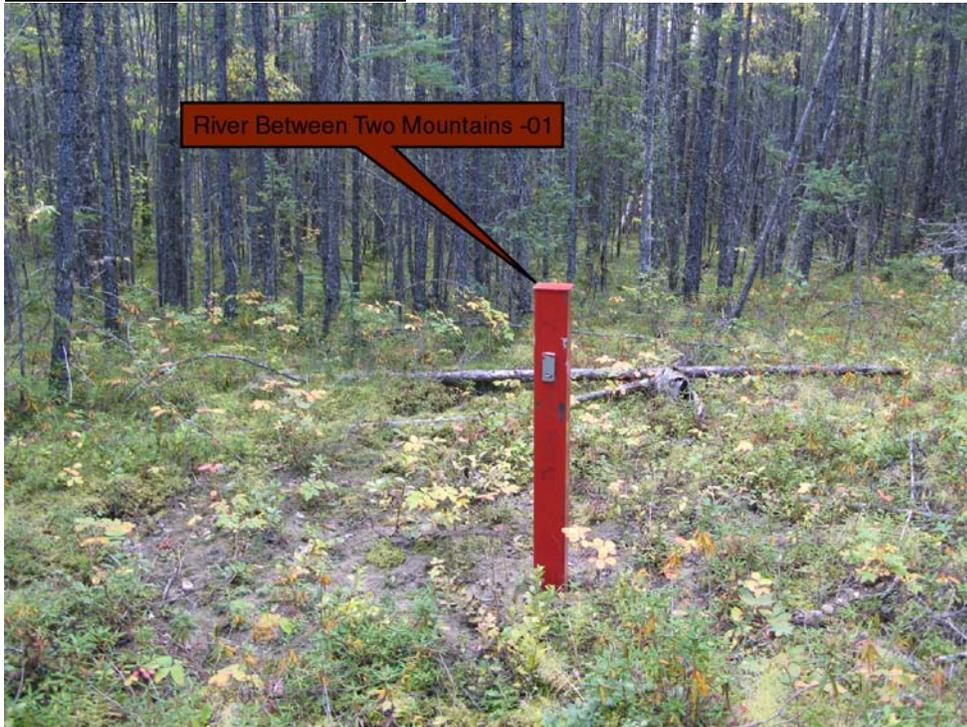


Photo taken Aug 2008



Photo taken Aug 2008

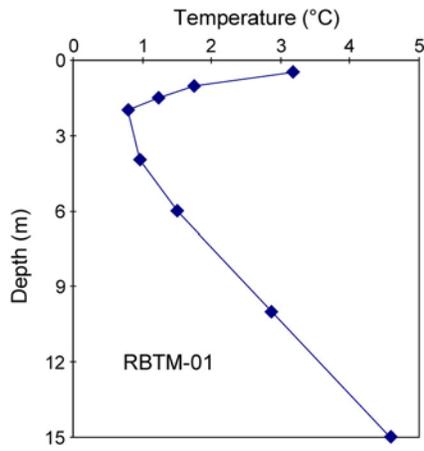
River Between Two Mountains

Borehole No: RBTM-01		Northing: 6979706		Easting: 489609		Zone: 10											
Borehole Depth: 20.6		Location: River between Two Mountains 01				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel						
0		Peat: Organic soil.															
1		Clay: Silty, low plastic, brown, grey.															
2																	
3																	
4																	
5																	
6		Silt: Clayey, low plastic, brown, moist to wet.															
7		Sand: Silty, little fines, fine to medium grained, brown, moist.															
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16		Gravel: To cobbles sizes, some sand, little fines, brown.															
17																	
18																	
19																	
20																	
21																	
22																	

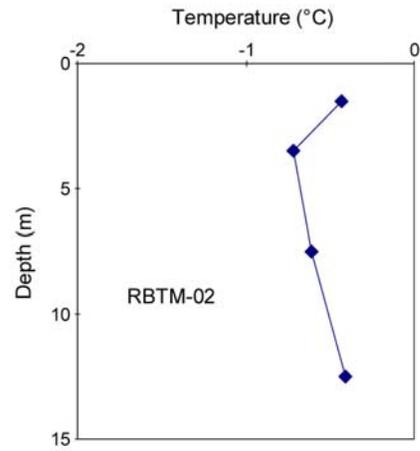
River Between Two Mountains

Borehole No: RBTM-02		Northing: 6977913		Easting: 490871		Zone: 10											
Borehole Depth: 12.5		Location: River between Two Mountains 02				Date: 6-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Peat: Organics. Clay: Silty, medium plastic, brown.	Vr-Vs														
1																	
2		Sand: Fine to coarse, little fine gravel, brown.	Nbn														
3		Clay: Silty, little sand, little gravel, brown.	Vr-Vs														
4		Clay: Silty, grey, medium plastic.	Vr-Vs, no excess ice														
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

River Between Two Mountains

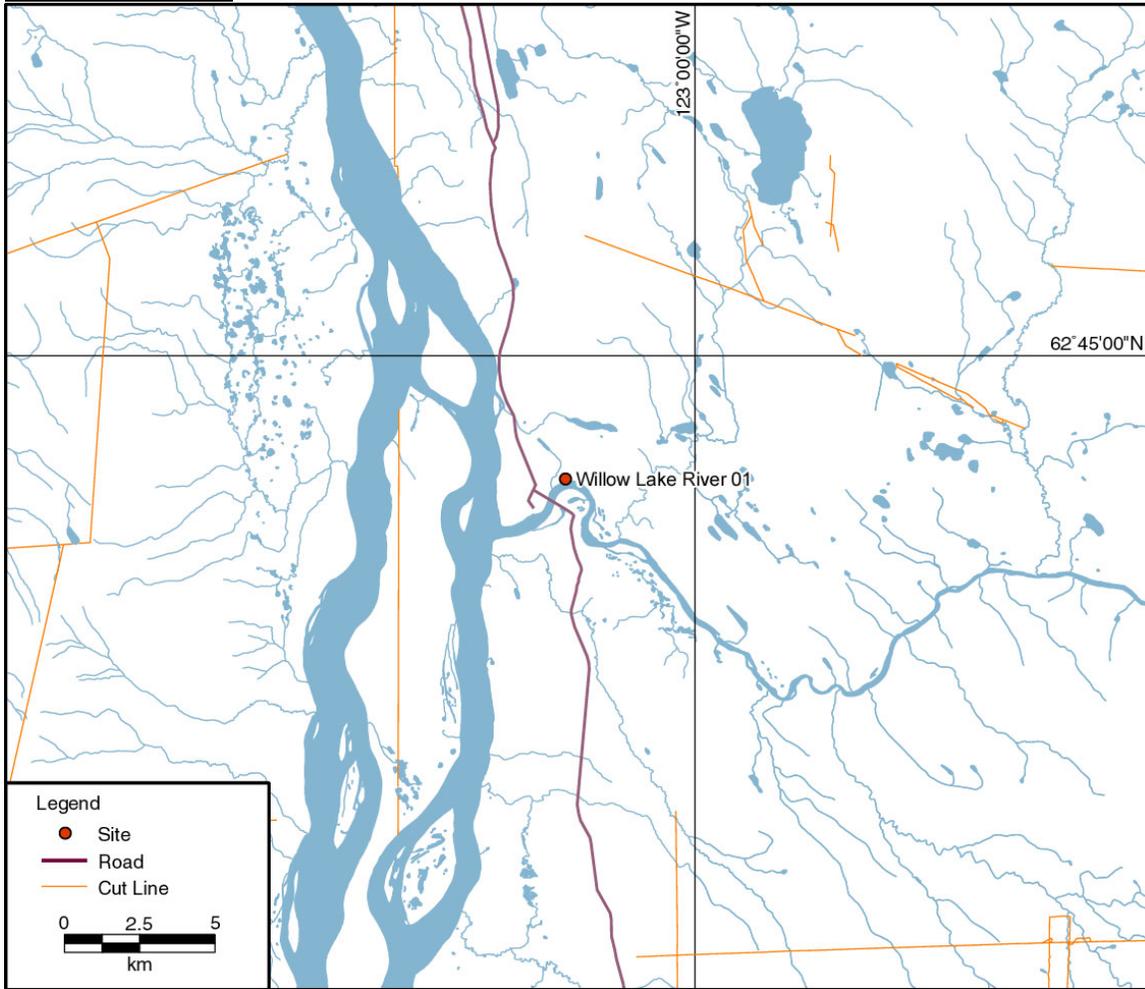


August 23 2007 data



August 23 2007 data

Willowlake River



Willowlake River



Willowlake River



Photo taken Aug 2007

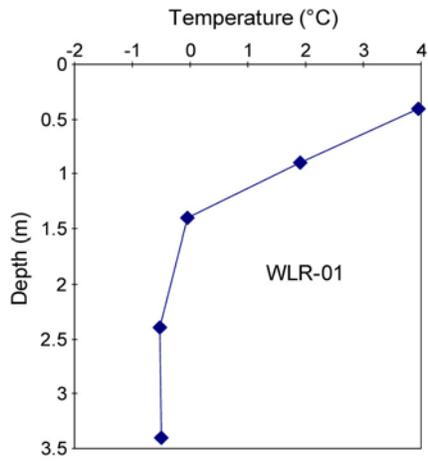


Photo taken Aug 2007

Willowlake River

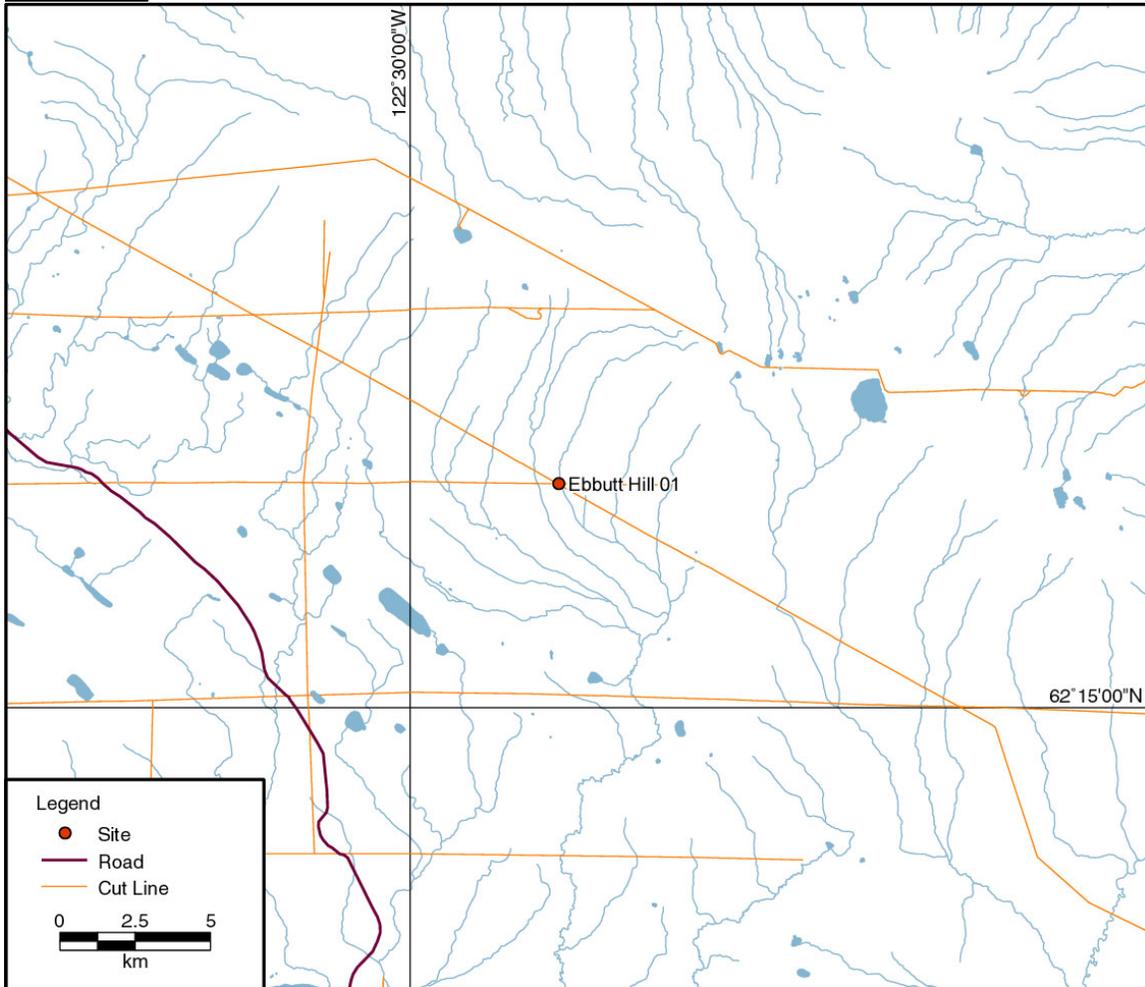
Borehole No: WLR-01		Northing: 6953658		Easting: 495685		Zone: 10								
Borehole Depth: 3.7		Location: Willow Lake River 01				Date: 6-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Organics. Clay: Silty, low to medium plastic, brown.	Nbn											
1														
2														
3		Sand: Traces fines, trace fine gravel, brown. Gravel: To cobble sizes, some sand, little fines, brown.												
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Willowlake River

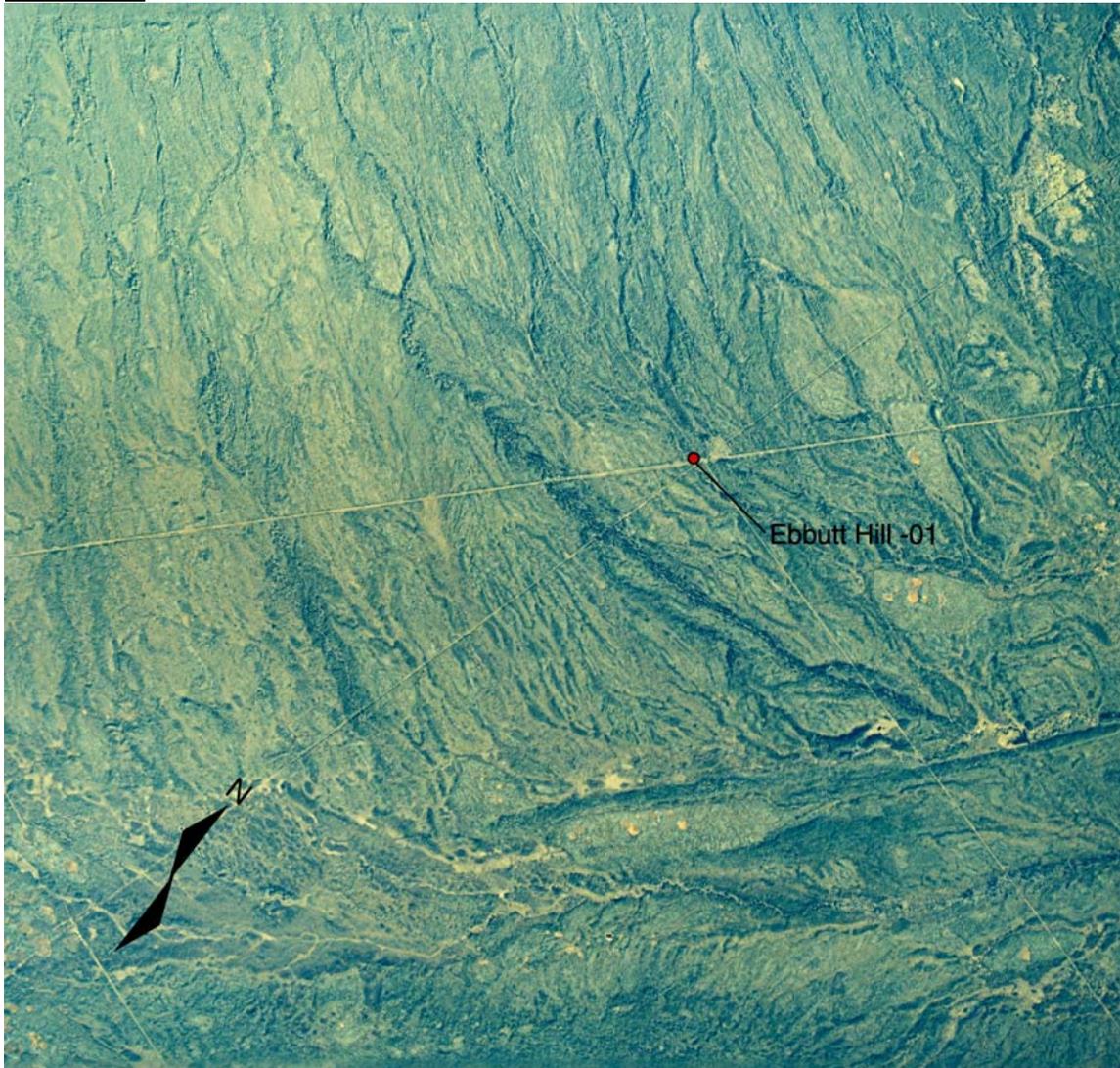


September 02 2008 data

Ebbutt Hill



Ebbutt Hill



Ebbutt Hill

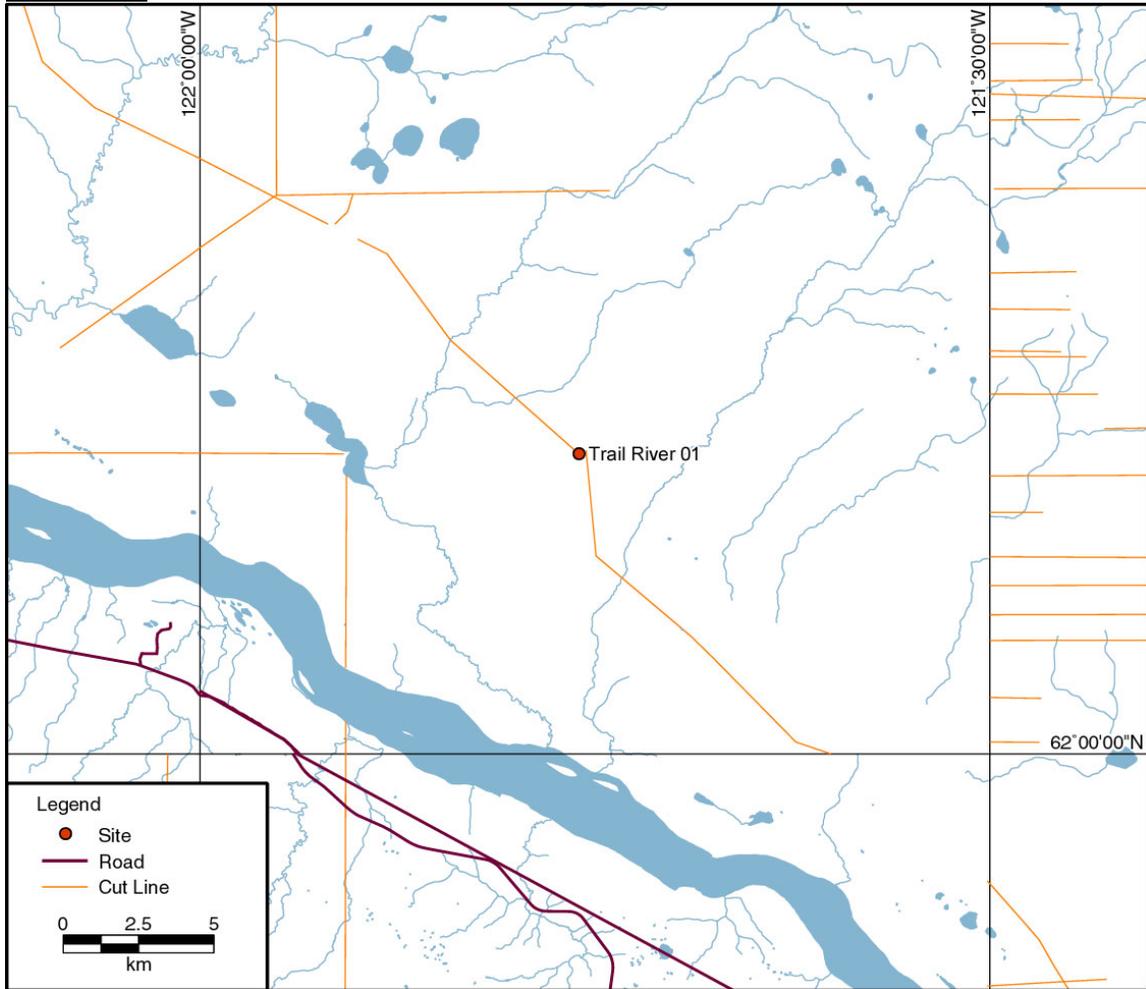


Photo taken May 2006

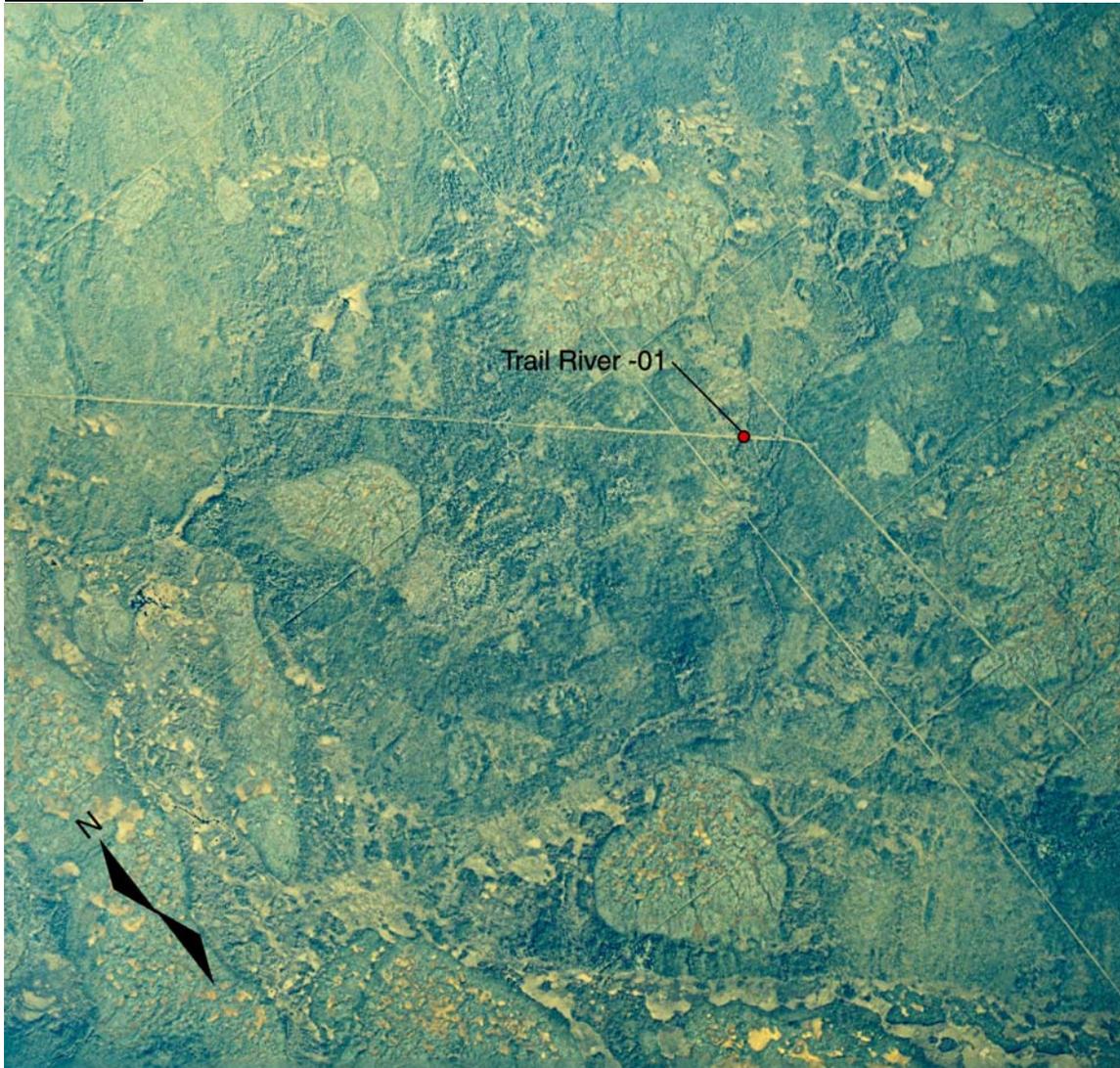
Ebbutt Hill

Borehole No: EH-01		Northing: 6909592		Easting: 530835		Zone: 10													
Borehole Depth: 16		Location: Ebbutt Hill 01				Date: 10-Mar-07													
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)											
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel								
0	Peat																		
0-1	Silt: Black.		Frozen, silt with visible ice	~45	~55	~85	201.74	~5	~85	~10	~0								
1-2																			
2-3	Till: Sandy.		Frozen																
3-4				~45	~55	~85		~5	~85	~10	~0								
4-5																			
5-6	Till: Gravelly sand lense.		Frozen																
6-7				~45	~55	~85		~5	~85	~10	~0								
7-16	Till: Gravelly sand.		Unfrozen																
16-22																			

Trail River



Trail River



Trail River



Photo taken Sep 2007

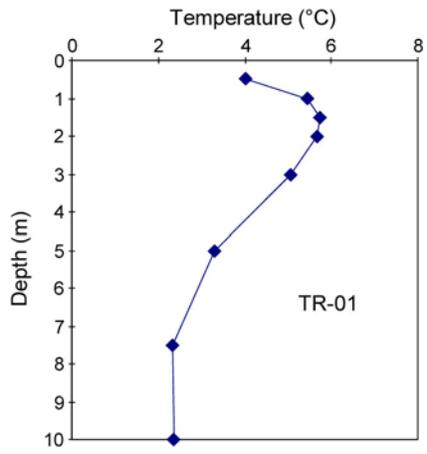


Photo taken Sep 2007

Trail River

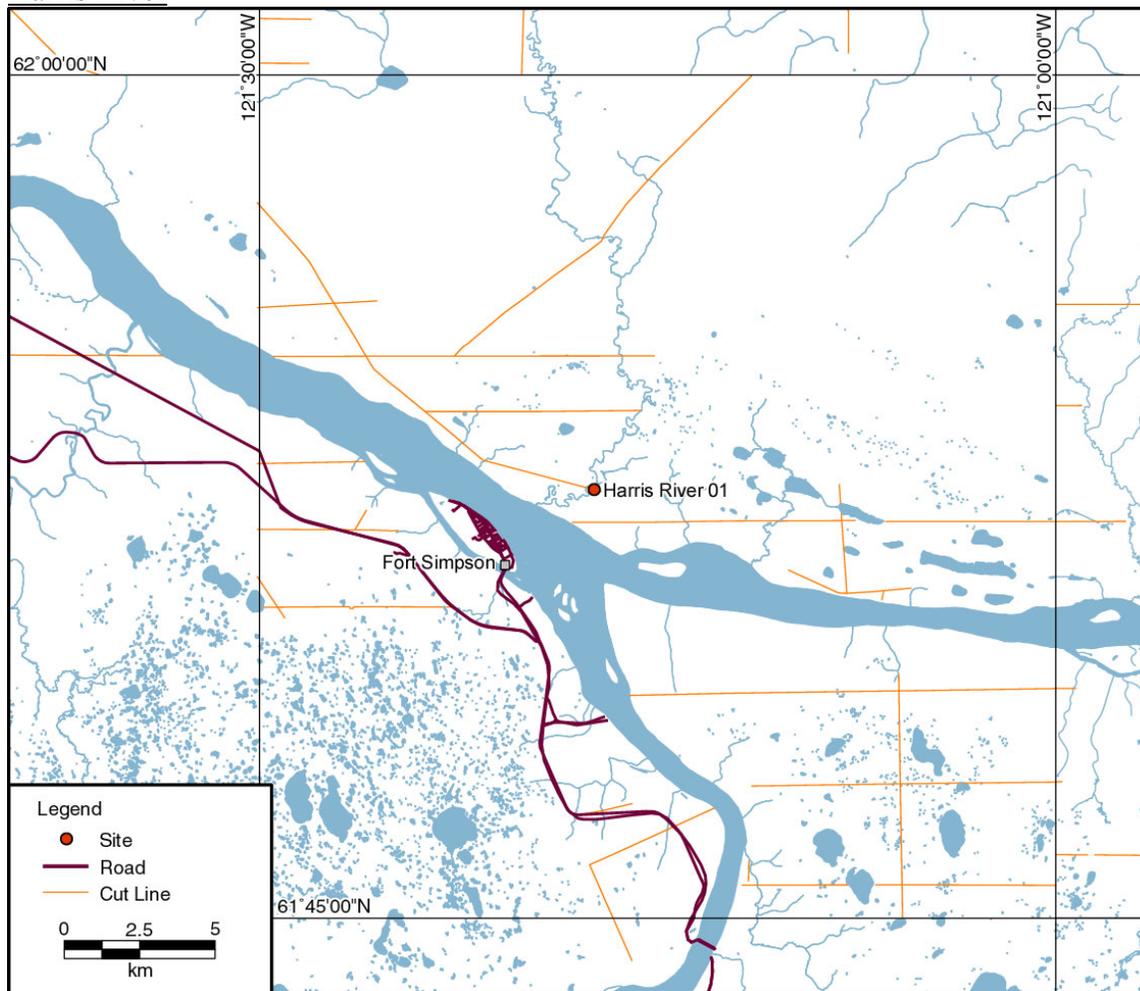
Borehole No: TR-01		Northing: 6884732		Easting: 564755		Zone: 10								
Borehole Depth: 12.2		Location: Trail River 01				Date: 9-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Peat: Dry black.												
0.5		Clay: Silt with gravel.					510.10							
1		Till: Silty, some gravels.												
4		Gravel: Coarse, till, hard to drill.												
6		Till: Gravelly.												
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Trail River



September 27 2007 data

Harris River



Harris River



Harris River



Photo taken Sep 2007

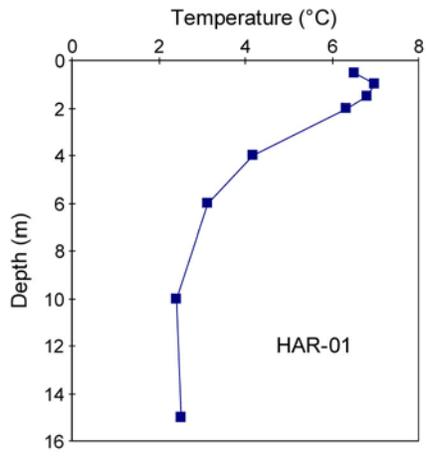


Photo taken Sep 2007

Harris River

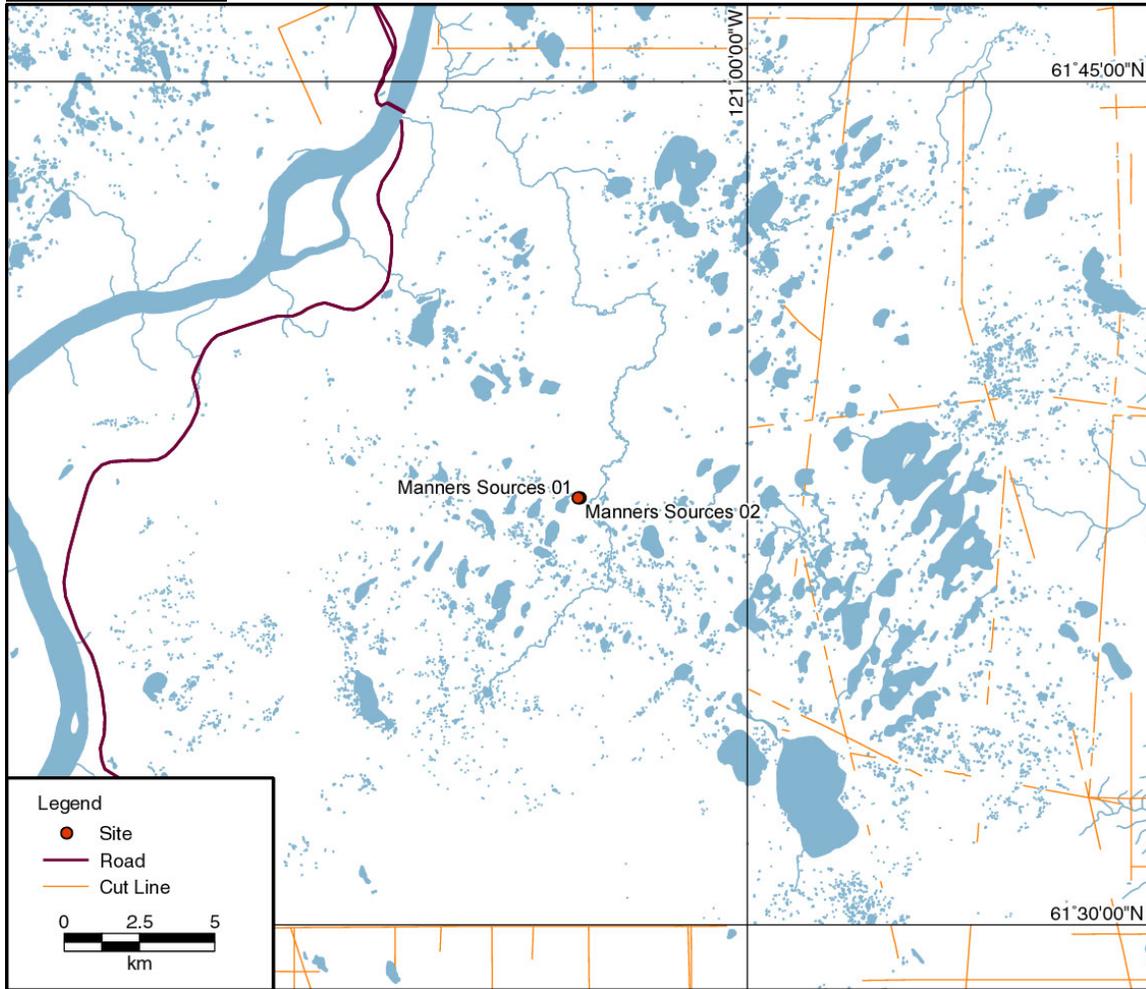
Borehole No: HAR-01		Northing: 6861672		Easting: 589928		Zone: 10								
Borehole Depth: 16		Location: Harris River 01				Date: 8-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Sand: Dry with gravels.												
1		Clay and Sand.												
2		Till: Clay, silt and some gravels to 25 mm.												
3		Till: Sandy with coarse gravels.												
4														
5														
6														
7														
8		Till: Wet, sand with gravel up to 40 mm.												
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Harris River

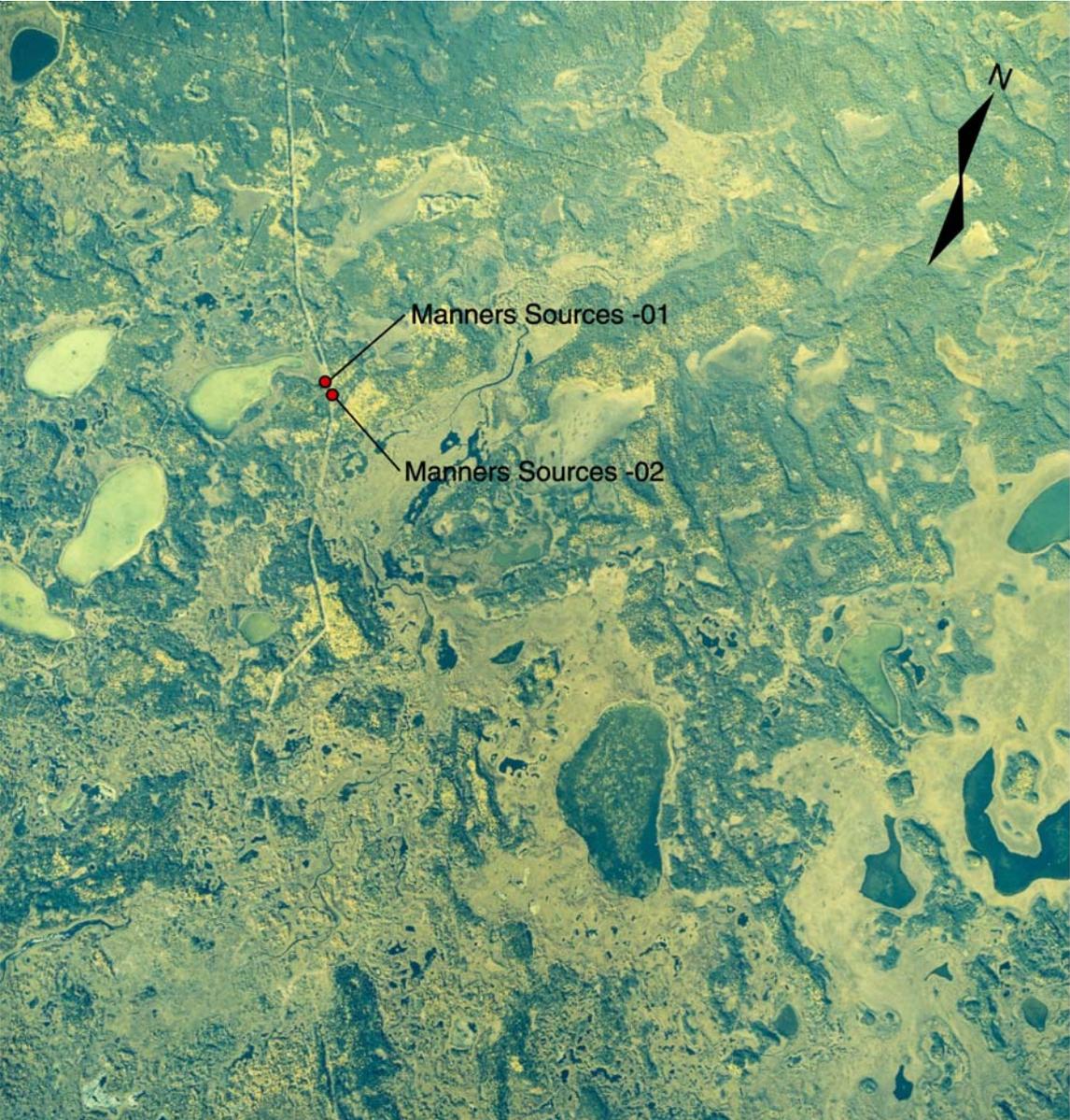


September 27 2008 data

Manners Sources



Manners Sources



Manners Sources



Photo taken Sep 2008



Photo taken Sep 2008

Manners Sources



Photo taken Sep 2007

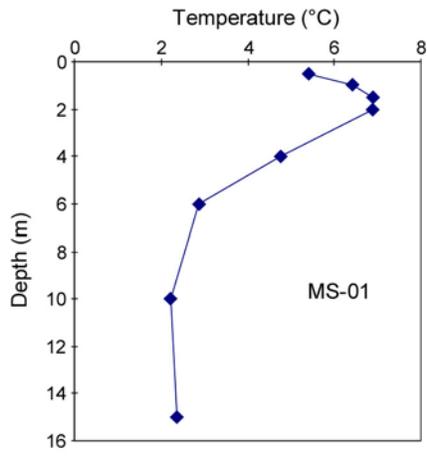


Photo taken Sep 2007

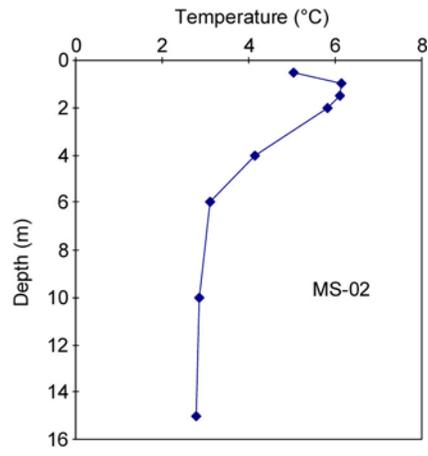
Manners Sources

Borehole No: MS-02		Northing: 6834045		Easting: 600487		Zone: 10								
Borehole Depth: 16		Location: Manners Sources 02				Date: 24-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0	Yellow	Sand: Dry yellow.												
1														
2	Yellow	Sand: Yellow brown.												
3														
4	Blue	Clay: With sand lens.												
5														
6	Blue													
7														
8	Blue													
9														
10	Blue													
11														
12	Blue													
13														
14	Blue	Clay and Sand.												
15														
16														
17														
18														
19														
20														
21														
22														

Manners Sources

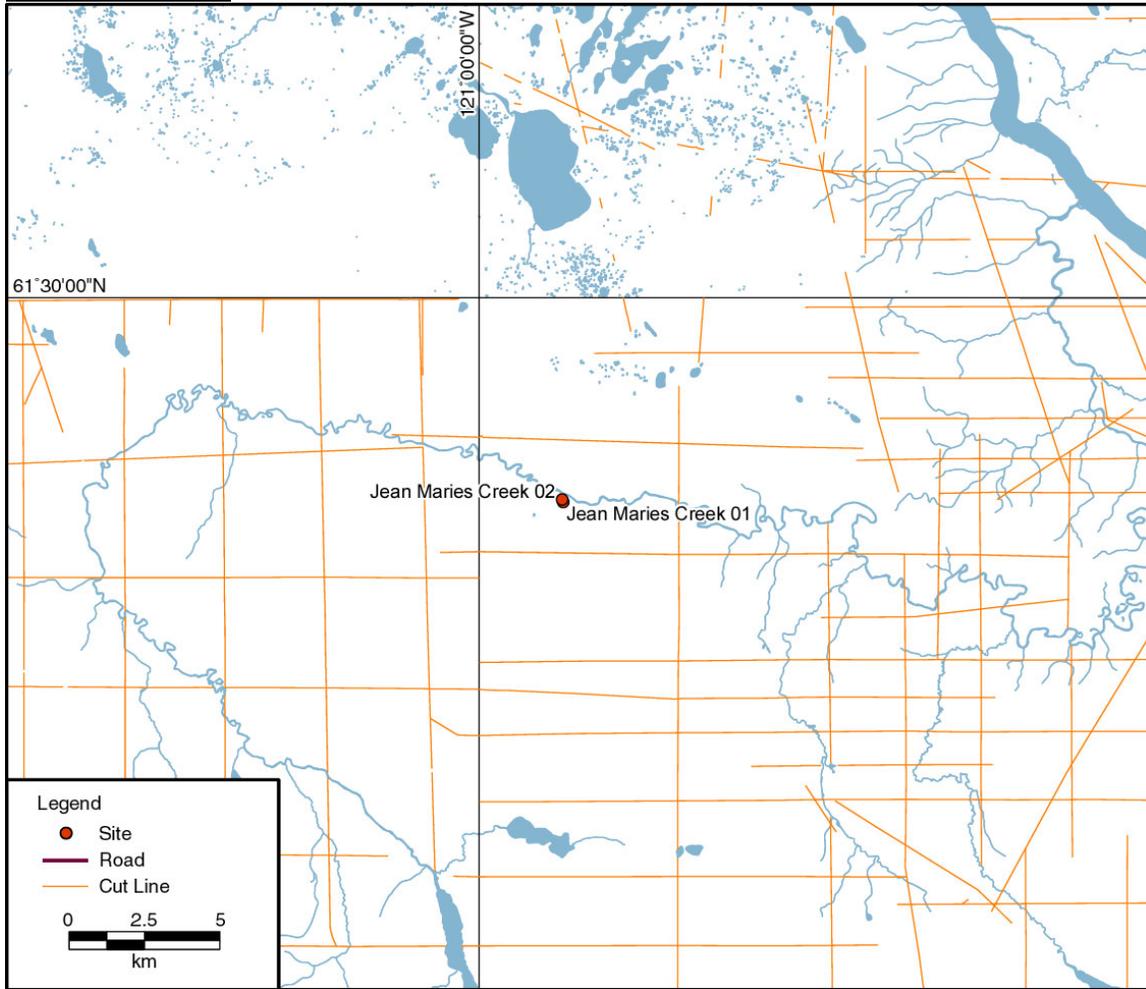


September 27 2007 data



September 27 2007 data

Jean Marie Creek



Jean Marie Creek



Jean Marie Creek



Photo taken Sep 2007



Photo taken Sep 2007

Jean Marie Creek



Photo taken Sep 2007



Photo taken Sep 2007

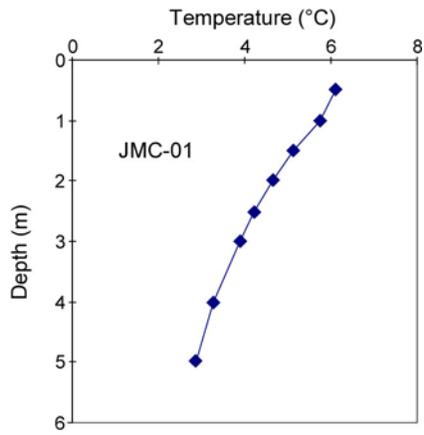
Jean Marie Creek

Borehole No: JMC-01		Northing: 6813447		Easting: 609445		Zone: 10								
Borehole Depth: 8.5		Location: Jean Maries Creek 01				Date: 22-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Peat.	Frozen											
0		Peat.	Unfrozen			366.84								
1		Sand.	Unfrozen			169.01								
2														
3				♦♦										
3		Sand: With gravels up to 30mm.	Unfrozen											
4				♦♦♦										
5														
5		Sand: With large cobbles.		♦										
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

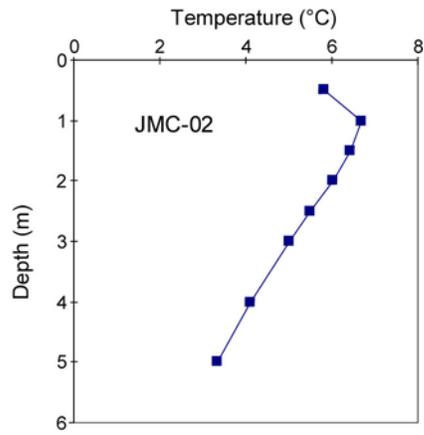
Jean Marie Creek

Borehole No: JMC-02		Northing: 6813529		Easting: 609407		Zone: 10											
Borehole Depth: 10		Location: Jean Maries Creek 02				Date: 23-Mar-07											
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)									
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel			
0		Sand: Dry.															
1																	
2		Sand and Clay: Wet sand with clay.															
3																	
4		Sand: Gravelly.															
5		Sand and Gravel: With clay lens.															
6																	
7																	
8		Mudstone: Semi-mudstone.															
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

Jean Marie Creek

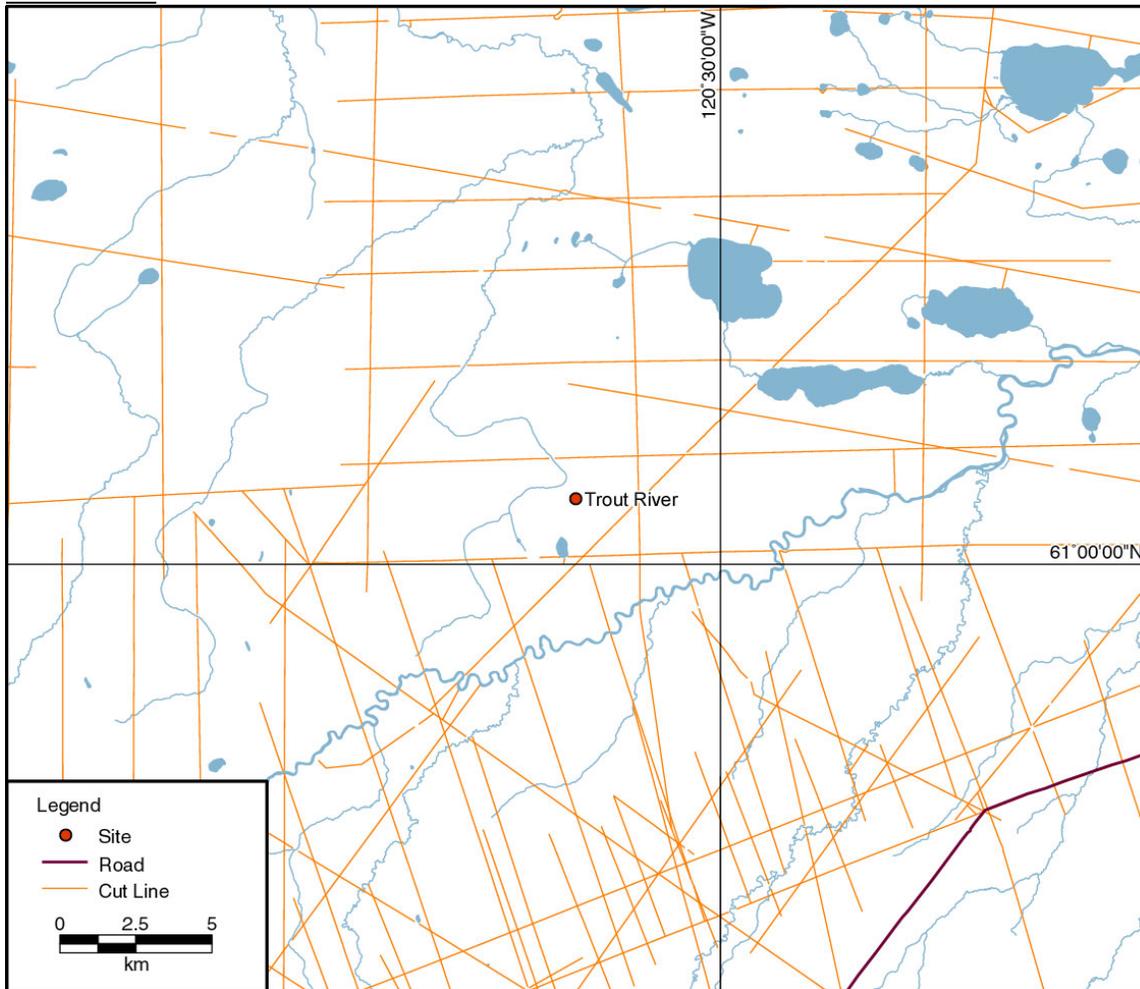


September 26 2008 data

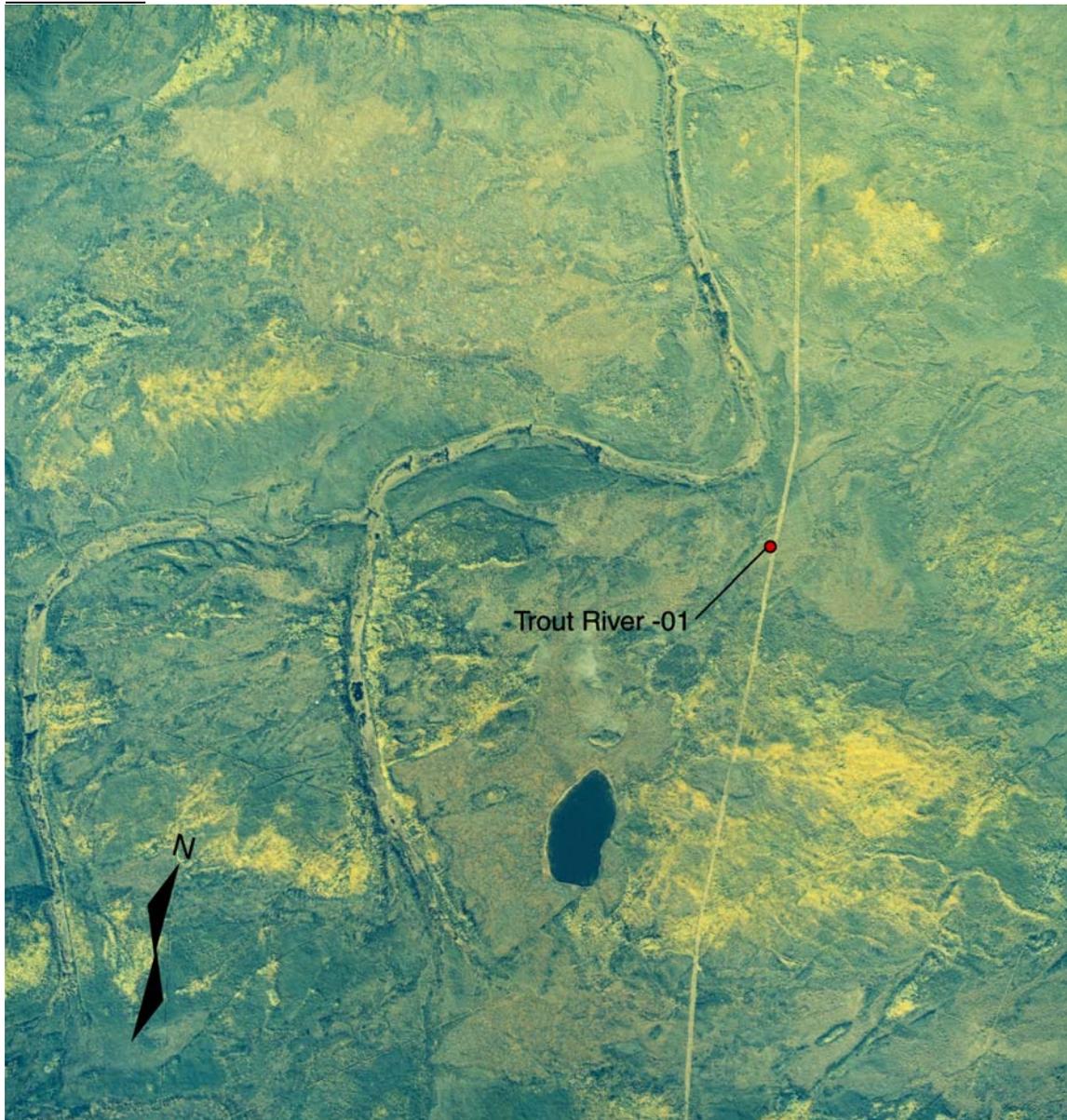


September 26 2008 data

Trout River



Trout River



Trout River



Photo taken Sep 2007



Photo taken Sep 2007

Trout River



Photo taken Sep 2007

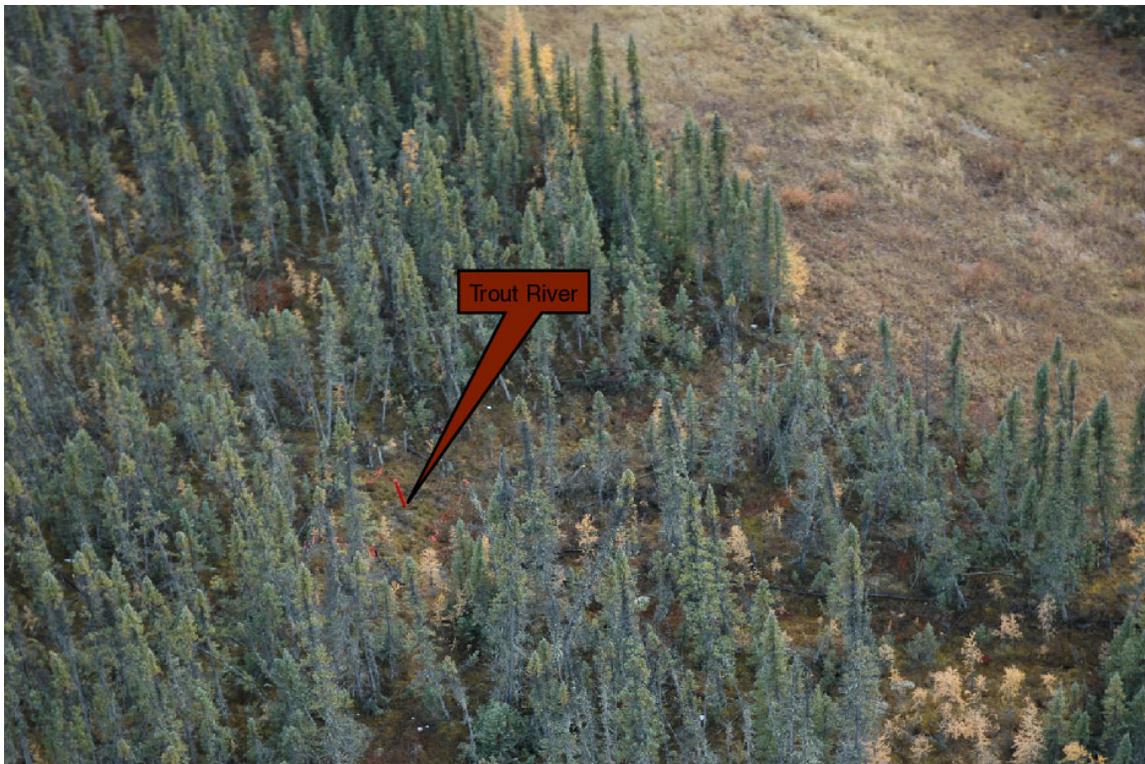
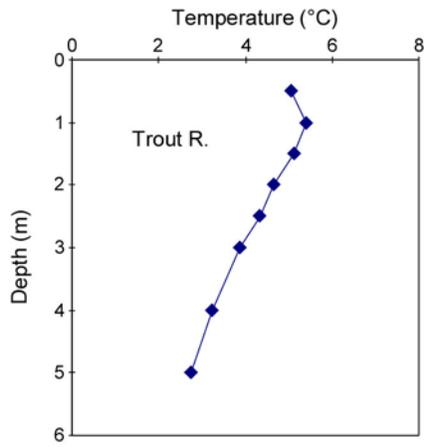


Photo taken Sep 2007

Trout River

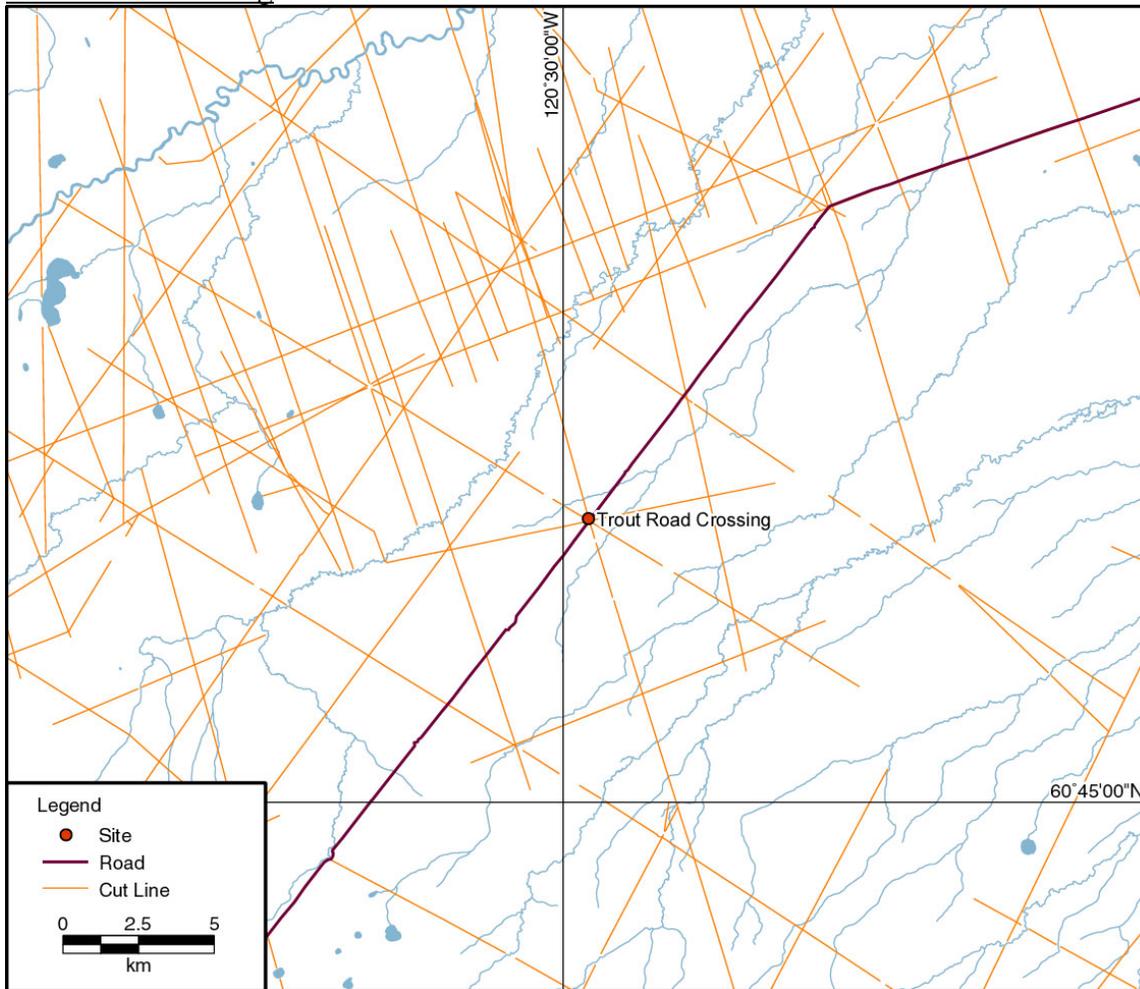
Borehole No: Trout R.		Northing: 6767353		Easting: 630326		Zone: 10								
Borehole Depth: 7.2		Location: Trout River				Date: 22-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0	20	40		60	80	100	Clay	Silt	Sand	Gravel
0		Peat and Clay.												
1		Silt: Sand.												
2														
3														
4		Till: Gravelly (coarse sand with gravels).												
5		Sand: With gravels up to 30mm.												
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Trout River



September 26 2008 data

Trout Road Crossing



Trout Road Crossing



Trout Road Crossing



Photo taken Sep 2007

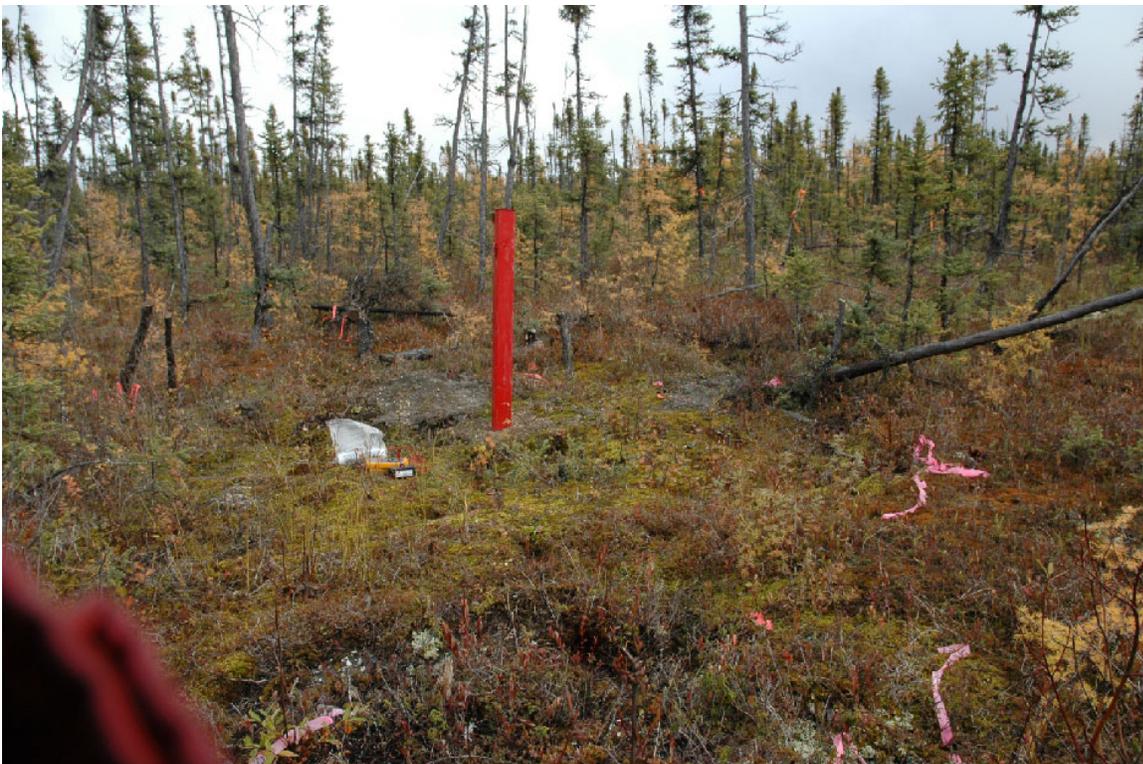


Photo taken Sep 2007

Trout Road Crossing



Photo taken Sep 2007

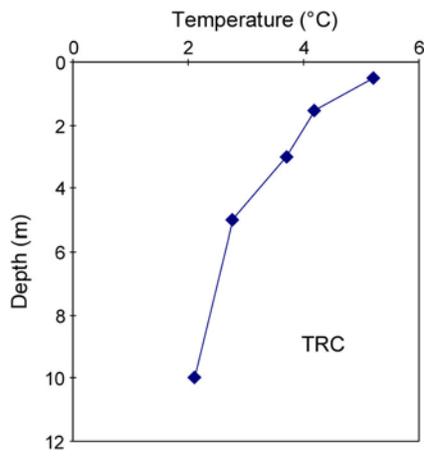


Photo taken Sep 2007

Trout Road Crossing

Borehole No: TRC		Northing: 6746943		Easting: 636730		Zone: 10								
Borehole Depth: 12		Location: Trout Road Crossing				Date: 21-Mar-07								
Depth (m)	Soil Type	Soil Description	Ground Ice Description	Plastic M.C. Liquid			Bulk Density (kg/m ³)	Grain Size (%)						
				0 20 40 60 80 100	0 20 40 60 80 100	0 20 40 60 80 100		Clay	Silt	Sand	Gravel			
0		Peat: Black.												
1		Silt and Clay: Wet.												
2		Silt: Till, trace gravels.												
3														
4														
5														
6		Till: Some gravels up to 25mm.												
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														

Trout Road Crossing



September 26 2007 data