Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8303

Report on 2016 field activities and collection of ground thermal and active layer data in the Mackenzie corridor, Northwest Territories

S.L. Smith, J. Chartrand, C. Duchesne, and M. Ednie

2017

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8303

Report on 2016 field activities and collection of ground thermal and active layer data in the Mackenzie corridor, Northwest Territories

S.L. Smith, J. Chartrand, C. Duchesne, and M. Ednie

2017

Permanent link: https://doi.org/10.4095/306212

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
Smith, S.L., Chartrand, J., Duchesne, C., and Ednie, M., 2017. Report on 2016 field activities and collection of ground thermal and active layer data in the Mackenzie corridor, Northwest Territories; Geological Survey of Canada, Open File 8303, 96 p. https://doi.org/10.4095/306212

Publications in this series have not been edited; they are released as submitted by the author.

ABSTRACT

This report presents a summary of field activities conducted in 2016 in the Mackenzie corridor (north of Wrigley), N.W.T. Air temperature, ground thermal and active layer data acquired from permafrost monitoring sites visited in 2016 are provided in graphical and tabular format. Ground temperature records for the 2007-2016 period are also presented and indicate that permafrost is generally warming throughout the corridor and, for a majority of sites, permafrost is currently warmer than the baseline established during the International Polar Year (2007-2009). The data presented provide essential baseline information that can be utilized by stakeholders and others for various purposes such as land management activities, regulatory processes and design of northern infrastructure. This report will be distributed to community organizations and stakeholders in the study region to provide an update on field activities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Geological Survey of Canada (GSC) has maintained a permafrost and active-layer monitoring network in the Mackenzie Valley and Delta since the 1980s. This network provides information on ground thermal conditions and active-layer thickness that is essential for land use planning decisions, engineering design of infrastructure, and for understanding the impacts of climate change on permafrost environments. The information collected from these monitoring sites improves the characterization of regional baseline ground thermal conditions and can support development decisions in the Mackenzie corridor.

This report provides a summary of the field activities to collect air and ground temperature and active-layer data during summer and fall 2016 in the portion of the Mackenzie corridor, north of Wrigley. Graphical and tabular summaries of data are provided. Since many of the ground thermal monitoring sites were established in 2007, time series for selected sites are also provided to show the fluctuations in ground temperature over the 2007-2016 period. A summary of changes in active-layer thickness since 1991 is also provided.

A primary objective of this report is to update stakeholders in the region on our activities and to make the data collected available to them. This information is also of interest to those requiring regional permafrost and active-layer information such as industry, engineers, and the academic and modelling communities.

2 STUDY SITES AND INSTRUMENTATION

Ground thermal monitoring sites along the Mackenzie corridor in the Inuvialuit, Gwich'in, Sahtu, and Deh Cho Settlement Regions (north of Wrigley) were visited between early August and late September 2016. The location and brief description of each site visited in 2016 is provided in Figures 1, 2, and 3 and in Table 1. A visit is planned to sites in the southern portion of the corridor (south of Wrigley) in 2017. Ground temperatures are measured with multi-sensor temperature cables installed in boreholes generally up to 20 m in depth. Data loggers are connected to most of the cables to record temperatures every eight hours and provide a continuous record of ground temperature throughout the year. The measurement system allows for a resolution of ±0.01 °C and an accuracy of ±0.1 °C. Further details on the site establishment, site characteristics and instrumentation can be found in Smith et al. (2007, 2008b, 2009a, and 2010a). At other sites ground temperatures are only measured manually during site visits. Many of the sites were established in 2006-2007 (e.g. Smith et al., 2009a; Wolfe et al., 2010) but some have been in operation since the 1980s such as those established along the Enbridge pipeline right-of-way (e.g. Pilon et al., 1989; Smith et al., 2008a).

The GSC also maintains about 40 active-layer monitoring sites throughout the Mackenzie corridor (many of which have been in operation since the early 1990s. In late July and early August 2016, sites in the Gwich'in and Inuvaluit regions were visited (Table 2, Figure 1). Thaw tubes have been installed at these sites to determine the maximum thaw penetration and the ground surface position during the period of maximum thaw in the year prior to the site visit. Data obtained during 2016 site visits, therefore, allow the determination of the active-layer

thickness for 2015. Further details on thaw tube establishment, instrumentation, and site characteristics can be found in Nixon and Taylor (1994), Nixon et al. (1995), and Smith et al. (2009b).

Air and ground surface temperature data are collected at a number of ground thermal and active-layer monitoring sites (Tables 1 and 2). Air temperatures are recorded using single channel data loggers connected to a temperature sensor inserted into radiation shields 1.5 m above the ground surface as described by Taylor (2000) and Duchesne et al. (2014). Ground surface temperatures are recorded using similar data loggers but with an internal temperature sensor that is inserted 3 to 5 cm below the ground surface. The data loggers have a resolution of 0.5 ºC at -20 ºC and an accuracy ranging from 0.5 ºC at -20 ºC to 0.2 ºC at 0 ºC and record temperature every 3 hours.

Table 1. Thermal monitoring sites in the Inuvialuit, Gwich'in, Sahtu, and Deh Cho Settlement Regions.

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Inuvialuit	North Head Shore	90TT13	3	69.72	134.46	Thermokarst coastal plain	Tundra	Ground	13/08/2016
Inuvialuit	Taglu	TAG04 Sedge	n/a	69.37	134.99	Point bar	Horsetail	None	12/08/2016
		TAG04 SWIL	n/a	69.37	134.98	Point bar	Dwarf willow shrubs	None	12/08/2016
		91TTC	15	69.37	134.95	Surface of Holocene Mackenzie delta	Low shrub tundra	Ground	12/08/2016
Inuvialuit	Kumak	KUM02 SWIL	n/a	69.32	135.21	Point bar	Dwarf willow shrubs	None	12/08/2016
		KUM02 TWIL	n/a	69.32	135.21	Point bar	Tall willow shrubs	None	12/08/2016
		KC-07	n/a	69.31	135.25	Tundra upland	Grass and moss tundra	None	12/08/2016
Inuvialuit	Dennis Lake	T7 Upland	n/a	69.31	134.54	Moraine uplands	Dwarf birch tundra with willow and alder shrubs	None	13/08/2016
Inuvialuit	Lousy Point Ridge	90TT05	n/a	69.22	134.29	Glaciofluvial ridge	Low shrub tundra	Air / Ground	13/08/2016
Inuvialuit	Lousy Point Low Terrace	90TT06	n/a	69.22	134.29	Glaciofluvial ridge	Low shrub tundra	Air / Ground	13/08/2016
Inuvialuit	Yaya Lake Low	90TT04	10	69.14	134.70	Ice contact complex	Shrub tundra	Ground	12/08/2016
Inuvialuit	Parsons Lake	T5 Upland	n/a	68.96	133.84	Moraine uplands	Dwarf birch tundra with willow and alder shrubs	None	14/08/2016
		T5 Slump	n/a	68.96	133.84	Thaw slump	Willow and alder shrubs	None	14/08/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Inuvialuit	Reindeer Station plateau	91TT12	152	68.69	134.11	Plateau surface, till plain	Shrub tundra	Air / Ground	13/08/2016
Inuvialuit	Reindeer Depot (Williams Island)	91TT13	5	68.68	134.15	Surface of bar in Mackenzie Delta	Riparian willow and alder shrub	Air / Ground	16/08/2016
Inuvialuit	Jimmy Creek Valley	JV-1 Bottom	n/a	68.63	133.63	Moraine uplands	Dwarf birch tundra with willow and alder shrubs	None	14/08/2016
Inuvialuit	Navy Channel	03TC1	5	68.42	133.79	Surface of Holocene Mackenzie delta adjacent to eastern edge rising 10s of meters to till plain	Riparian high willow shrub, open, incomplete ground cover of forbs and sedge (forest tundra)	Air / Ground	16/08/2016
Gwich'in	Norris Creek	NC-01	15	68.41	133.29	Thick organic material over moraine plain	Shrub tundra	None	12/08/2016
Gwich'in	Navy Road	01TC1	60	68.40	133.76	Fine grained colluvium sloping toward river, post glacial (~10Ka)	Taiga post fire succession, scattered birch and alder, open dwarf birch, heath ground cover	Ground	11/08/2016
Gwich'in	Inuvik Airport Trees	01TC2	84	68.32	133.44	Fluted till plain, glacial (>10Ka)	Taiga open black spruce, heath ground cover	Ground	14/08/2016
Gwich'in	Inuvik Airport Bog	12TC1	68	68.32	133.43	Bog between ridges on fluted till plain, glacial (>10Ka)	Taiga open bog, scattered shrub, heath ground cover (forest tundra)	None	10/08/2016
		01TC3	68	68.32	133.43	Bog between ridges on fluted till plain, glacial (>10Ka)	Taiga open bog, scattered shrub, heath ground cover (forest tundra)	Ground	10/08/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Gwich'in	Campbell Lake	CaL-01	115	68.24	133.10	Moraine plain	Peatland	None	12/08/2016
		CaL-02	118	68.24	133.10	Moraine plain	Cutline	None	12/08/2016
		CaL-03	118	68.24	133.10	Moraine plain	Black spruce forest	None	12/08/2016
Gwich'in	North Caribou Lake	NCL-01	209	68.15	132.93	Moraine plain	Peatland	None	12/08/2016
		NCL-02	217	68.15	132.93	Moraine plain	Stunted black spruce forest	None	12/08/2016
Gwich'in	Hill Lake	HL-01	229	67.99	132.49	Moraine plain	Tundra	None	12/08/2016
		HL-02	234	67.99	132.49	Moraine plain	Shrub tundra	None	12/08/2016
Gwich'in	Wood Bridge Lake	WBL-01	204	67.90	132.18	Alluvial plain	Black spruce forest	None	12/08/2016
Gwich'in	Rengleng River mouth	91TT14	8	67.80	134.13	Alluvial plain	Mixed spruce and hardwood forest	Air / Ground	15/08/2016
Sahtu	Jackfish Creek	JF-02	90	66.29	128.47	Eolian dune on moraine plain, well drained, elevated area	Black spruce forest and moss cover	None	23/09/2016
Sahtu	Fort Good Hope South	FGHS-01	134	66.21	128.50	Hummocky peatland	Dense shrub and open black spruce	Air / Ground	23/09/2016
		FGHS-02	134	66.21	128.50	Hummocky peatland	Peat plateau, lichen, open black spruce	None	23/09/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Sahtu	Snafu Creek	SC-01	100	66.00	128.35	Moraine plain	Peat bog, open black spruce forest, and lichen cover	None	23/09/2016
Sahtu	Chick Lake	CL-01	122	65.90	128.24	Moraine plain	Peat and organic soil with open black spruce forest and shrubs	None	23/09/2016
Sahtu	Gibson Lake	GL-01	228	65.75	127.89	Hummocky moraine plain	Recovering burnt area with peat and shrubs	Ground	23/09/2016
Sahtu	Hanna River	HR-01	104	65.67	127.83	Lacustrine plain	Boggy burnt area	None	23/09/2016
Sahtu	Elliot Creek	EC-01	54	65.52	127.62	Lacustrine undulating plain, well drained elevated area	Peat cover on edge of open, mature black spruce forest	None	23/09/2016
		EC-02	54	65.52	127.62	Lacustrine plain overlain by alluvial sediments	Peat cover on edge of dense, mature black spruce forest	None	23/09/2016
Sahtu	Oscar Creek	OC-01	64	65.44	127.44	Undulating glaciolacustrine terrain overlain by alluvial sediments	Peat cover with dense-forested birch and black spruce	None	23/09/2016
Sahtu	Billy Creek North	BCN-01	90	65.40	127.32	Alluvial and eolian sediments overlying low-lying lacustrine plain	Peat cover with dense-forested black spruce and mixed shrub	None	23/09/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Sahtu	Kee Scarp	Kee Scarp-HT	270	65.30	126.72	Top of narrow ridge. Borehole is in shale (which is underlain by limestone) with 20 cm moss and organic cover at surface	Boreal forest, mixture aspen birch pine and spruce with ground cover of grasses and small shrub	None	23/09/2016
Sahtu	Norman Wells Pump Station	84-1-T4	61	65.29	126.89	Ground moraine	Moss, lichen, ericaceous shrubs with black spruce and tamarack	Air / Ground	26/09/2016
Sahtu	Normal Wells Town	Arena	80	65.28	126.83	Ground moraine	Disturbed area adjacent to parking lot	None	26/09/2016
		Water Treatment Plant	80	65.28	126.84	Ground Moraine	Disturbed area adjacent to parking lot	None	26/09/2016
Sahtu	Van Everdingen	30m	n/a	65.27	126.75	Lacustrine plain	Open forest, moss, shrub, spruce/tamarack	Air / Ground	26/09/2016
Sahtu	Canyon Creek North A	84-2A-HT	110	65.23	126.50	Ground moraine	Lichen, moss, ericaceous shrubs with black spruce and tamarack	None	25/09/2016
		84-2A-T4	110	65.23	126.50	Ground moraine	Lichen, moss, ericaceous shrubs with black spruce and tamarack	None	25/09/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Sahtu	Canyon Creek North B	84-2B-T4	110	65.23	126.52	Ground moraine	Moss with white spruce	Air / Ground	23/09/2016
Sahtu	Vermillion Creek	VC-01	92	65.10	126.14	Moraine plain (site at approach to water crossing)	NW side of creek, on top of ridge in black spruce forest	Air / Ground	23/09/2016
		VC-02	92	65.10	126.13	Moraine plain (site at approach to water crossing)	SE side of creek on plateau in area of burnt black spruce	None	23/09/2016
Sahtu	Police Island	PI-01	113	64.83	125.012	Lacustrine plain	Recovering burn (burnt black spruce forest)	None	24/09/2016
		PI-02	113	64.83	125.01	Lacustrine plain	Unburnt, black spruce forest with moss and lichen ground cover	None	24/09/2016
Sahtu	Old Fort Point	OFP-01	112	64.65	124.84	Lacustrine plain	Open mixed spruce, pine deciduous forest adjacent to open, low-lying fen	None	24/09/2016
Sahtu	Little Smith Creek	LS-01	80	64.43	124.74	Alluvial flood plain	Open mature black spruce forest	None	24/09/2016
		LS-02	112	64.43	124.73	Glaciofluvial outwash plain	Tamarack, birch, poplar, and pine forest transition to spruce	None	24/09/2016
Sahtu	Saline River	SR-02	140	64.29	124.49	Glaciofluvial veneer over lacustrine	Burnt black spruce forest	None	24/09/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Sahtu	KP182	Bottom	133	64.28	124.47	Lacustrine plain	Forested (recovering burn, burned 1994)- aspen, willow, birch, tamarack	Ground	25/09/2016
		Mid Slope HT192	138	64.28	124.47	Lacustrine plain	Forested (recovering burn, burned 1994)- aspen, willow, birch, tamarack	Ground	25/09/2016
		Top of Slope	144	64.28	124.47	Lacustrine plain	Forested (recovering burn, burned 1994)- aspen, willow, birch, tamarack	Ground	25/09/2016
		Crest of Slope	139	64.28	124.47	Lacustrine plain	Forested (recovering burn, burned 1994)- aspen, willow, birch, tamarack	Air / Ground	25/09/2016
		Unburnt	141	64.28	124.47	Lacustrine plain	Forested - white spruce, white birch with black spruce, moss and peat ground cover	Ground	25/09/2016
Sahtu	Steep Creek	Steep-02 (crest)	134	64.18	124.38	Alluvial and colluvial, north facing slope of stream valley (site at edge of cleared right-of-way)	Mixed, white spruce, jackpine, aspen, birch	None	24/09/2016
Deh cho	Table Mountain A	85-7A-HA108	255	63.61	123.64	Ground moraine	Lichen, moss, ericaceous shrubs with black spruce and alder	None	24/09/2016

Table 1. (Continued)

Settlement region	Site name	Borehole name	Elevation (m a.s.l.)	Latitude (N)	Longitude (W)	Landform	Vegetation cover	Air / ground surface temperature	Date visited in 2016
Deh cho	KP313	KP313 T2	250	63.26	123.43	Lacustrine plain, bottom of slope	Moss cover and peat, forested, mix of birch and spruce	Ground	24/09/2016
		KP313 T4	250	63.26	123.43	Lacustrine plain, mid slope, W side of ROW	Moss cover and peat, forested, mix of birch and spruce	None	24/09/2016
		KP313 T5	250	63.26	123.43	Lacustrine plain, mid slope, E side of ROW	Moss cover and peat, forested, mix of birch and spruce	None	24/09/2016
		KP313 T6	250	63.26	123.43	Lacustrine plain, top of slope	Thin moss and organic cover, forested, mix of birch and spruce	Air / Ground	24/09/2016

Table 2. Active-layer and air/ground surface temperature monitoring sites throughout the corridor. Active-layer thickness for 2015 determined from thaw tubes at active-layer monitoring sites is provided.

Note: Probed thaw depths (where indicated in table) are taken on day of visit and are for the 2016 thaw season. Probed active-layer values at ground temperature sites are presented in Appendix A.

Site name	Site ID	Latitude (°N)	Longitude (°W)	2015 Active layer (m)	Air / Ground temperature record	Date visited
North Head shore	90TT13	69.72	134.46	0.56	Ground	13/08/2016
North Point summit	90TT02	69.66	134.39	0.54	None	13/08/2016
North Point mid-slope	90TT11	69.66	134.38	0.65	None	13/08/2016
North Point shore	90TT12	69.66	134.36	0.52	None	13/08/2016
Mason Bay high	90TT08	69.53	134.02	0.91	None	13/08/2016
Mason Bay shore	90TT09	69.53	134.01	0.67	None	13/08/2016
Illasarvik	94TT01	69.49	134.55	0.57	None	13/08/2016
Taglu	91TTC	69.37	134.95	>1.30 (probe)	Air / Ground	12/08/2016
Lousy Point hollow	91TT09	69.22	134.30	0.34	None	13/08/2016
Lousy Point ridge	90TT05	69.22	134.28	0.82	Air / Ground	13/08/2016
Lousy Point low terrace	90TT06	69.22	134.28	0.43	Air / Ground	13/08/2016
YaYa Lake high	90TT03	69.15	134.71	1.11 (probe)	None	13/08/2016
YaYa Lake low	90TT04	69.14	134.70	0.93	Air / Ground	13/08/2016
Swimming Point slope	91TT01	69.11	134.40	0.60	None	13/08/2016
Trail Valley Creek	91TT11	68.74	133.49	0.64	None	14/08/2016
Reindeer Station plateau	91TT12	68.69	134.11	0.72	Air / Ground	13/08/2016
Williams Island	91TT13	68.68	134.14	1.46	Air / Ground	16/08/2016
Navy Channel	90TT17	68.42	133.79	1.80	Air / Ground	16/08/2016
Upper Air	90TT16	68.32	133.53	0.75	None	11/08/2016
Havikpak Creek	93TT02	68.32	133.52	0.71	None	11/08/2016
Caribou Creek	93TT01	68.11	133.48	0.78	None	11/08/2016
Rengleng River mouth	91TT14	67.80	134.13	1.11	Air / Ground	14/08/2016

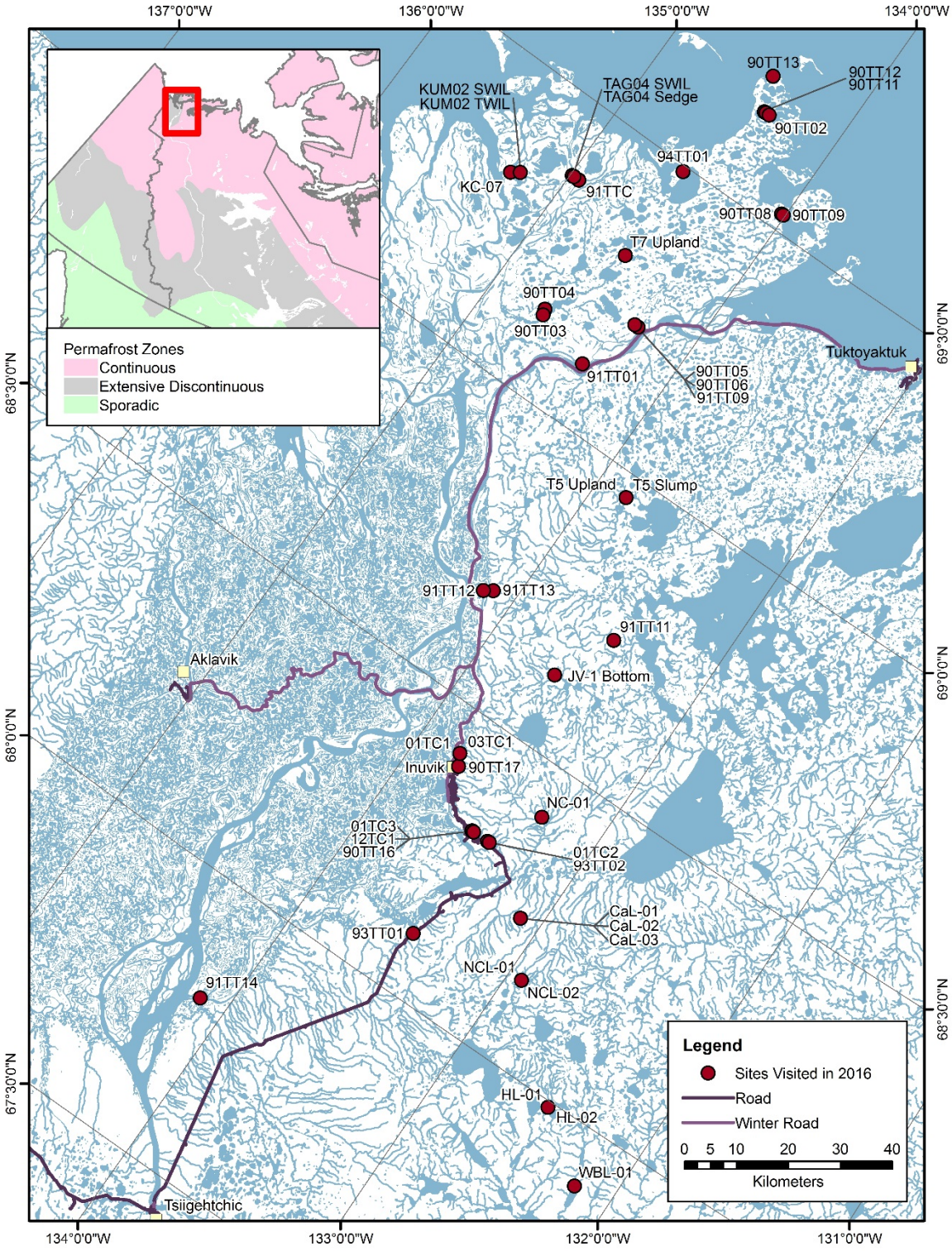


Figure 1. Permafrost and active-layer monitoring sites north and south of Inuvik, visited in 2016.

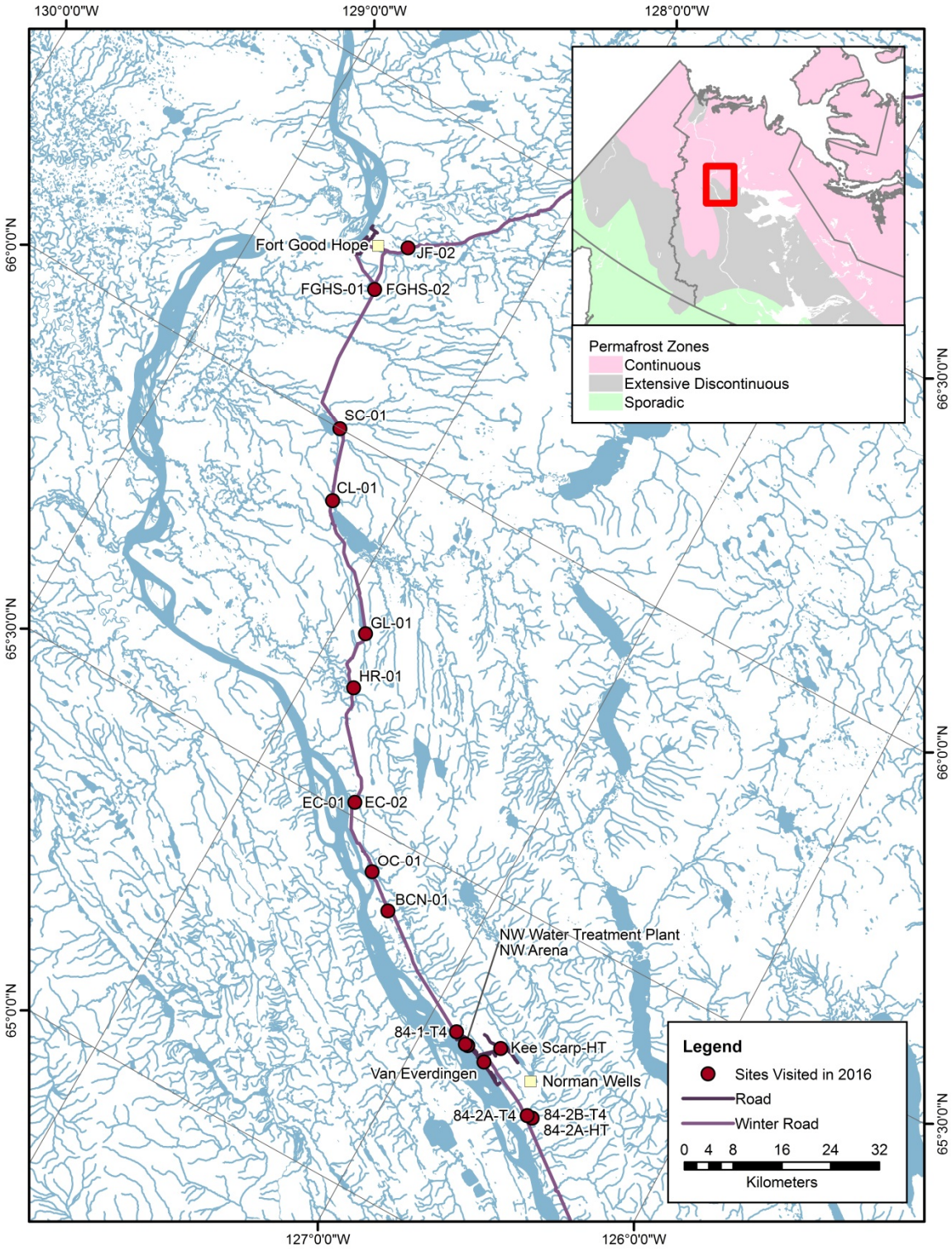


Figure 2. Permafrost and active-layer monitoring sites between Fort Good Hope and Norman Wells in the Sahtu Settlement Region, visited in 2016.

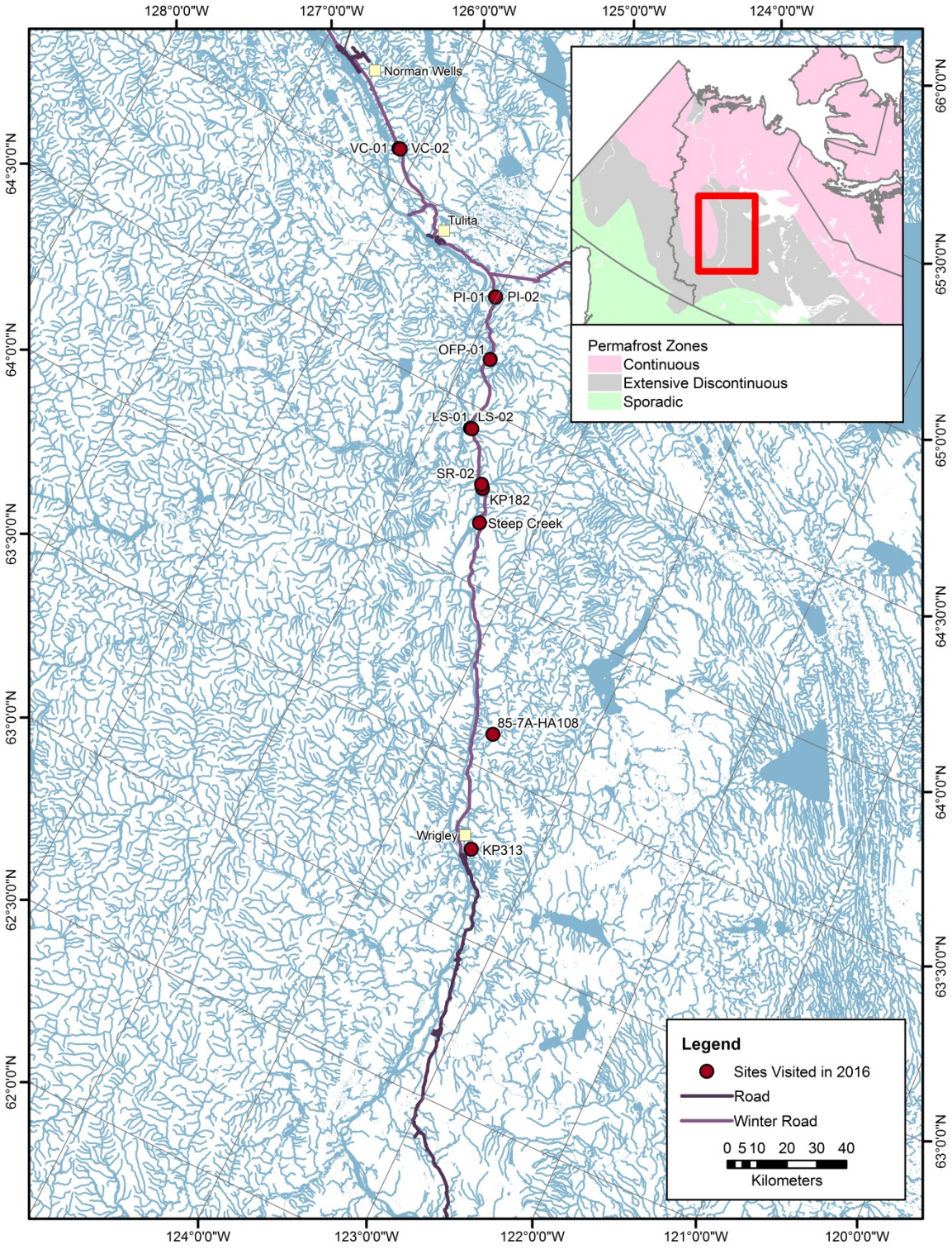


Figure 3. Permafrost and active-layer monitoring sites south of Norman Wells in the Sahtu and Deh Cho Settlement Regions, visited in 2016.

3 DATA COLLECTION AND PRESENTATION

Site visits were conducted between early August and late September 2016 to collect ground temperature data from the data loggers, to take manual temperature measurements, and to service the instrumentation. The temperature record acquired from the data loggers was checked visually and any irregular data were removed.

The data record acquired for each site was analyzed to determine the annual minimum and maximum temperature at each depth and to define the annual ground temperature envelope for the 2015-2016 period. Temperature envelopes are presented in graphical and tabular format for each site in Appendix A. The maximum thaw depth for each site was determined by either interpolating between the maximum temperatures reached at the depths that bracket 0 °C or by use of a frost probe at the time of visit. Maximum thaw depth is included with each temperature envelope in Appendix A. Previous data collected from the thermal monitoring sites have been presented in earlier annual reports (e.g. Smith et al., 2016).

At some sites the data logger malfunctioned or instrumentation was damaged so that a continuous temperature record could not be acquired. At other sites, cables are not connected to data loggers. For these sites the manual temperature measurements made during the summer or fall 2016 site visit are presented in Appendix A.

Mean annual ground temperature (MAGT) for each site was determined at the depth of zero annual amplitude (ZAA). For practical purposes the ZAA depth is defined as the depth where seasonal variation is less than 0.1 °C. For sites where the temperature cable extends below this depth, the MAGT was determined for the depth of the shallowest sensor for which the seasonal variation is less than 0.1 °C. For sites with cables shallower than the ZAA depth, MAGT at the deepest measurement depth was determined. The MAGT based on data collected for the 2015-2016 period is shown in Figure 4. Throughout the discontinuous permafrost zone, MAGT is generally above -2 °C with colder conditions at the transition between discontinuous and continuous permafrost zones, but MAGT is still above -2.5 °C. Permafrost in the northern portion of the corridor is generally much colder with MAGT below -4 °C at many sites and lower than -6 °C at tundra upland sites. However, permafrost can still be quite warm at some sites due to their proximity to water bodies and also deep snow covers (e.g. Burn and Kokelj, 2009; Smith et al., 2010b).

Air and ground surface temperature records were visually checked and any irregularities were removed. Monthly averages of air and ground surface temperatures were determined and are presented in graphical and tabular format in Appendix A. The air and ground surface temperature data collected prior to 2016 are summarized in Duchesne et al. (2014) as well as previous annual reports (e.g. Smith et al., 2016).

The 2015 active-layer thickness data determined from thaw tubes are presented in Table 2 for all active-layer monitoring sites that were visited in early August 2016. Data collected prior to 2016 have been published in Smith et al. (2009b) and previous annual reports (e.g. Smith et al., 2016) and have also been summarized in Duchesne et al. (2015a, b).

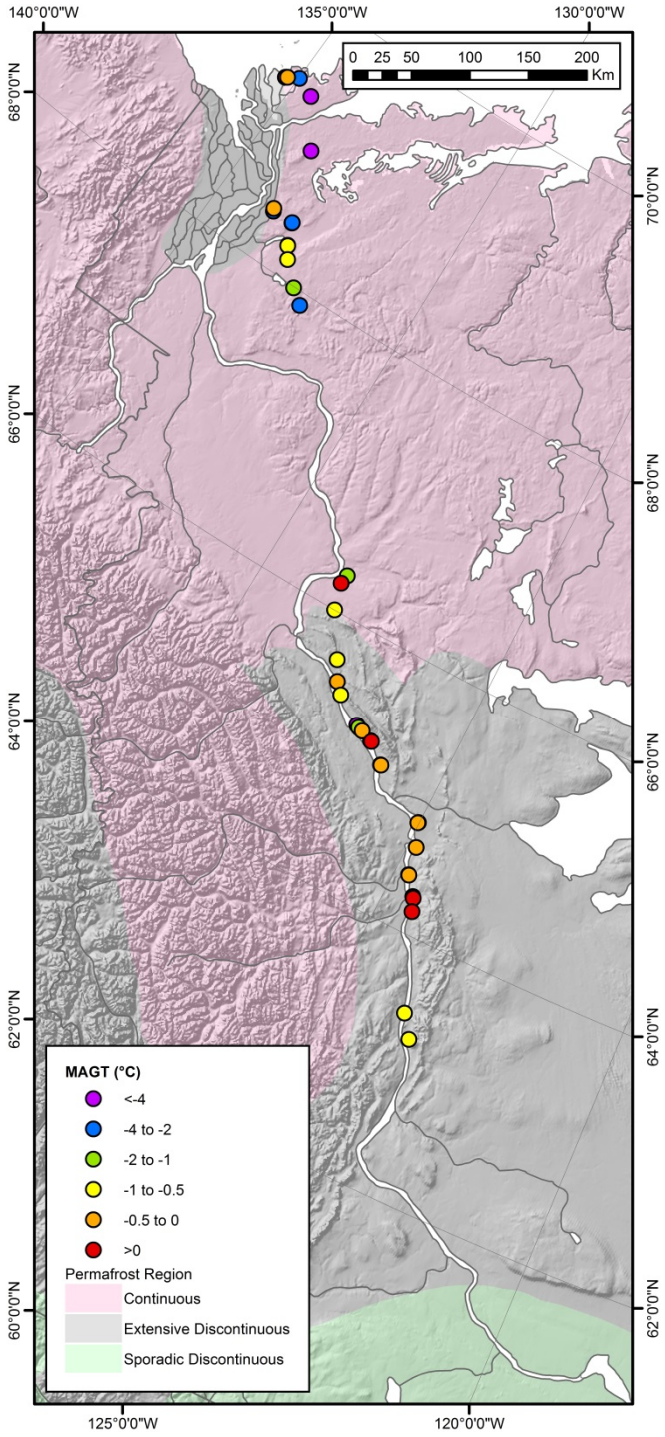


Figure 4. Current (2015-16) MAGT for the Mackenzie corridor based on temperature at ZAA depth or the measurement depth closest to it.

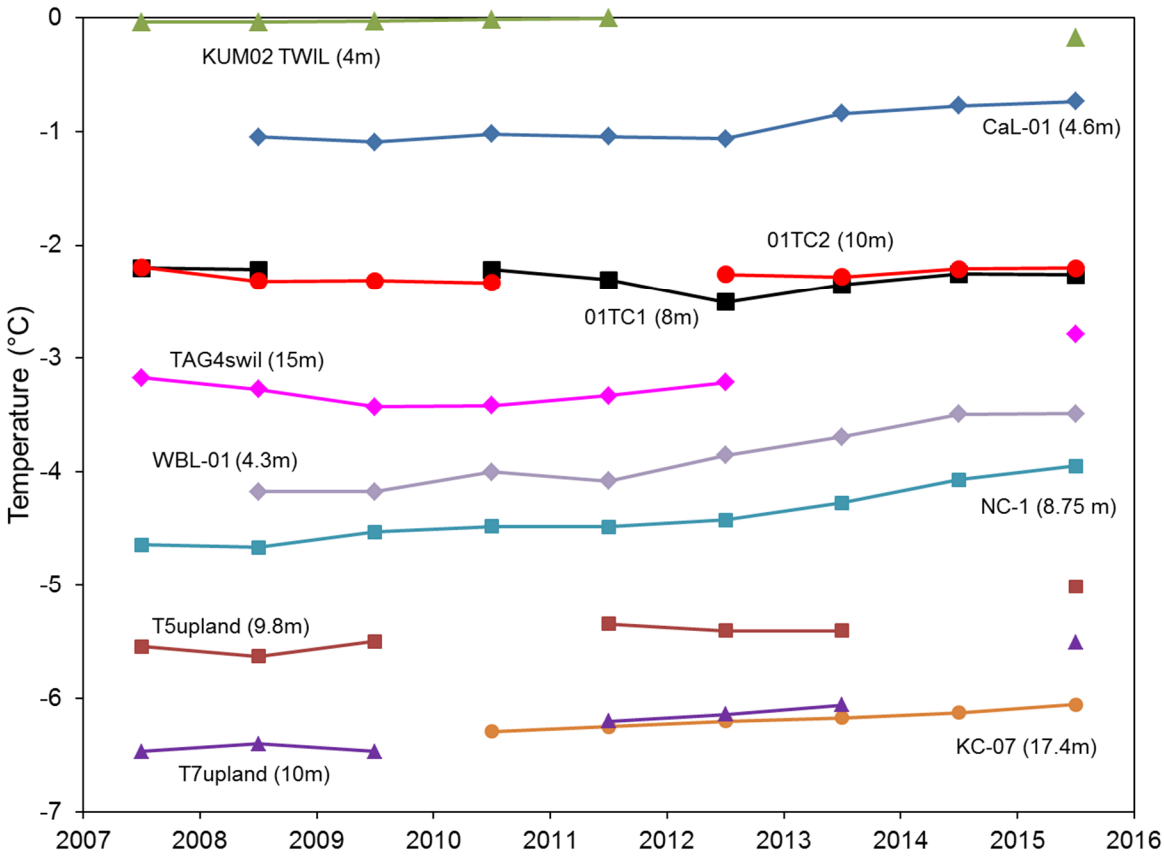


Figure 5. MAGT at measurement depth at or closest to ZAA depth for selected sites in the continuous permafrost zone.

4 CHANGES OVER TIME

4.1 Changes in Ground Temperatures 2007-2016

Many of the monitoring sites were established in 2007 and data are now available for about nine full years. Although data records are too short to assess any long-term trends in ground temperatures, they can be used to characterize recent temperature fluctuations and the range in ground temperature that may occur at an individual site.

MAGT determined at the ZAA depth or the measurement depth closest to it has been determined for each year for the 2007-16 period. Temperatures at the ZAA depth are desirable for tracking long-term trends whereas temperatures at shallower depths will reflect shorter term fluctuations. For sites with data loggers, the annual period for MAGT calculation is either September 1 to August 31 or August 1 to July 31 depending on the schedule for the site visit and data acquisition for the sites. For sites where only manual measurements are available the temperature recorded at the ZAA depth during the site visit is used as the MAGT. Time series for selected permafrost

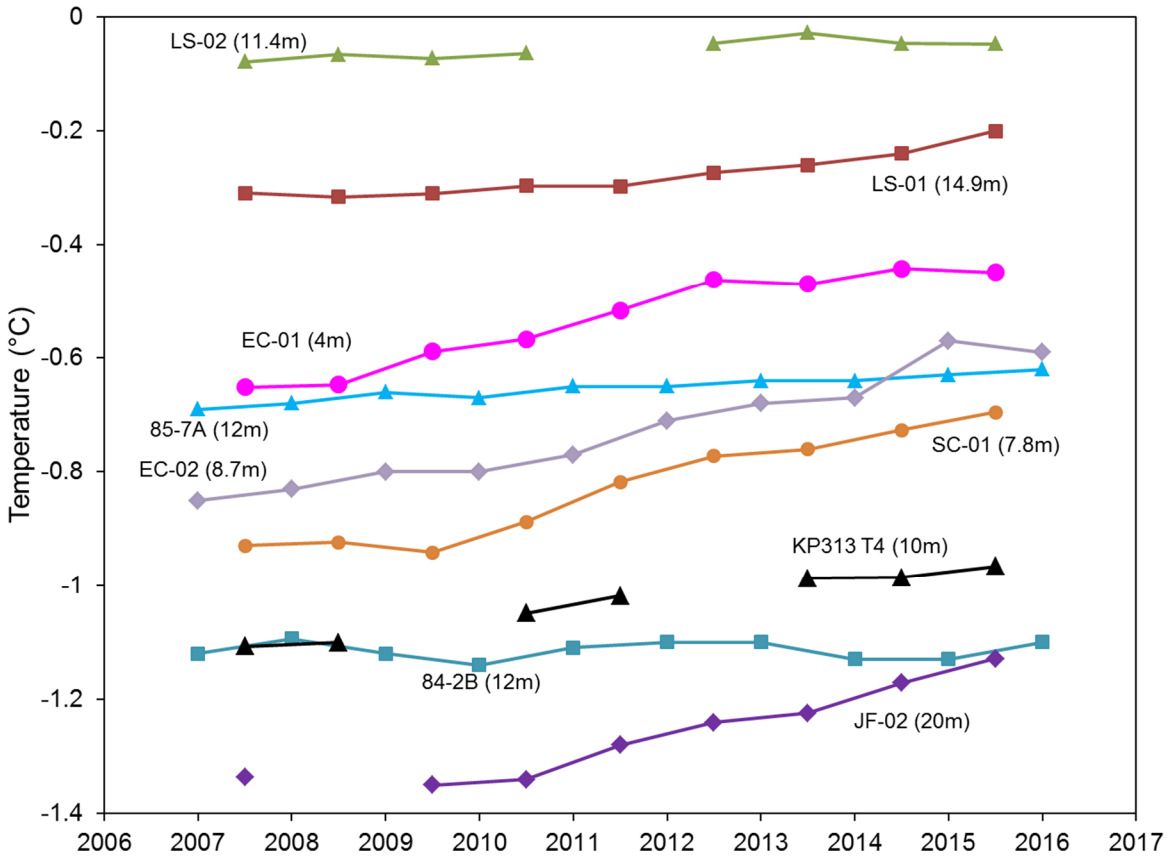


Figure 6. MAGT at the measurement at or closest to MAGT depth for selected sites in the discontinuous permafrost zone.

sites in the continuous and discontinuous permafrost regions (Figures 5 and 6) are discussed below.

Analysis of data collected in the continuous permafrost zone indicates that at most sites permafrost has been warming at rates as high as 0.1 °C per year (Figure 5). However, at some of the warmer permafrost sites, (e.g. KUM02 TWIL, 01TC1, 01TC2), little warming or even slight cooling has occurred. At many sites there also appears to be an increase in the rate of warming since about 2011 which may be associated with a period of higher air temperature since 2010 (Figure 7). It should also be noted that the measurement depths for some of the sites south of Inuvik (NC-01, WBL-01) are shallower than that for most of the more northerly sites, and also above the ZAA depth, which is part of the reason the change in ground temperature is greater for these sites.

For warmer permafrost in the discontinuous zone, the change in MAGT has been relatively small compared to that for the colder permafrost sites in the continuous region. Between Norman Wells and Fort Good Hope, MAGT has increased over the last nine years by up to 0.03 $°Cy^{-1}$ (Figure 6). Between Norman Wells and Wrigley, increases in MAGT have been less than 0.02 $°Cy^{-1}$ and for some sites the change has been negligible (Figure 6). Analysis of longer term

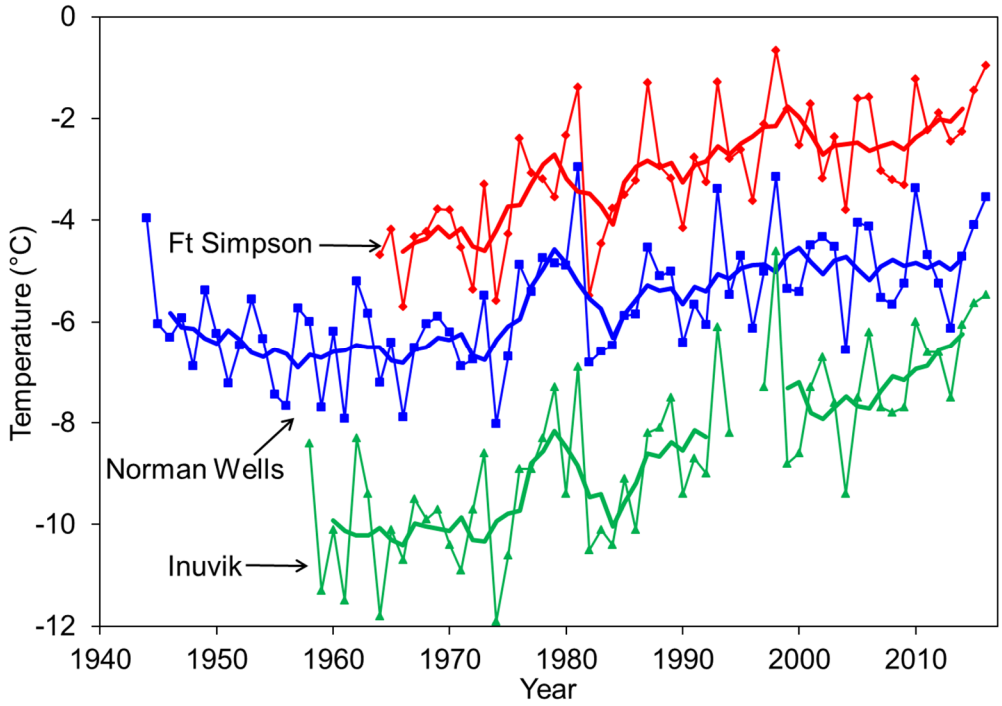


Figure 7. Mean annual air temperature for three Environment Canada weather stations in the Mackenzie Valley. The thick line represents the 5-year running mean. Data from Environment Canada (http://climate.weather.gc.ca/).

records for the central Mackenzie Valley (see Smith et al., 2015; Romanovsky et al., 2016) indicate that permafrost has been warming in the central Mackenzie Valley since the mid 1980s with MAGT increasing at a lower rate more recently which may reflect a period of fairly stable air temperature in the region (Figure 7). At some sites, MAGT has increased since 2010 (Figure 6) and this may be the result of higher air temperatures in the last 5 years compared to those between 2007 and 2009 (Figure 7).

There have also been local environmental changes at some sites that may have an impact on ground temperature. In summer 2014, forest fires affected extensive areas of the N.W.T. Burning occurred at the Elliot Creek site (EC-02). Damage to trees and some charing of the surface occurred (Figure 8a, b) but the fire was not severe enough to completely destroy the organic layer. An increase in MAGT was observed over the last few years and this may be in response to the alteration of vegetation and surface conditions due to the fire.

Vegetation clearing has also occurred at the edge of the right-of-way of the winter road in 2015 and 2016 to install a fibre optic cable. Clearing at Little Smith Creek at the base of the slope adjacent to the road resulted in complete removal of trees at LS-01 (Figure 8c) which may over time, result in warmer ground conditions. Although MAGT was higher in 2015-2016 than it was in 2014-2015, this is not likely due to the effect of clearing as there is a lag period of several months between changes in temperature at the surface and those at greater depth.

A

B

C

Figure 8. Recent environmental changes: (A) Burned area around EC-02 borehole, Sept. 2014; (B) EC-02 borehole, Sept. 2015; (C) Clearing around LS-01 borehole, Sept. 2016.

Overall, MAGTs are currently higher than they were when most of the sites were established in 2007. During the International Polar Year (IPY, 2007-2009), a ground temperature baseline was established (Smith et al., 2010b). Figure 9 summarizes the differences between current MAGT for sites visited in 2016, and the IPY baseline. Changes in MAGT over the last nine years have generally been greater for colder permafrost sites and unfrozen sites. At some of the colder permafrost sites, the current MAGT is more than 0.6 °C higher than the IPY baseline. For warmer permafrost sites, especially where MAGT is close to 0 °C and soils are ice rich, latent heat effects associated with phase change result in very little change in ground temperature over the last nine years (e.g. Bonnaventure et al., 2015; Smith et al., 2010b).

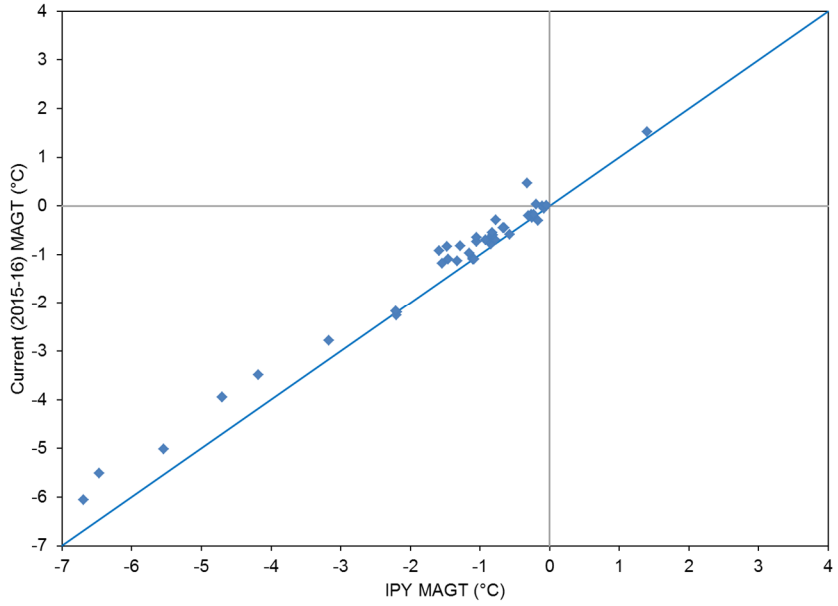


Figure 9. Comparison of current (2015-2016) MAGT with IPY baseline temperature for sites visited in 2016.

4.2 Changes in Active-Layer Thickness

Active-layer thickness (ALT) exhibits much greater interannual variation than the deeper ground temperature measurements. The change in ALT, relative to the 10 year mean for 2003-12 is summarized for 25 sites in Figure 10. ALT has generally increased since 2008 and exceeded the long-term mean since 2009, reaching a peak in 2012, but still less than the maximum in 1998 which was one of the warmest years on record (Duchesne et al., 2015a). This recent increase in ALT is likely in response to warmer air temperatures more recently (Figure 7). ALT decreased slightly after 2012. However, ALT in 2015 was generally greater than it was in 2014.

5 SUMMARY

This report provided a summary of field activities in the Mackenzie corridor during summer and fall 2016. A summary of the ground thermal data collected at permafrost monitoring sites in August and September 2016 for the previous one-year period has been presented in graphical and tabular format. The 2015 active-layer thickness data for active-layer monitoring sites visited in 2016 were also provided. Existing time series were also provided and the results indicated that permafrost generally continues to warm in the corridor. This report will be distributed to the various community organizations and stakeholders within the region in order to provide them with an update of our activities. The data presented can be utilized for land management activities, regulatory processes, and for engineering design. The addition of these data to existing records builds up the ground temperature time-series and also improves the quality of baseline permafrost data against which change may be measured for the Mackenzie corridor.

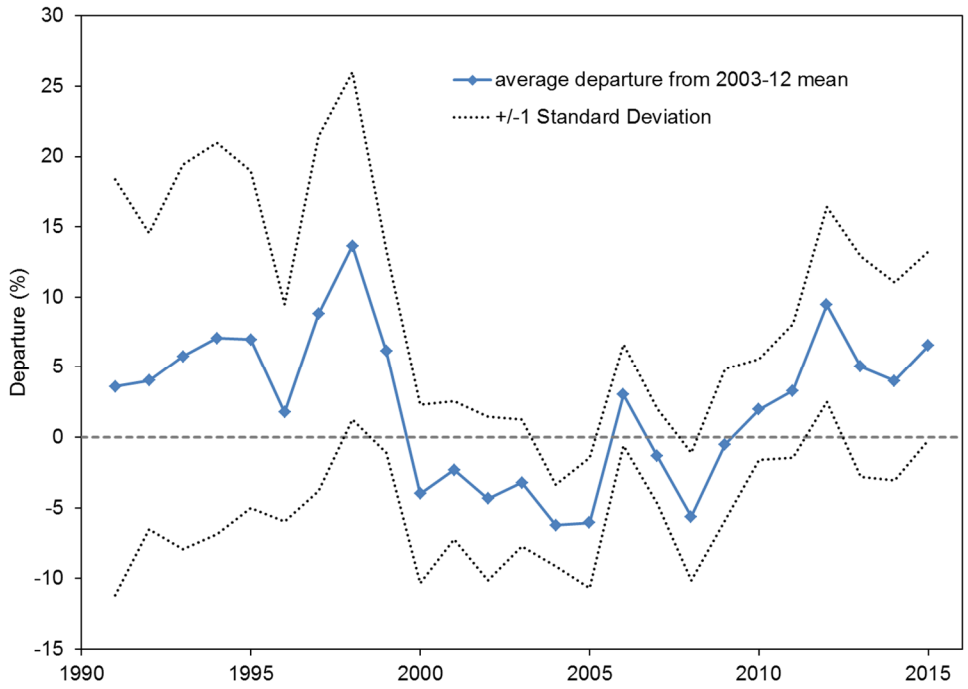


Figure 10. Mean ALT departures (%) from 2003-12 mean for 25 sites (note 2015 ALT based only on northern sites visited in 2016).

6 ACKNOWLEDGEMENTS

Support for the 2016 field data collection was provided by Natural Resources Canada. Logistical support was provided by the Polar Continental Shelf Program and the Aurora Research Institute. We are also grateful for the continuing support for this project of the various community organizations and stakeholders in the region. We would like to thank Colleen Fish and Inuvik resident, Willie Modeste, for their help with fieldwork. Review comments provided by Wendy Sladen were much appreciated.

7 REFERENCES

Bonnaventure, P.P., Smith, S.L., Riseborough, D.W., Duchesne, C., and Ednie, M. 2015. The ground thermal regime across the Mackenzie Valley Corridor, Northwest Territories Canada. Paper 67. In GEOQuébec 2015 (68th Canadian Geotechnical Conference and 7th Canadian Conference on Permafrost). Québec. GEOQuébec 2015 Organizing Committee.

Burn, C.R., and Kokelj, S.V. 2009. The environment and permafrost of the Mackenzie Delta area. Permafrost and Periglacial Processes, 20(2): 83-105. doi:10.1002/ppp.653

Duchesne, C., Riseborough, D., and Smith, S.L. 2014. Air and near surface ground temperatures, indices and summary statistics from 1994 to 2011 for the Mackenzie Valley corridor, N.W.T.; Geological Survey of Canada Open File 7392. doi:10.4095/292675

Duchesne, C., Smith, S.L., Ednie, M., and Bonnaventure, P.P. 2015a. Active layer variability and change in the Mackenzie Valley, Northwest Territories. Paper 117. In GEOQuébec 2015 (68th Canadian Geotechnical Conference and 7th Canadian Conference on Permafrost). Québec. GEOQuébec 2015 Organizing Committee.

Duchesne, C., Smith, S., Ednie, M., and Chartrand, J. 2015b. 20 years of active layer monitoring in the Mackenzie Valley, Northwest Territories. Geological Survey of Canada, Scientific Presentation SP31. doi:10.4095/296513

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, p. 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. p. 27-34.

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, 332 p.

Romanovsky, V.E., Smith, S.L., Isaksen, K., Shiklomanov, N.I., Streletskiy, D.A., Kholodov, A.L., Christiansen, H.H., Drozdov, D.S., Malkova, G.V., and Marchenko, S.S. 2016. [Arctic] Terrestrial Permafrost [in "State of the Climate in 2015"]. Bulletin of the American Meteorological Society, 97(8): S149-S152.

Smith, S.L., Ye, S., and Ednie, M. 2007. Enhancement of permafrost monitoring network and collection of baseline environmental data between Fort Good Hope and Norman Wells, Northwest Territories; Geological Survey of Canada Current Research, 2007-B7, 10 p. doi:10.4095/224524

Smith, S.L., Burgess, M.M., Riseborough, D., and Chartrand, J. 2008a. Permafrost and terrain research and monitoring sites of the Norman Wells to Zama pipeline – Thermal data collection and case histories, April 1985 to September 2001; Geological Survey of Canada Open File 5331. doi:10.4095/224831

Smith, S.L., Nguyen, T.-N., Riseborough, D.W., Ednie, M., Ye, S., and Chartrand, J. 2008b. 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. doi:10.4095/226049

Smith, S.L., Chartrand, J., Nguyen, T.N., Riseborough, D.W., Ednie, M., and Ye, S. 2009a. 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, 183 p. doi:10.4095/226435

Smith, S.L., Riseborough, D.W., Nixon, F.M., Chartrand, J., Duchesne, C., and Ednie, M. 2009b. Data for Geological Survey of Canada active layer monitoring sites in the Mackenzie valley, N.W.T.; Geological Survey of Canada Open File 6287, 100 p. doi:10.4095/248197

Smith, S.L., Nguyen, T.N., Riseborough, D.W., Ednie, M., Ye, S., and Chartrand, J. 2010a. Baseline geotechnical and permafrost data from new field sites established in the Mackenzie corridor south of Norman Wells, Northwest Territories; Geological Survey of Canada Current Research 2010-2, 18 p. doi:10.4095/261487

Smith, S.L., Romanovsky, V.E., Lewkowicz, A.G., Burn, C.R., Allard, M., Clow, G.D., Yoshikawa, K., and Throop, J. 2010b. Thermal state of permafrost in North America - A contribution to the International Polar Year. Permafrost and Periglacial Processes, 21: 117-135. doi:10.1002/ppp.690

Smith, S.L., Lewkowicz, A.G., Duchesne, C., and Ednie, M. 2015. Variability and change in permafrost thermal state in northern Canada. Paper 237. In GEOQuébec 2015 (Proceedings 68th Canadian Geotechnical Conference and 7th Canadian Conference on Permafrost). Québec. GEOQuébec 2015 Organizing Committee.

Smith, S.L., Chartrand, J., Duchesne, C., and Ednie, M. 2016. Report on 2015 field activities and collection of ground thermal and active layer data in the Mackenzie Corridor, Northwest Territories, Geological Survey of Canada Open File 8125.

Taylor, A.E. 2000. Relationship of ground temperatures to air temperatures in forests. In The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, (ed.) L.D. Dyke and G.R. Brooks; Geological Survey of Canada, Bulletin 547, p. 111-117.

Wolfe, S.A., Smith, S.L., Chartrand, J., Kokelj, S.V., Palmer, M., and Stevens, C. 2010. Geotechnical database and descriptions of permafrost monitoring sites established 2006-10 in the northern Mackenzie Corridor, Geological Survey of Canada Open File 6677. doi:10.4095/287167

APPENDIX A

GRAPHICAL AND TABULAR PRESENTATION OF GROUND TEMPERATURE DATA FOR THE PERIOD 2015-16

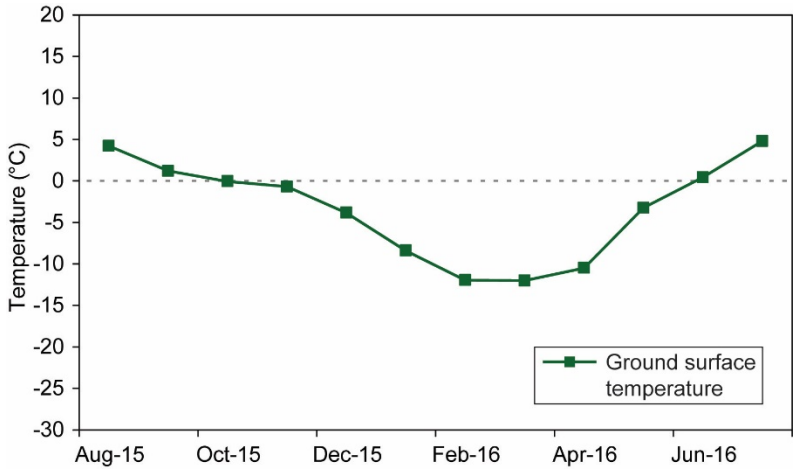
The annual maximum (red line) and minimum (blue line) temperature profile, or ground temperature envelope, is provided for each site for which a continuous 2015-2016 record of ground temperature is available. For sites that do not have a continuous record for 2015-2016, the ground temperature profile based on a single manual measurement during the 2016 site visit (in August or September) is provided (green line). The thaw depth is provided for each site and is based on interpolation of temperature profiles unless otherwise noted. Where insufficient temperature data are available to determine the thaw depth, the measurement obtained through probing on the day of the site visit is provided. Mean monthly air and ground surface temperature (5 cm depth) data for the 2015-2016 period is presented in graphical and table format for each site where available.

North Head shore — 90TT13

Inuvialuit Settlement Region

Latitude: 69.72 N Longitude: 134.46 W
Elevation: 3 m a.s.l.
Landform: Thermokarst coastal plain
Vegetation cover: Tundra
Thaw Depth: 0.49 m (probed)
Site visit: August 13, 2016

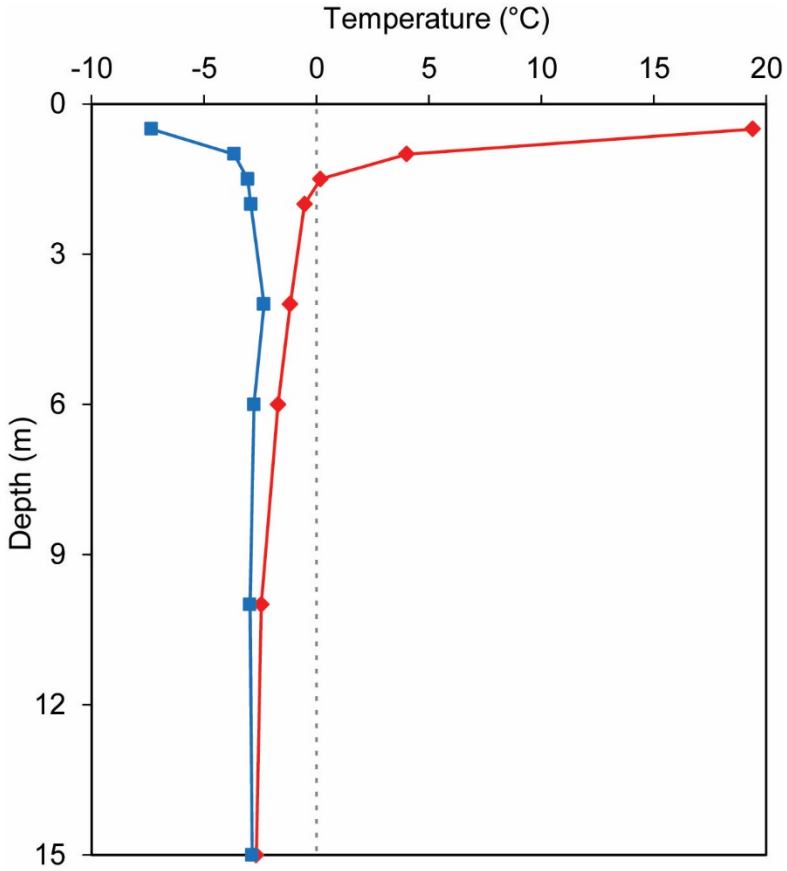
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	4.22
Sept / 2015	n/a	1.21
Oct / 2015	n/a	-0.07
Nov / 2015	n/a	-0.69
Dec / 2015	n/a	-3.85
Jan / 2016	n/a	-8.40
Feb / 2016	n/a	-11.97
Mar / 2016	n/a	-12.01
Apr / 2016	n/a	-10.49
May / 2016	n/a	-3.24
Jun / 2016	n/a	0.43
Jul / 2016	n/a	4.79



TAG04 — SWIL

Inuvialuit Settlement Region

Latitude: 69.37 N Longitude: 134.98 W
Elevation: n/a
Landform: Point Bar
Vegetation cover: Dwarf willow shrubs
Thaw Depth: 1.52 m
Site visit: August 12, 2016



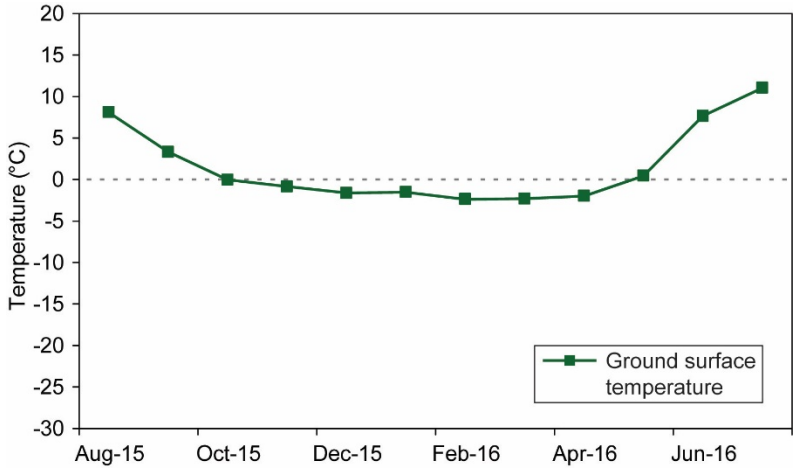
Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	19.39	-7.33
1	4.01	-3.66
1.5	0.18	-3.06
2	-0.53	-2.92
4	-1.17	-2.33
6	-1.70	-2.78
10	-2.45	-2.96
15	-2.68	-2.86

Taglu — 91TTC

Inuvialuit Settlement Region

Latitude: 69.37 N Longitude: 134.95 W
Elevation: 15 m a.s.l.
Landform: Surface of Holocene Mackenzie delta
Vegetation cover: Low shrub tundra
Thaw Depth: >1.30 m (probed)
Site visit: August 12, 2016

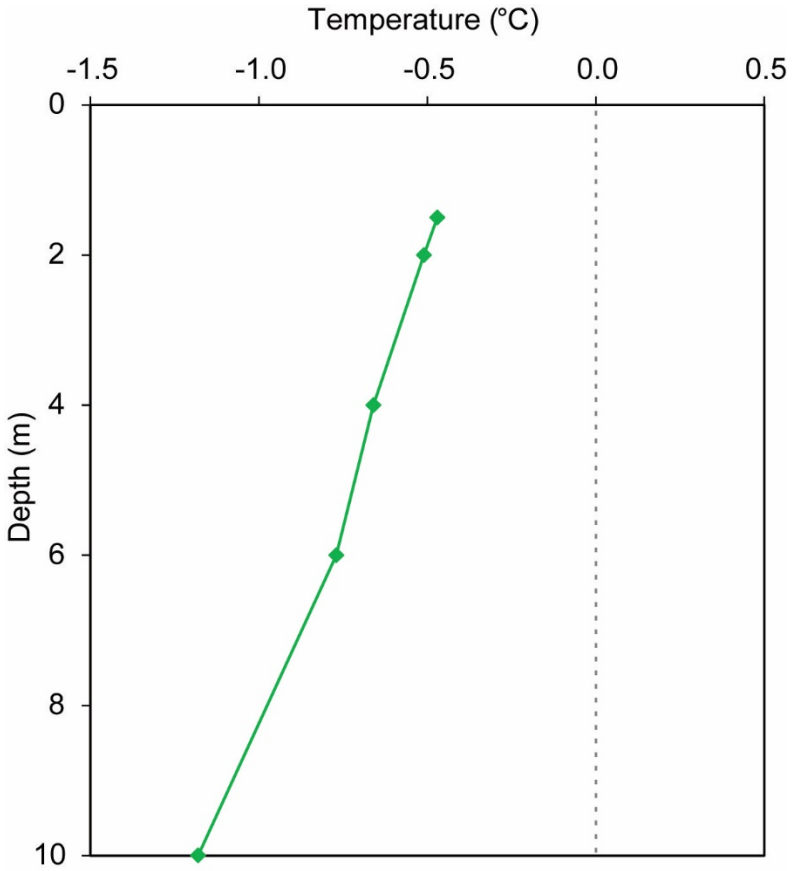
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	8.10
Sept / 2015	n/a	3.33
Oct / 2015	n/a	-0.05
Nov / 2015	n/a	-0.84
Dec / 2015	n/a	-1.63
Jan / 2016	n/a	-1.53
Feb / 2016	n/a	-2.37
Mar / 2016	n/a	-2.31
Apr / 2016	n/a	-2.00
May / 2016	n/a	0.44
Jun / 2016	n/a	7.66
Jul / 2016	n/a	11.04



KUM02 — SWIL

Inuvialuit Settlement Region

Latitude: 69.32 N Longitude: 135.21 W
Elevation: n/a
Landform: Point bar
Vegetation cover: Dwarf willow shrubs
Thaw Depth: n/a
Site visit: August 12, 2016

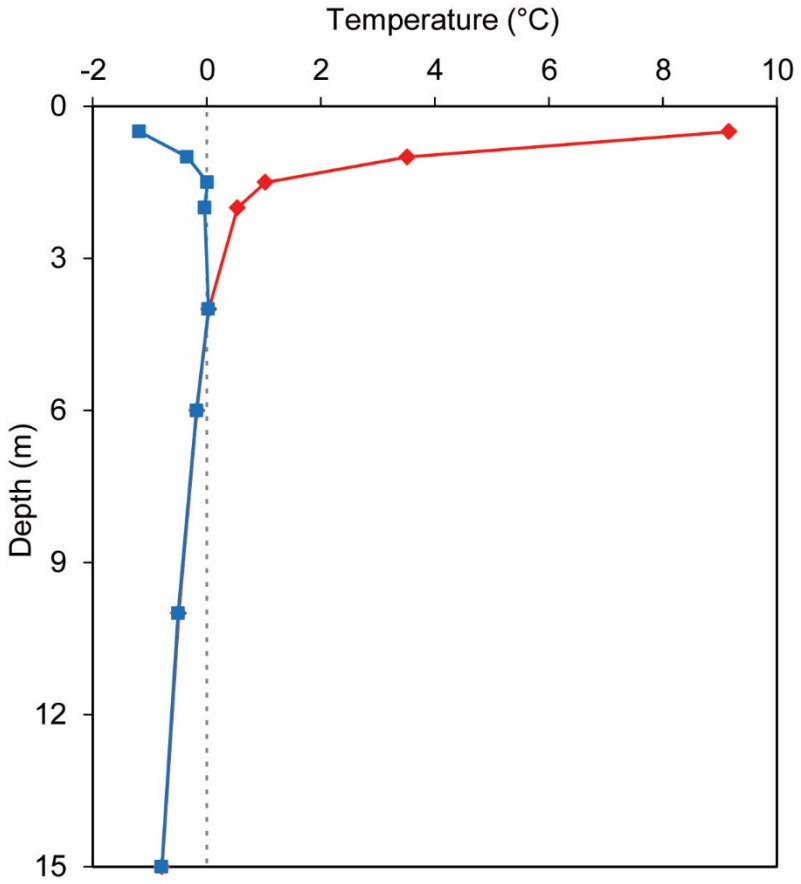


Depth (m)	Temp (°C)
1.5	-0.47
2	-0.51
4	-0.66
6	-0.77
10	-1.18

KUM02 — TWIL

Inuvialuit Settlement Region

Latitude: 69.32 N Longitude: 135.21 W
Elevation: n/a
Landform: Point bar
Vegetation cover: Tall willow shrubs
Thaw Depth: 4.14 m
Site visit: August 12, 2016
Note: From 1.5 to 4.0 m minimum temperature likely ~0°C (within measurement error)

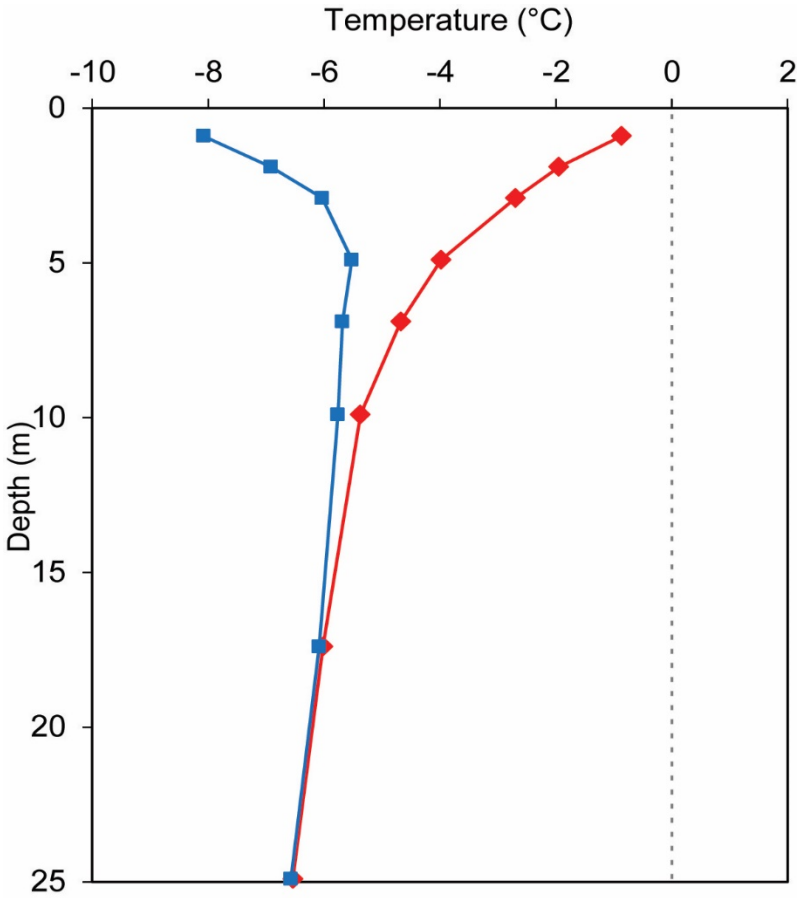


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	9.15	-1.18
1	3.52	-0.34
1.5	1.03	0.01
2	0.54	-0.04
4	0.03	0.03
6	-0.17	-0.18
10	-0.49	-0.50
15	-0.79	-0.79

KC-07

Inuvialuit Settlement Region

Latitude: 69.31 N Longitude: 135.25 W
Elevation: n/a
Landform: Tundra upland
Vegetation cover: Grass and moss tundra
Thaw Depth: 0.57 m (probed)
Site visit: August 12, 2016

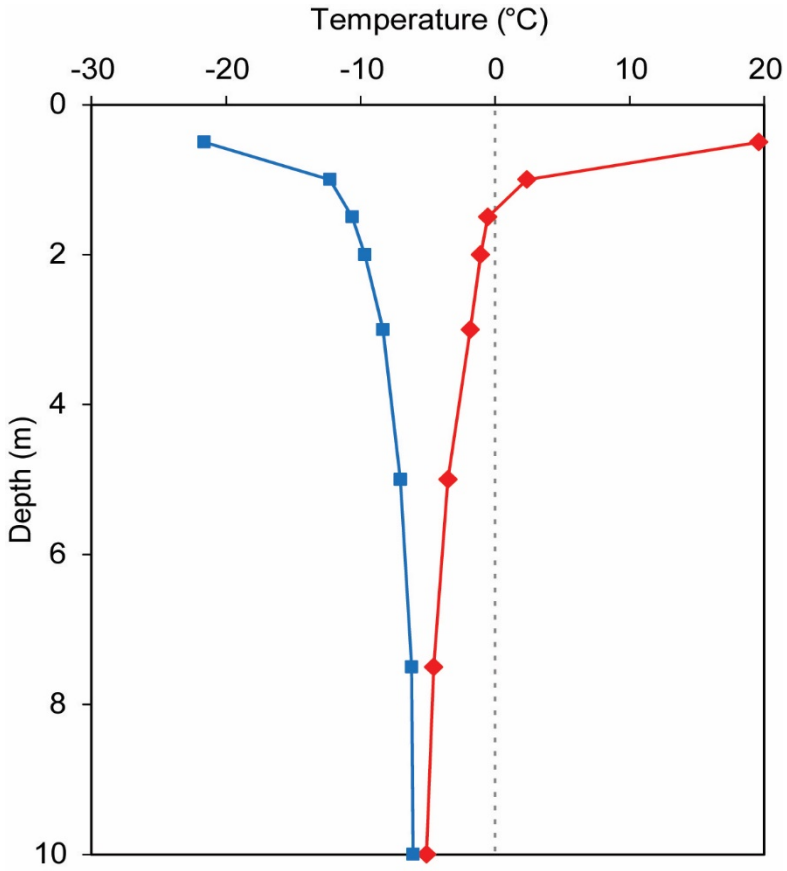


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.9	-0.87	-8.08
1.9	-1.95	-6.92
2.9	-2.69	-6.03
4.9	-3.98	-5.52
6.9	-4.67	-5.68
9.9	-5.37	-5.76
17.4	-6.02	-6.09
24.9	-6.54	-6.57

T7 Upland

Inuvialuit Settlement Region

Latitude: 69.31 N Longitude: 134.54 W
Elevation: n/a
Landform: Moraine uplands
Vegetation cover: Dwarf birch tundra with willow and alder shrubs
Thaw Depth: 1.07 m
Site visit: August 13, 2016



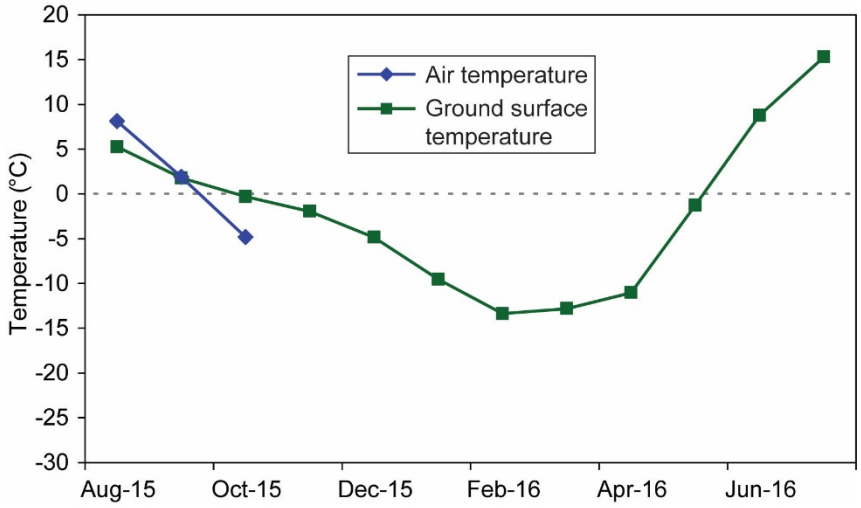
Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	19.58	-21.60
1	2.36	-12.28
1.5	-0.55	-10.62
2	-1.09	-9.68
3	-1.85	-8.33
5	-3.51	-7.03
7.5	-4.57	-6.20
10	-5.09	-6.10

Lousy Point ridge — 90TT05

Inuvialuit Settlement Region

Latitude: 69.22 N Longitude: 134.28 W
Elevation: 39 m a.s.l.
Landform: Glaciofluvial ridge
Vegetation cover: Low shrub tundra
Thaw depth: 0.77 m (probed)
Site visit: August 13, 2016

Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	8.12	5.26
Sept / 2015	1.90	1.77
Oct / 2015	-4.82	-0.30
Nov / 2015	n/a	-1.96
Dec / 2015	n/a	-4.85
Jan / 2016	n/a	-9.54
Feb / 2016	n/a	-13.36
Mar / 2016	n/a	-12.81
Apr / 2016	n/a	-11.03
May / 2016	n/a	-1.28
Jun / 2016	n/a	8.77
Jul / 2016	n/a	15.28

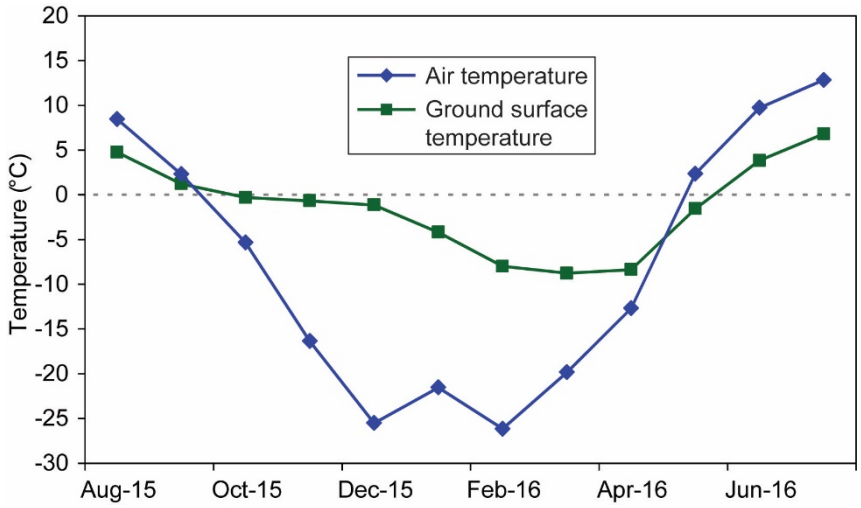


Lousy Point Low Terrace — 90TT06

Inuvialuit Settlement Region

Latitude: 69.22 N Longitude: 134.28 W
Elevation: 9 m a.s.l.
Landform: Glaciofluvial ridge
Vegetation cover: Low shrub tundra
Thaw depth: 0.40 m (probed)
Site visit: August 13, 2016

Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	8.46	4.76
Sept / 2015	2.30	1.22
Oct / 2015	-5.36	-0.30
Nov / 2015	-16.37	-0.67
Dec / 2015	-25.53	-1.14
Jan / 2016	-21.54	-4.20
Feb / 2016	-26.17	-8.01
Mar / 2016	-19.85	-8.78
Apr / 2016	-12.69	-8.36
May / 2016	2.34	-1.56
Jun / 2016	9.72	3.83
Jul / 2016	12.84	6.80

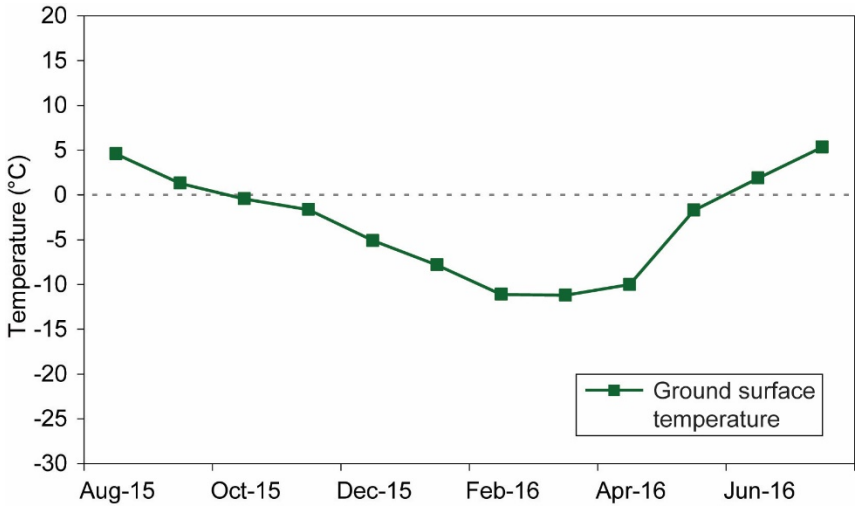


YaYa Lake low — 90TT04

Inuvialuit Settlement Region

Latitude: 69.14 N Longitude: 134.70 W
Elevation: 10 m a.s.l.
Landform: Ice contact complex
Vegetation cover: shrub tundra
Thaw Depth: 0.78 m (probed)
Site visit: August 13, 2016

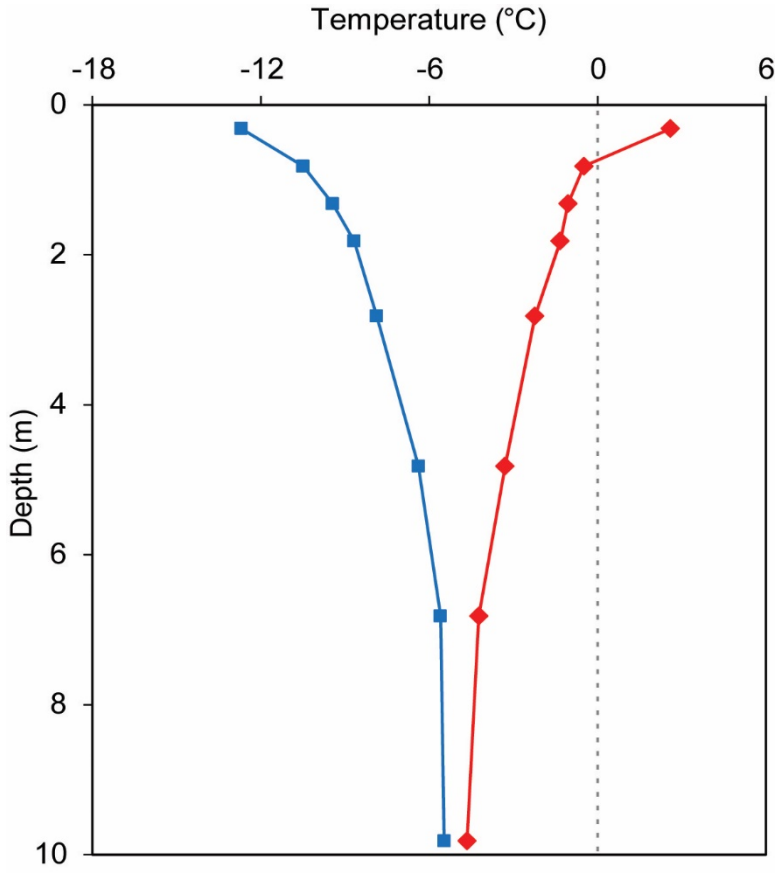
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	4.57
Sept / 2015	n/a	1.29
Oct / 2015	n/a	-0.44
Nov / 2015	n/a	-1.63
Dec / 2015	n/a	-5.11
Jan / 2016	n/a	-7.82
Feb / 2016	n/a	-11.11
Mar / 2016	n/a	-11.20
Apr / 2016	n/a	-10.01
May / 2016	n/a	-1.73
Jun / 2016	n/a	1.88
Jul / 2016	n/a	5.33



T5 Upland

Inuvialuit Settlement Region

Latitude: 68.96 N Longitude: 133.84 W
Elevation: n/a
Landform: Moraine uplands
Vegetation cover: Dwarf birch tundra with willow and alder shrubs
Thaw Depth: 0.74 m
Site visit: August 14, 2016

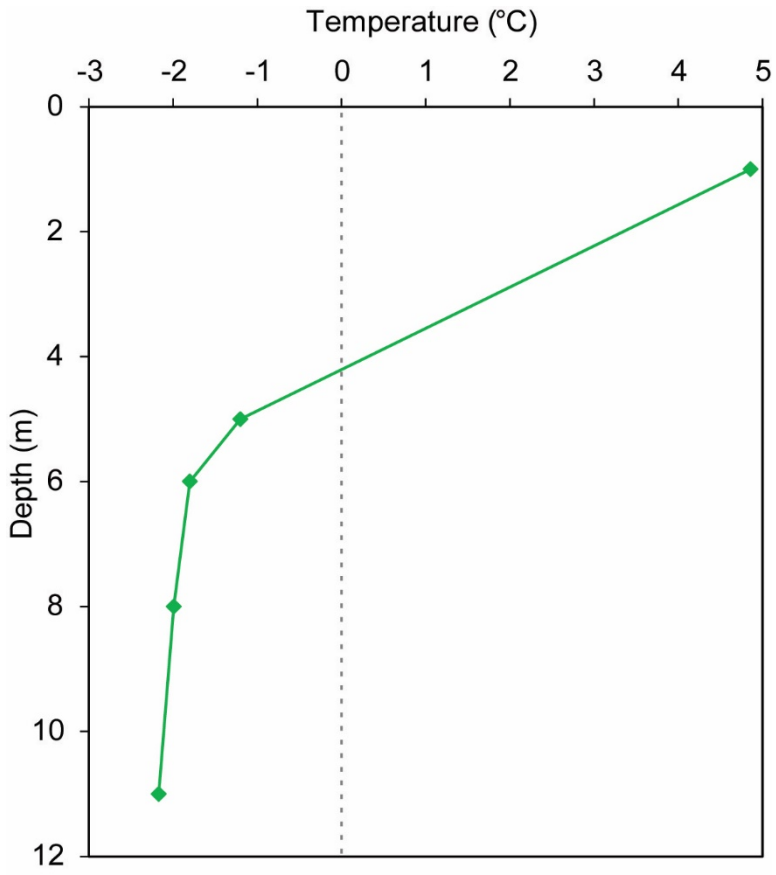


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.32	2.59	-12.69
0.82	-0.49	-10.49
1.32	-1.06	-9.44
1.82	-1.33	-8.68
2.82	-2.23	-7.87
4.82	-3.30	-6.38
6.82	-4.23	-5.59
9.82	-4.65	-5.47

T5 Slump

Inuvialuit Settlement Region

Latitude: 68.96 N Longitude: 133.84 W
Elevation: n/a
Landform: Thaw slump
Vegetation cover: Willow and alder shrubs
Thaw Depth: 4.21 m
Site visit: August 14, 2016



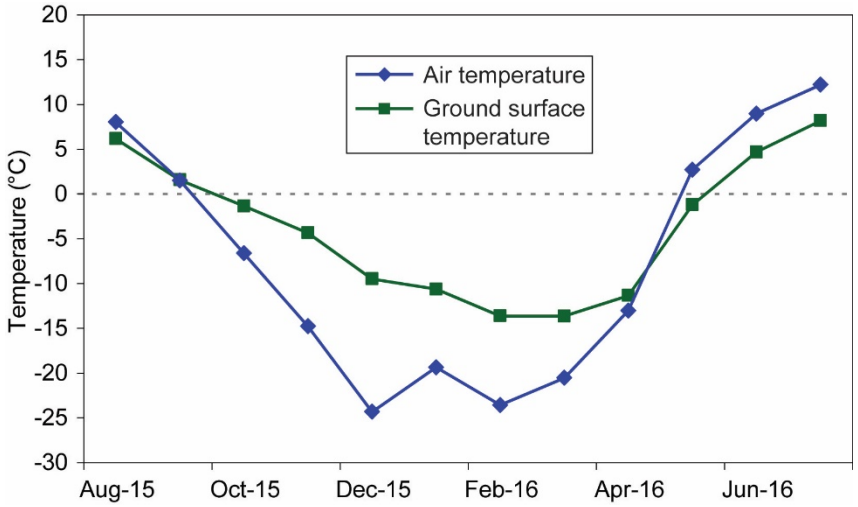
Depth (m)	Temp (°C)
1	4.86
5	-1.2
6	-1.8
8	-1.99
11	-2.17

Reindeer Station plateau — 91TT12

Inuvialuit Settlement Region

Latitude: 68.69 N Longitude: 134.11 W
Elevation: 152 m a.s.l.
Landform: Plateau surface, till plain
Vegetation cover: Shrub tundra
Thaw Depth: 0.51 m (Probed)
Site visit: August 13, 2016

Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	8.02	6.16
Sept / 2015	1.50	1.57
Oct / 2015	-6.62	-1.35
Nov / 2015	-14.79	-4.34
Dec / 2015	-24.32	-9.48
Jan / 2016	-19.36	-10.62
Feb / 2016	-23.58	-13.63
Mar / 2016	-20.55	-13.65
Apr / 2016	-13.03	-11.34
May / 2016	2.70	-1.21
Jun / 2016	8.96	4.67
Jul / 2016	12.19	8.17

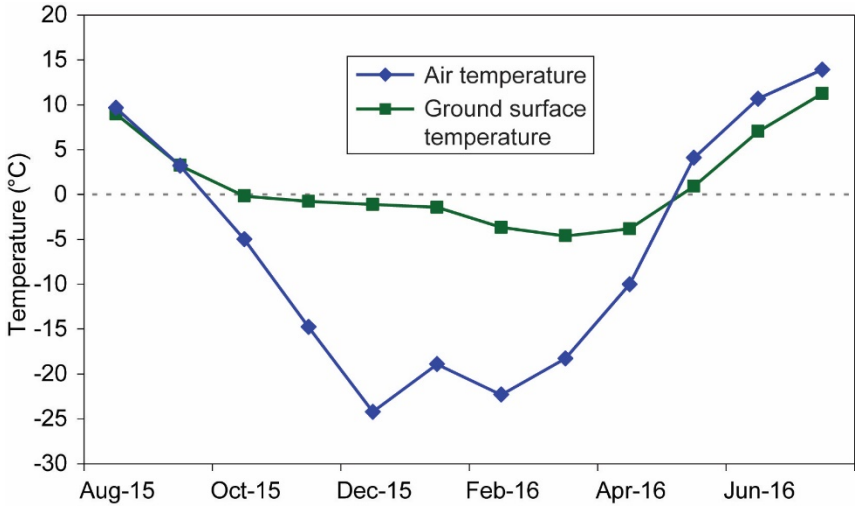


Reindeer Depot (Williams Island) — 91TT13

Inuvialuit Settlement Region

Latitude: 68.68 N Longitude: 134.15 W
Elevation: 5 m a.s.l.
Landform: Surface of bar in Mackenzie Delta
Vegetation cover: Riparian willow and alder shrub
Thaw Depth: >1.30 m (Probed)
Site visit: August 16, 2016

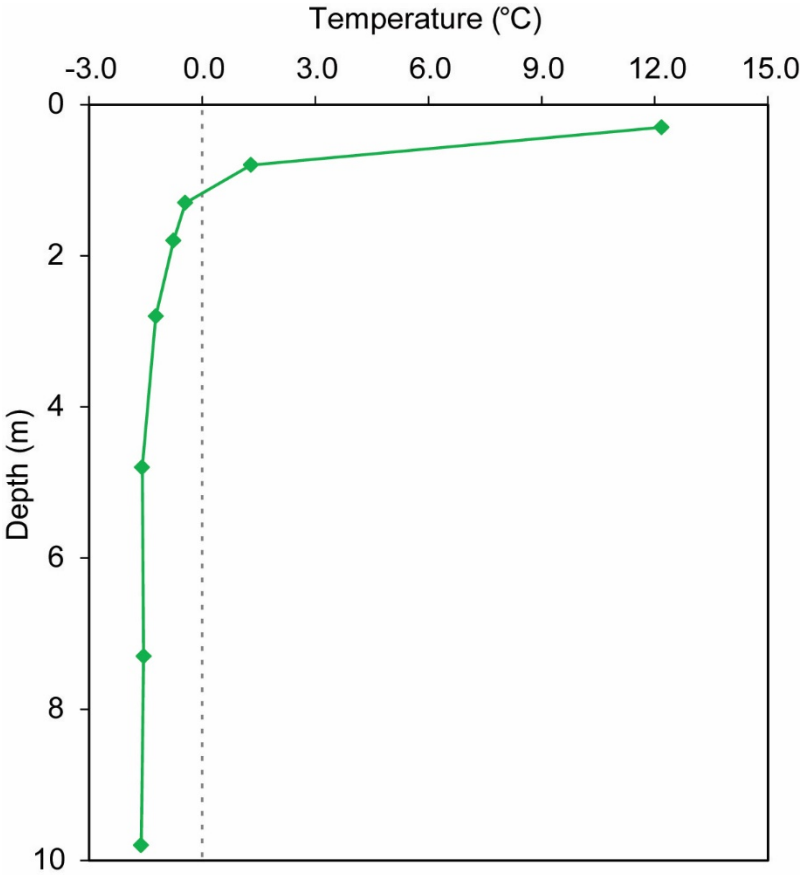
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	9.65	8.96
Sept / 2015	3.18	3.22
Oct / 2015	-5.00	-0.17
Nov / 2015	-14.77	-0.78
Dec / 2015	-24.23	-1.12
Jan / 2016	-18.92	-1.42
Feb / 2016	-22.32	-3.68
Mar / 2016	-18.28	-4.63
Apr / 2016	-10.01	-3.83
May / 2016	4.07	0.92
Jun / 2016	10.66	7.01
Jul / 2016	13.92	11.24



Jimmy Creek valley — JV-1 Bottom

Inuvialuit Settlement Region

Latitude: 68.63 N Longitude: 133.63 W
Elevation: n/a
Landform: Moraine uplands
Vegetation cover: Dwarf birch tundra with willow and alder shrubs
Thaw Depth: 0.86 m
Site visit: August 14, 2016

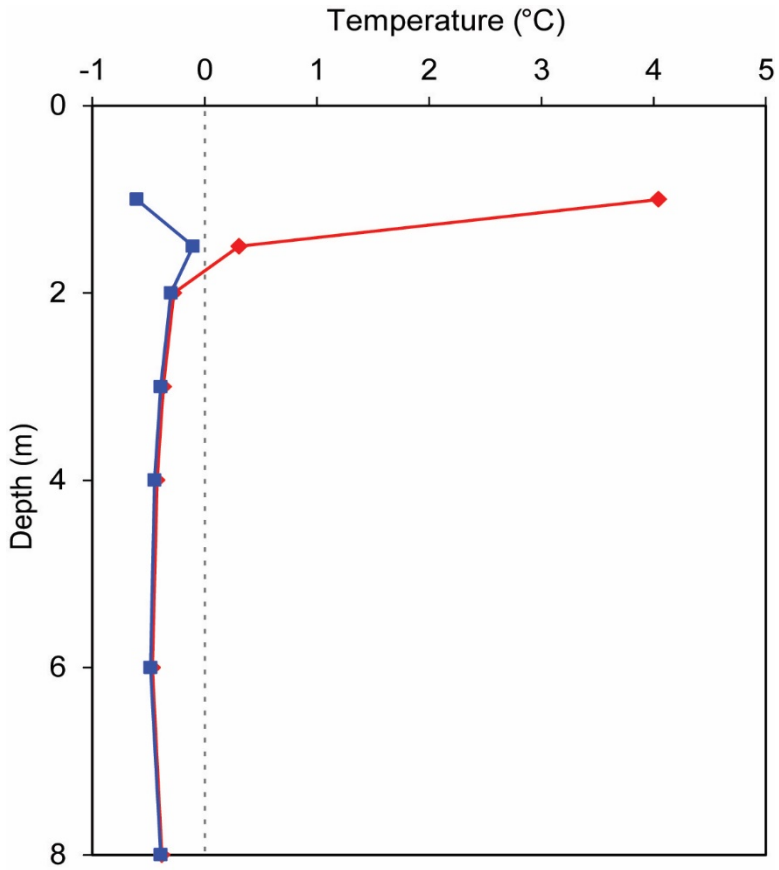


Depth (m)	Temp (°C)
0.3	12.18
0.8	1.29
1.3	-0.45
1.8	-0.76
2.8	-1.23
4.8	-1.59
7.3	-1.55
9.8	-1.62

Navy Channel — 03TC1

Inuvialuit Settlement Region

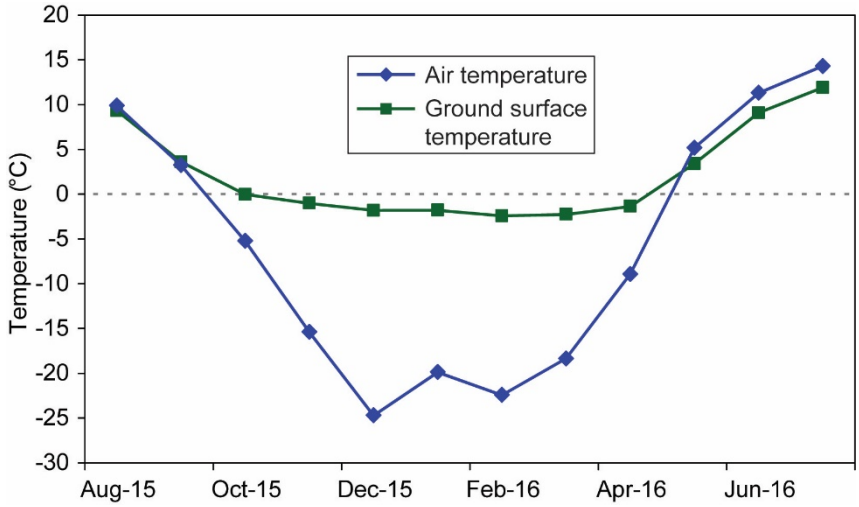
Latitude: 68.42 N Longitude: 133.79 W
Elevation: 5 m a.s.l.
Landform: Surface of Holocene Mackenzie delta adjacent to eastern edge rising 10s of meters to till plain
Vegetation cover: Riparian high willow shrub, open, incomplete ground cover of forbs and sedge (forest tundra)
Thaw Depth: 1.54 m
Site visit: August 16, 2016



Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
1	4.04	-0.60
1.5	0.31	-0.10
2	-0.28	-0.30
3	-0.37	-0.39
4	-0.42	-0.45
6	-0.47	-0.48
8	-0.38	-0.39

Navy Channel — 03TC1 (continued)

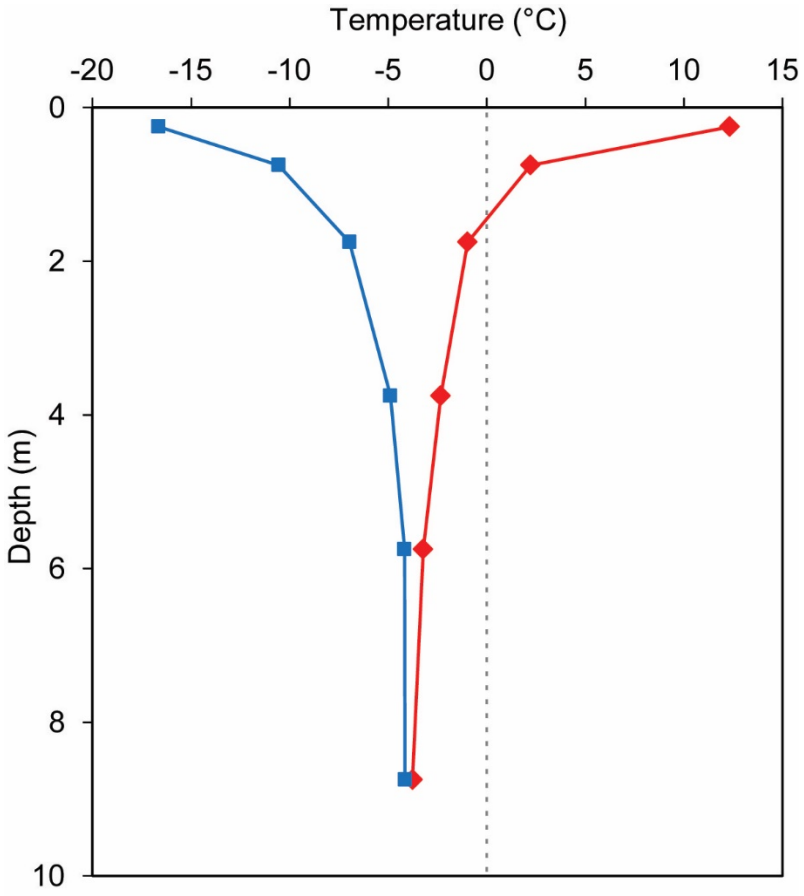
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	9.87	9.31
Sept / 2015	3.22	3.59
Oct / 2015	-5.24	-0.05
Nov / 2015	-15.41	-1.02
Dec / 2015	-24.72	-1.81
Jan / 2016	-19.89	-1.80
Feb / 2016	-22.43	-2.44
Mar / 2016	-18.36	-2.26
Apr / 2016	-8.94	-1.37
May / 2016	5.18	3.40
Jun / 2016	11.31	9.07
Jul / 2016	14.29	11.91



Norris Creek — NC-01

Gwich'in Settlement Region

Latitude: 68.41 N Longitude: 133.29 W
Elevation: 15 m a.s.l.
Landform: Thick organic material over moraine plain
Vegetation cover: Shrub Tundra
Thaw Depth: 0.86 m
Site visit: August 12, 2016

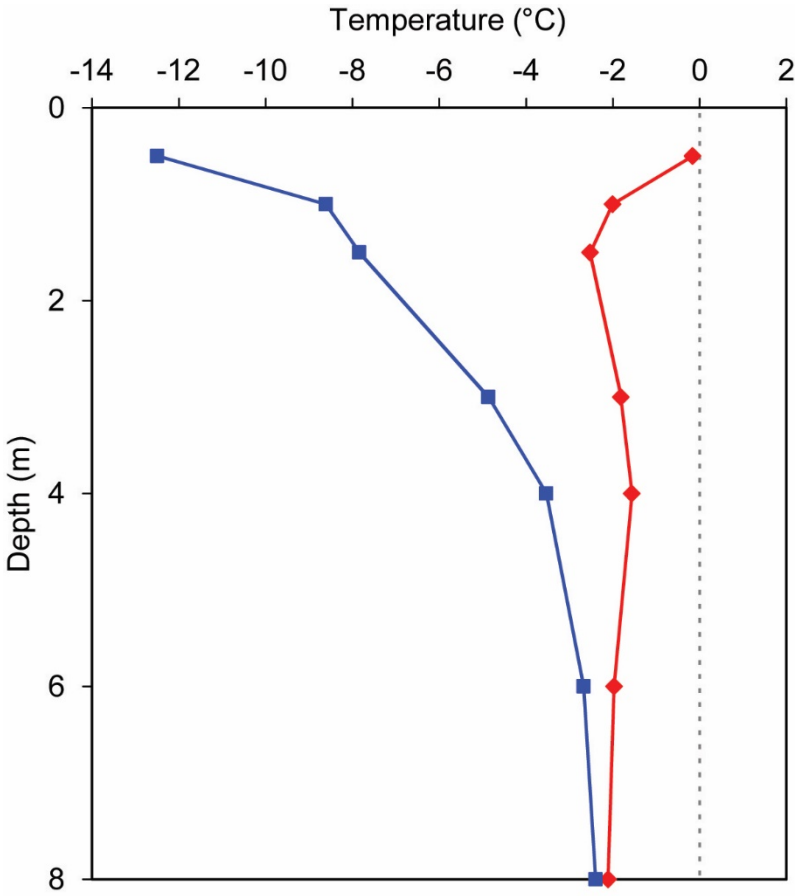


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.25	12.32	-16.64
0.75	2.22	-10.56
1.75	-0.97	-6.96
3.75	-2.34	-4.89
5.75	-3.23	-4.18
8.75	-3.77	-4.15

Navy Road — 01TC1

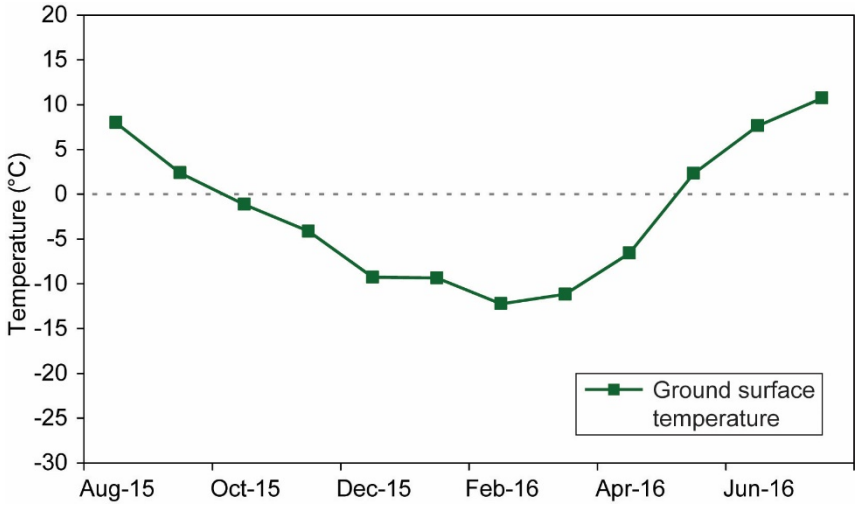
Gwich'in Settlement Region

Latitude: 68.40 N Longitude: 133.76 W
Elevation: 60 m a.s.l.
Landform: Fine grained colluvium sloping toward river, post glacial (~10Ka)
Vegetation cover: Taiga post fire succession, scattered birch and alder, open dwarf birch, heath ground cover
Thaw Depth: n/a
Site visit: August 11, 2016



Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	-0.16	-12.49
1	-2.01	-8.61
1.5	-2.52	-7.84
3	-1.81	-4.86
4	-1.56	-3.53
6	-1.97	-2.67
8	-2.11	-2.40

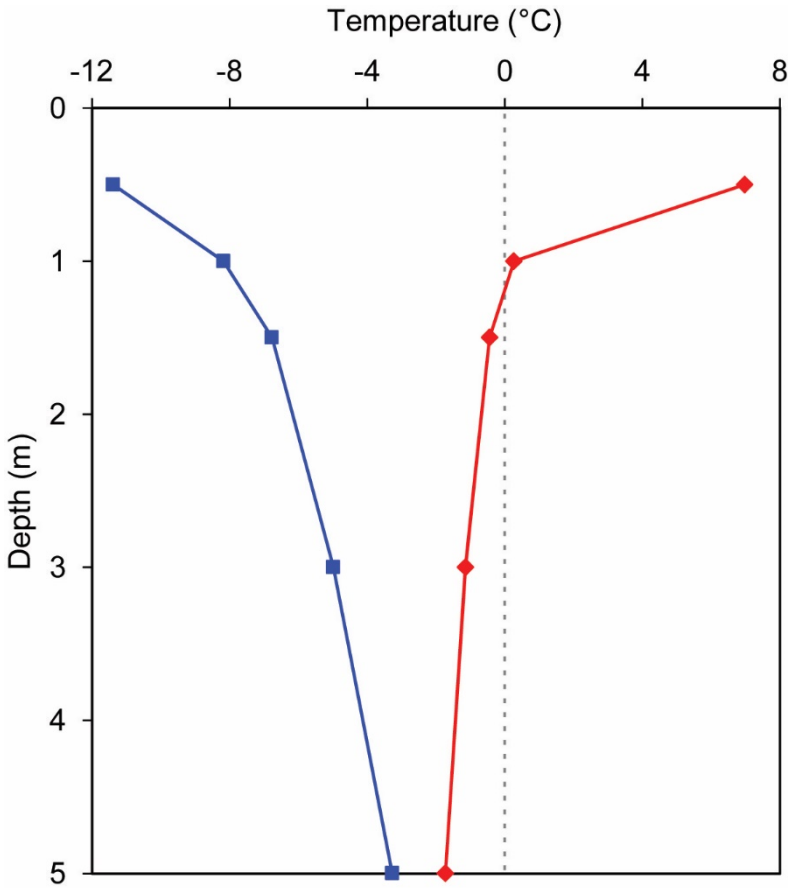
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	7.98
Sept / 2015	n/a	2.38
Oct / 2015	n/a	-1.14
Nov / 2015	n/a	-4.14
Dec / 2015	n/a	-9.28
Jan / 2016	n/a	-9.34
Feb / 2016	n/a	-12.23
Mar / 2016	n/a	-11.17
Apr / 2016	n/a	-6.59
May / 2016	n/a	2.30
Jun / 2016	n/a	7.64
Jul / 2016	n/a	10.73



Inuvik Airport (trees) — 01TC2

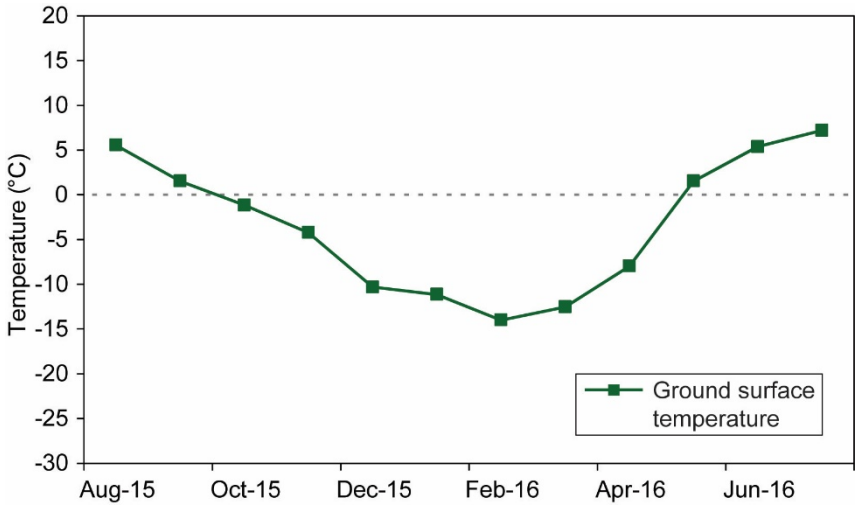
Gwich'in Settlement Region

Latitude: 68.32 N Longitude: 133.44 W
Elevation: 84 m a.s.l.
Landform: Fluted till plain glacial (>10Ka)
Vegetation cover: Taiga open black spruce, health ground cover
Thaw Depth: 1.02 m
Site visit: August 14, 2016



Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	6.98	-11.39
1	0.27	-8.19
1.5	-0.44	-6.77
3	-1.15	-4.99
5	-1.73	-3.28

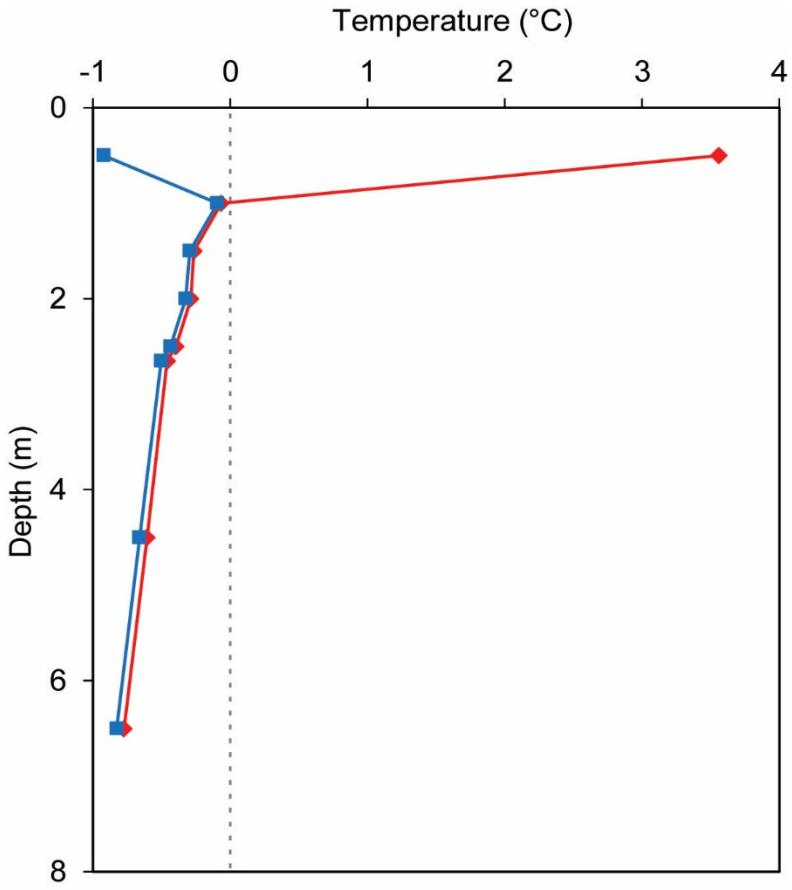
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	5.54
Sept / 2015	n/a	1.53
Oct / 2015	n/a	-1.16
Nov / 2015	n/a	-4.24
Dec / 2015	n/a	-10.32
Jan / 2016	n/a	-11.15
Feb / 2016	n/a	-14.01
Mar / 2016	n/a	-12.55
Apr / 2016	n/a	-7.97
May / 2016	n/a	1.53
Jun / 2016	n/a	5.38
Jul / 2016	n/a	7.19



Inuvik Airport (bog) — 12TC1

Gwich'in Settlement Region

Latitude: 68.32 N Longitude: 133.43 W
Elevation: 68 m a.s.l.
Landform: Bog between ridges on fluted till plain, glacial (>10Ka)
Vegetation cover: Taiga open bog, scattered shrub, heath ground cover (forest tundra)
Thaw Depth: 0.99 m
Site visit: August 10, 2016



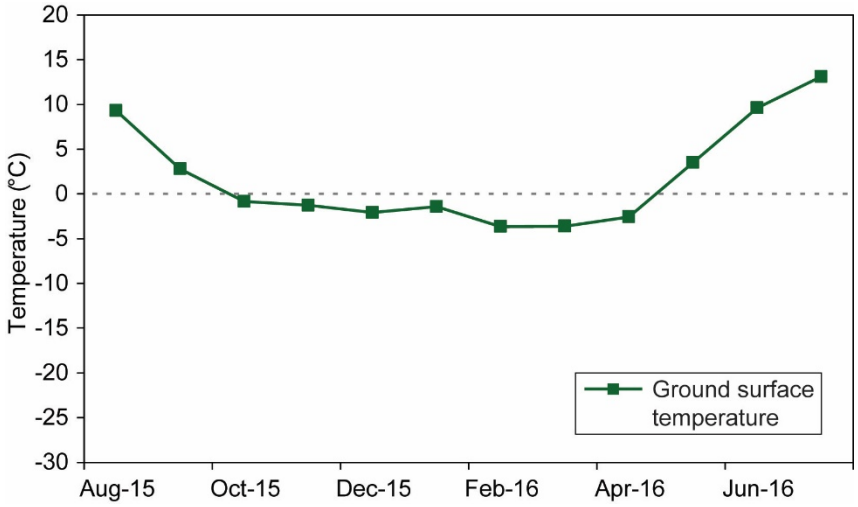
Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	3.56	-0.92
1.0	-0.07	-0.09
1.5	-0.26	-0.29
2.0	-0.29	-0.32
2.5	-0.40	-0.44
2.65	-0.46	-0.50
4.5	-0.61	-0.66
6.5	-0.77	-0.83

Inuvik Airport (bog) — 01TC3

Gwich'in Settlement Region

Latitude: 68.32 N Longitude: 133.43 W
Elevation: 68 m a.s.l.
Landform: Bog between ridges on fluted till plain, glacial (>10Ka)
Vegetation cover: Taiga open bog, scattered shrub, heath ground cover (forest tundra)
Thaw Depth: n/a
Site visit: August 10, 2016

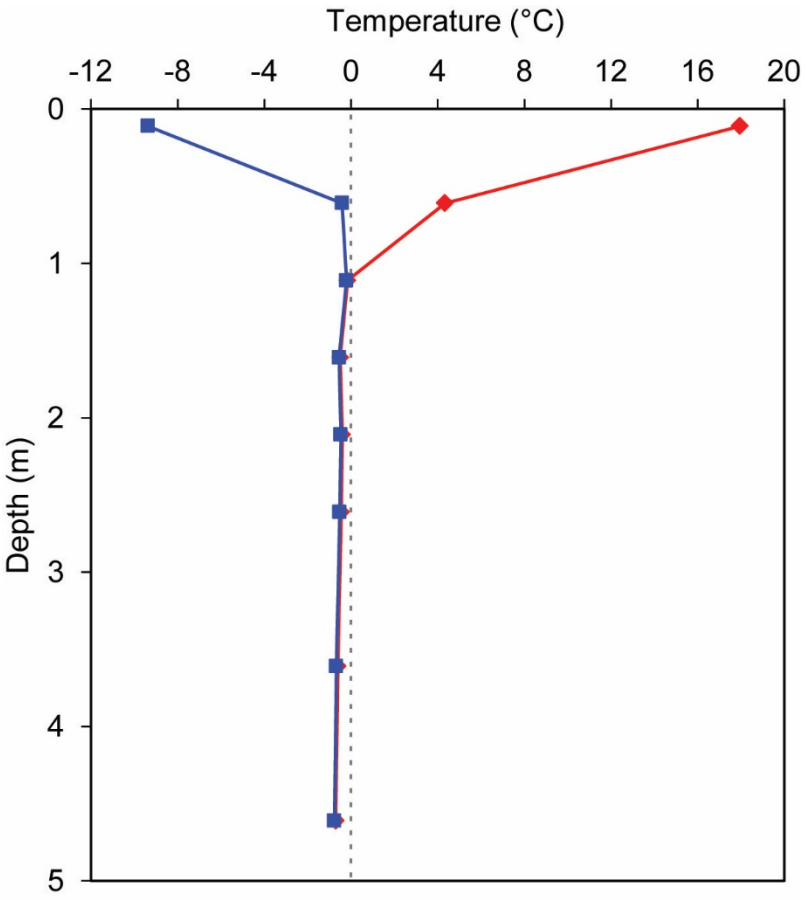
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	n/a	9.31
Sept / 2015	n/a	2.79
Oct / 2015	n/a	-0.85
Nov / 2015	n/a	-1.28
Dec / 2015	n/a	-2.09
Jan / 2016	n/a	-1.44
Feb / 2016	n/a	-3.65
Mar / 2016	n/a	-3.61
Apr / 2016	n/a	-2.57
May / 2016	n/a	3.50
Jun / 2016	n/a	9.61
Jul / 2016	n/a	13.09



Campbell Lake — CaL-01

Gwich'in Settlement Region

Latitude: 68.24 N Longitude: 133.10 W
Elevation: 115 m a.s.l.
Landform: Moraine plain
Vegetation cover: Peatland
Thaw Depth: 0.77 m
Site visit: August 12, 2016

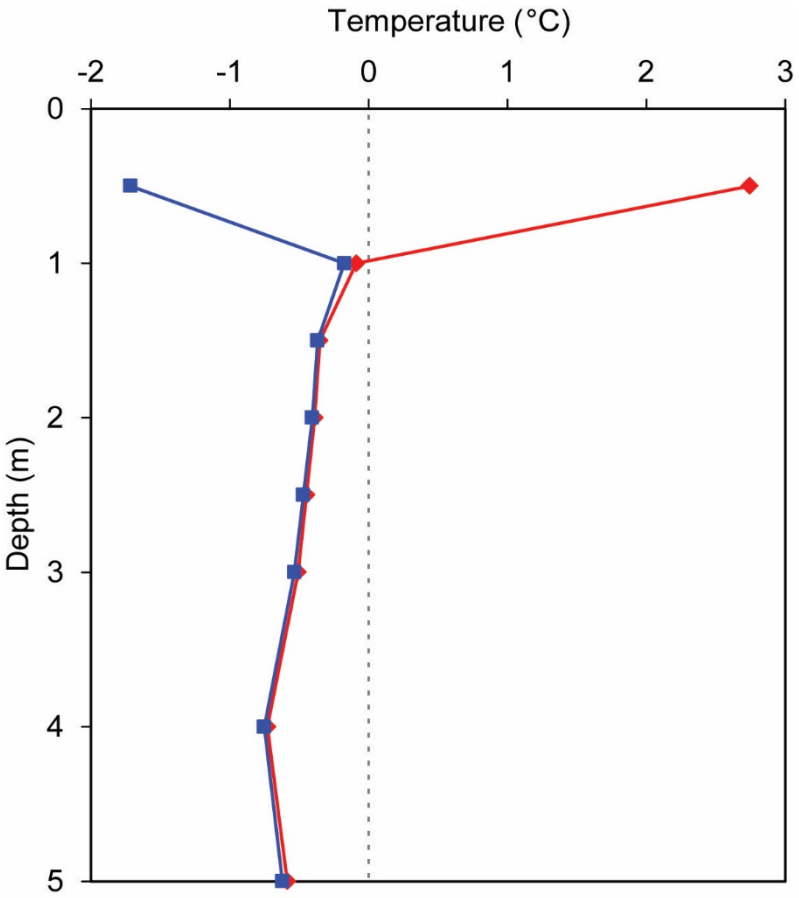


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.11	17.95	-9.37
0.61	4.34	-0.41
1.11	-0.16	-0.22
1.61	-0.49	-0.55
2.11	-0.40	-0.47
2.61	-0.45	-0.53
3.61	-0.61	-0.68
4.61	-0.70	-0.76

Campbell Lake — CaL-02

Gwich'in Settlement Region

Latitude: 68.24 N Longitude: 133.09 W
Elevation: 118 m a.s.l.
Landform: Moraine plain
Vegetation cover: Cutline through Black spruce forest
Thaw Depth: 0.98 m
Site visit: August 12, 2016

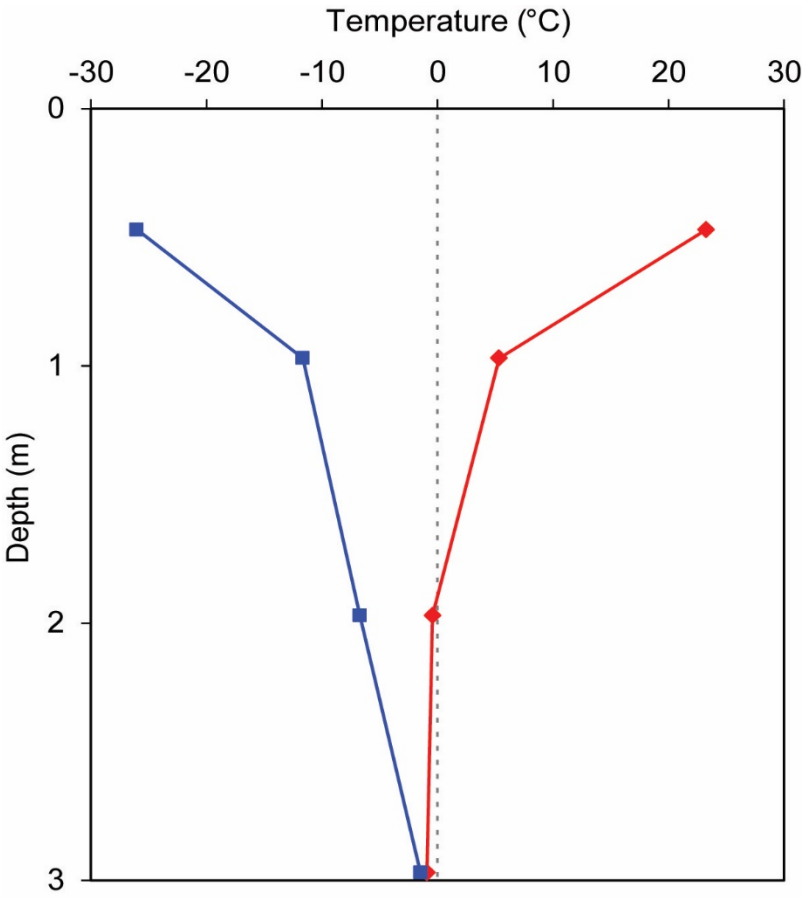


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	2.74	-1.72
1	-0.09	-0.18
1.5	-0.35	-0.37
2	-0.39	-0.41
2.5	-0.45	-0.47
3	-0.51	-0.54
4	-0.73	-0.75
5	-0.59	-0.62

Campbell Lake — CaL-03

Gwich'in Settlement Region

Latitude: 68.24 N Longitude: 133.10 W
Elevation: 118 m a.s.l.
Landform: Moraine plain
Vegetation cover: Black spruce forest
Thaw Depth: 1.12 m
Site visit: August 12, 2016

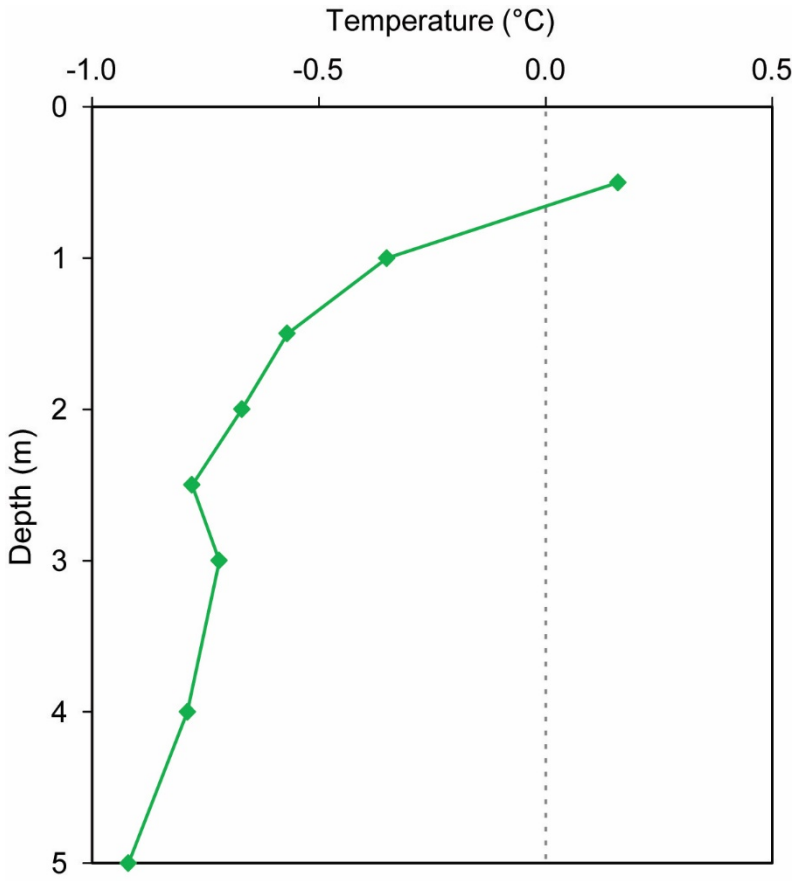


Aug 2015 – Jul 2016		
Depth (m)	Max (°C)	Min (°C)
0.47	23.27	-26.03
0.97	5.34	-11.66
1.97	-0.43	-6.71
2.97	-0.91	-1.46

North Caribou Lake — NCL-01

Gwich'in Settlement Region

Latitude: 68.15 N Longitude: 132.93 W
Elevation: 209 m a.s.l.
Landform: Moraine plain
Vegetation cover: Peatland
Thaw Depth: 0.66 m
Site visit: August 12, 2016
Note: Water at surface

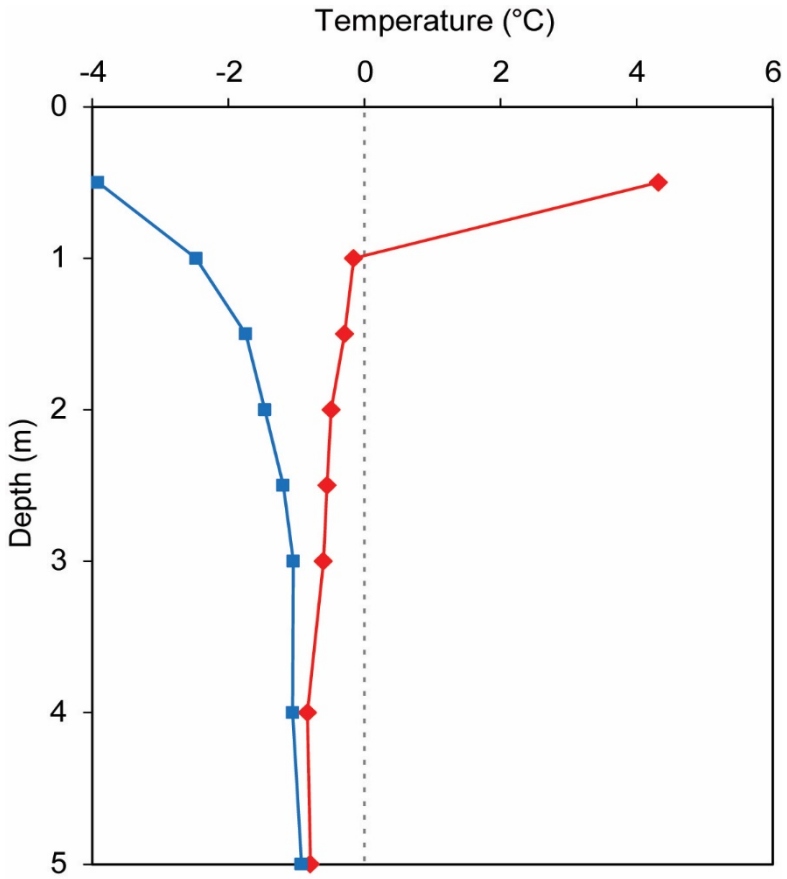


Depth (m)	Temp (°C)
0.5	0.16
1	-0.35
1.5	-0.57
2	-0.67
2.5	-0.78
3	-0.72
4	-0.79
5	-0.92

North Caribou Lake — NCL-02

Gwich'in Settlement Region

Latitude: 68.15 N Longitude: 132.93 W
Elevation: 217 m a.s.l.
Landform: Moraine plain
Vegetation cover: Stunted black spruce forest
Thaw Depth: 0.98 m
Site visit: August 12, 2016

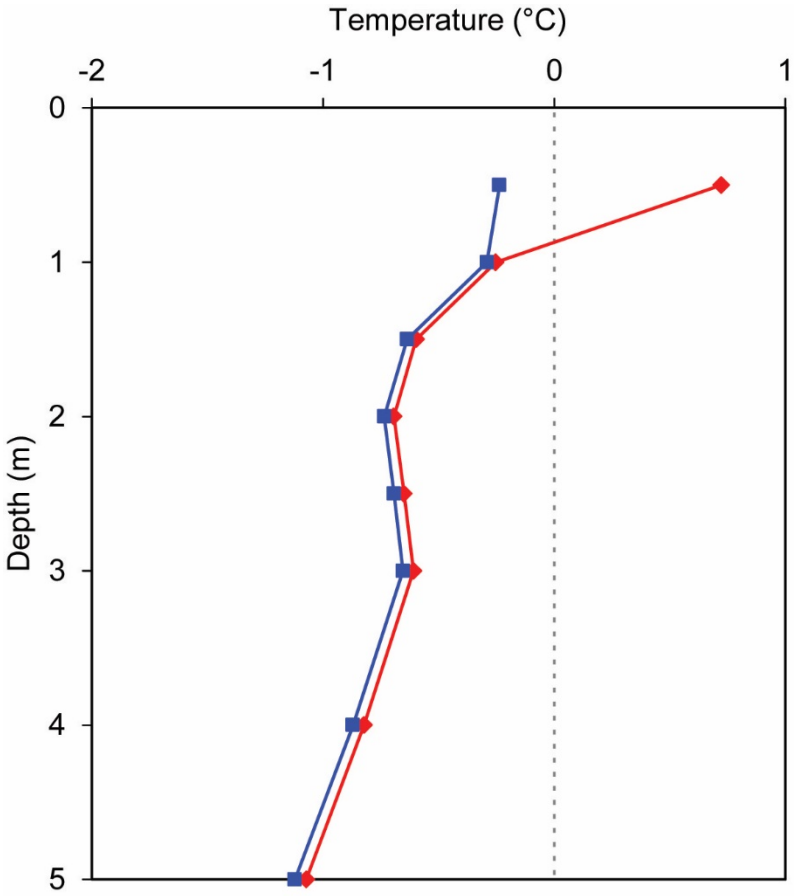


Aug 2015 – July 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	4.32	-3.91
1	-0.16	-2.47
1.5	-0.29	-1.74
2	-0.49	-1.46
2.5	-0.55	-1.19
3	-0.60	-1.04
4	-0.84	-1.05
5	-0.79	-0.92

Hill Lake — HL-01

Gwich'in Settlement Region

Latitude: 67.99 N Longitude: 132.49 W
Elevation: 229 m a.s.l.
Landform: Moraine plain
Vegetation cover: Tundra
Thaw Depth : 0.87 m
Site visit: August 12, 2016
Note: Water at surface

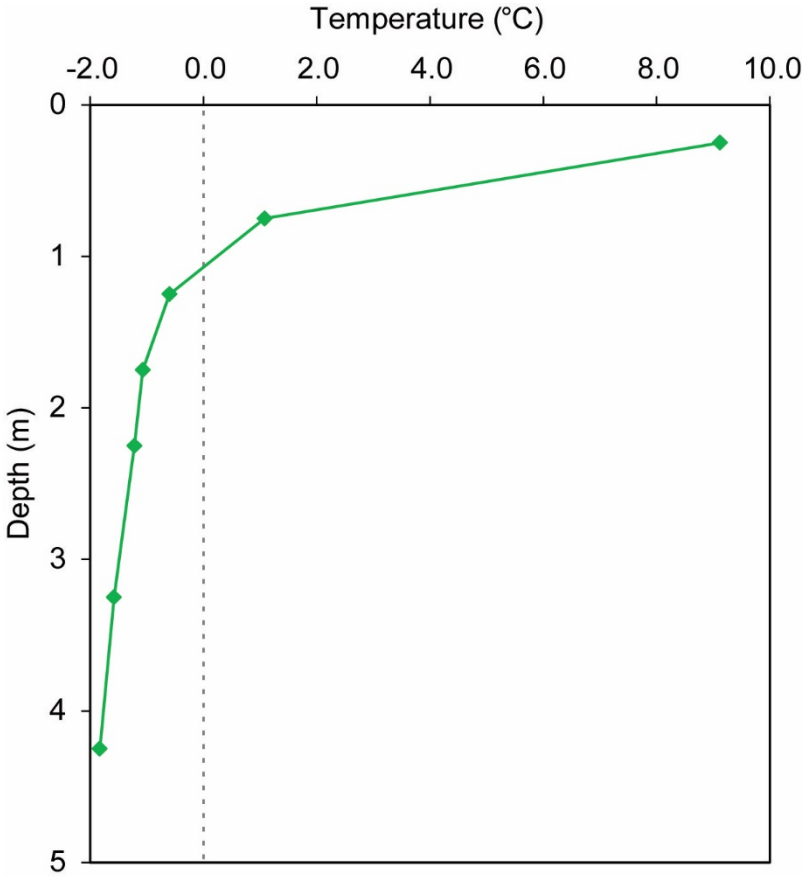


Aug 2015 – July 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	0.72	-0.24
1	-0.25	-0.29
1.5	-0.60	-0.64
2	-0.69	-0.74
2.5	-0.65	-0.69
3	-0.61	-0.65
4	-0.82	-0.87
5	-1.07	-1.12

Hill Lake — HL-02

Gwich'in Settlement Region

Latitude: 67.99 N Longitude: 132.49 W
Elevation: 234 m a.s.l.
Landform: Moraine plain
Vegetation cover: Shrub Tundra
Thaw Depth: 0.82 m
Site visit: August 12, 2016

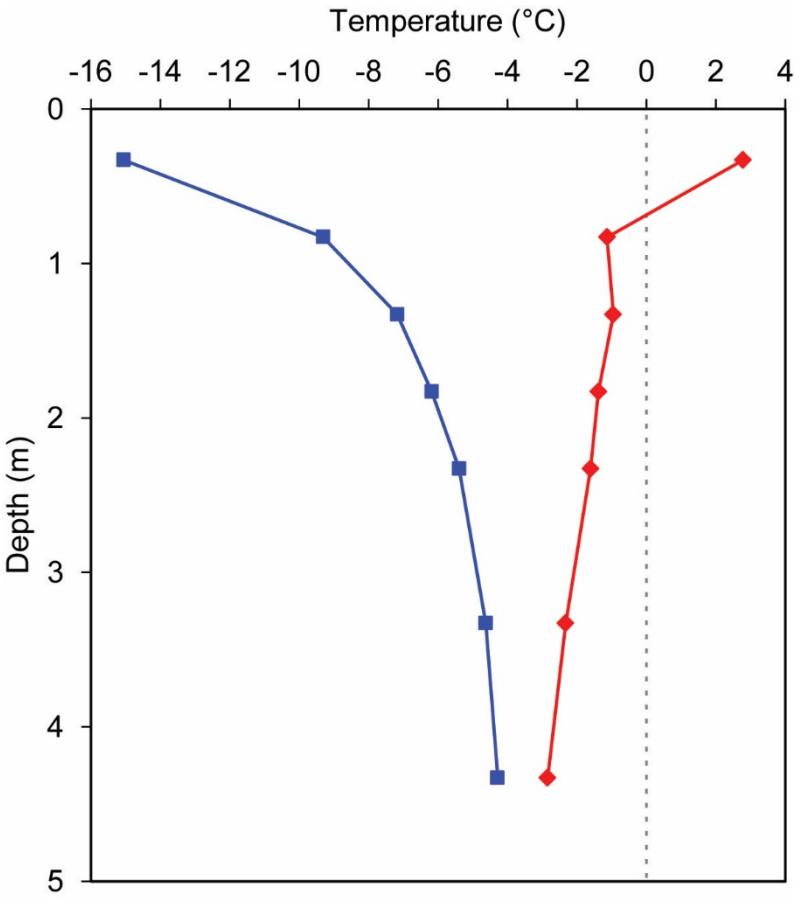


Depth (m)	Temp (°C)
0.25	9.12
0.75	1.08
1.25	-0.6
1.75	-1.07
2.25	-1.22
3.25	-1.58
4.25	-1.83

Wood Bridge Lake — WBL-01

Gwich'in Settlement Region

Latitude: 67.90 N Longitude: 132.18 W
Elevation: 204 m a.s.l.
Landform: Alluvial plain
Vegetation: Black spruce forest
Thaw Depth: 0.69 m
Site visit: August 12, 2016



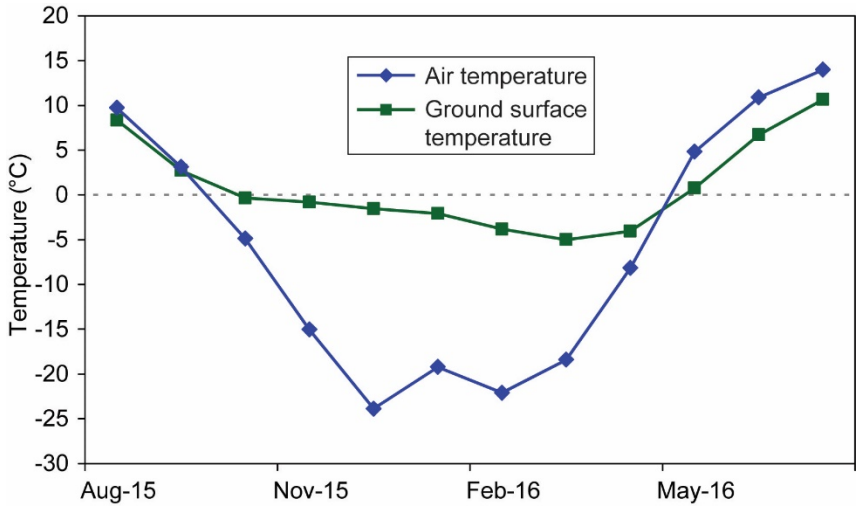
Aug 2015 – July 2016		
Depth (m)	Max (°C)	Min (°C)
0.33	2.78	-15.05
0.83	-1.13	-9.31
1.33	-0.96	-7.18
1.83	-1.38	-6.18
2.33	-1.61	-5.40
3.33	-2.33	-4.63
4.33	-2.85	-4.29

Rengleng River mouth — 91TT14

Gwich'in Settlement Region

Latitude: 67.80 N Longitude: 134.13 W
Elevation: 8 m a.s.l.
Landform: Alluvial plain
Vegetation cover: Mixed spruce and hardwood forest
Thaw Depth : n/a
Site visit: August 15, 2016

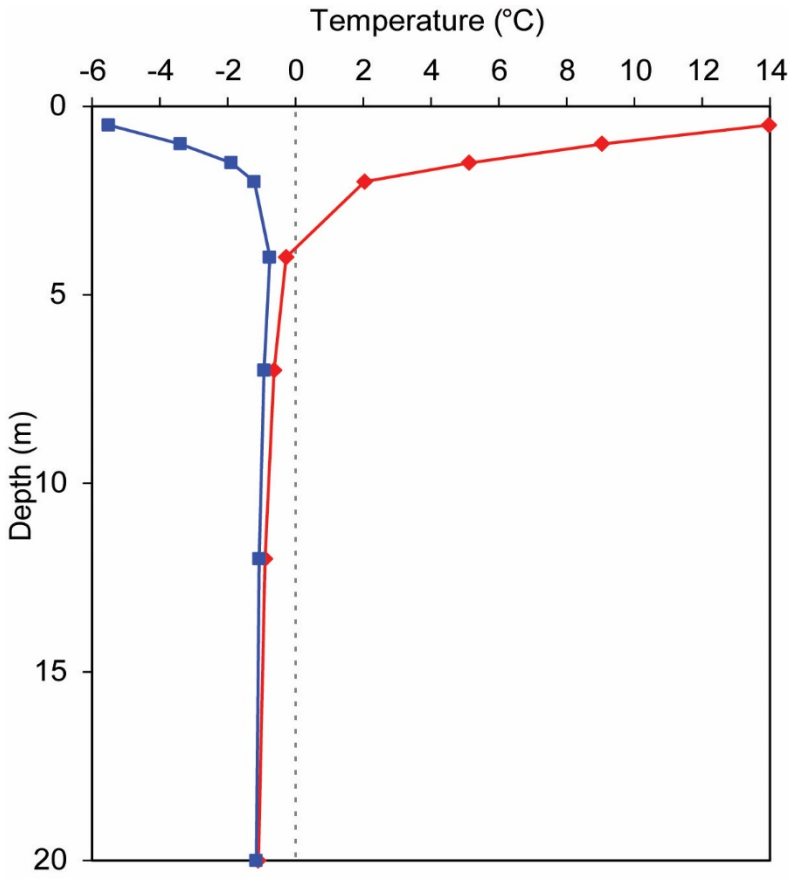
Month / Year	Temperature (°C)	
	Air	Surface
Aug / 2015	9.73	8.34
Sept / 2015	3.11	2.72
Oct / 2015	-4.89	-0.35
Nov / 2015	-15.05	-0.82
Dec / 2015	-23.88	-1.54
Jan / 2016	-19.22	-2.08
Feb / 2016	-22.10	-3.82
Mar / 2016	-18.41	-5.00
Apr / 2016	-8.18	-4.05
May / 2016	4.82	0.75
Jun / 2016	10.89	6.71
Jul / 2016	13.98	10.66



Jackfish Creek — JF-02

Sahtu Settlement Region

Latitude: 66.29 N Longitude: 128.47 W
Elevation: 90 m a.s.l.
Landform: Eolian dune on moraine plain, well drained, elevated area
Vegetation cover: Black spruce forest and moss cover
Thaw Depth: 2.33 m
Site visit: September 23, 2016



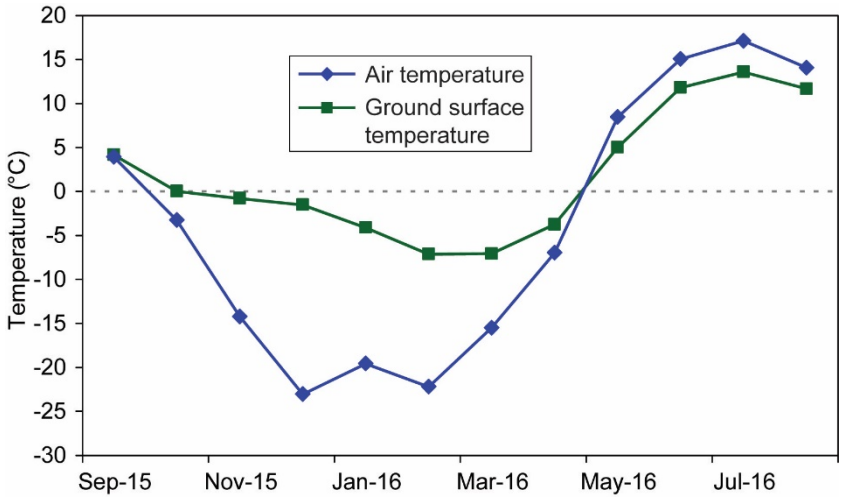
Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	13.97	-5.51
1	9.04	-3.39
1.5	5.12	-1.89
2	2.04	-1.22
4	-0.27	-0.76
7	-0.63	-0.93
12	-0.89	-1.07
20	-1.09	-1.15

Fort Good Hope South — FGHS-01

Sahtu Settlement Region

Latitude: 66.21 N Longitude: 128.50 W
Elevation: 134 m a.s.l.
Landform: Hummocky peatland
Vegetation cover: Dense shrub and open black spruce
Thaw Depth: n/a
Site visit: September 23, 2016

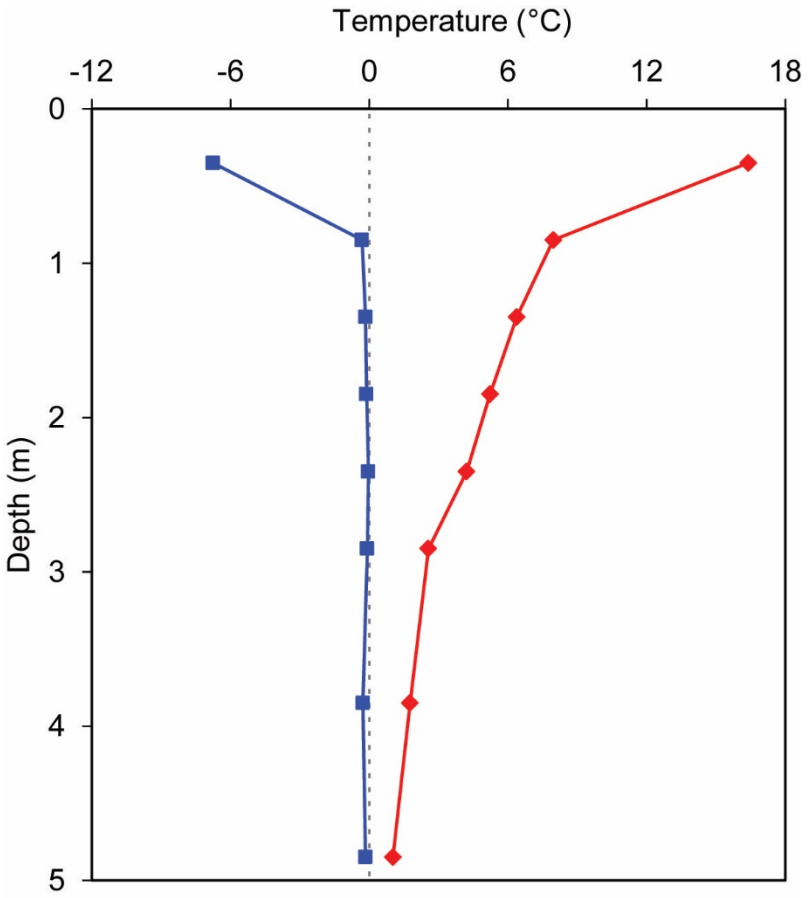
Month / Year	Temperature (°C)	
	Air	Surface
Sep / 2015	3.93	4.15
Oct / 2015	-3.27	0.01
Nov / 2015	-14.22	-0.80
Dec / 2015	-23.05	-1.53
Jan / 2016	-19.58	-4.12
Feb / 2016	-22.21	-7.13
Mar / 2016	-15.51	-7.07
Apr / 2016	-6.97	-3.75
May / 2016	8.45	5.00
Jun / 2016	15.06	11.81
Jul / 2016	17.12	13.58
Aug / 2016	14.07	11.68



Fort Good Hope South — FGHS-02

Sahtu Settlement Region

Latitude: 66.21 N Longitude: 128.50 W
Elevation: 134 m a.s.l.
Landform: Hummocky peatland
Vegetation cover: Peat plateau, lichen, open black spruce
Thaw Depth: 6.23 m (thaw depth was extrapolated from bottom two temperature measurements)
Site visit: September 23, 2016

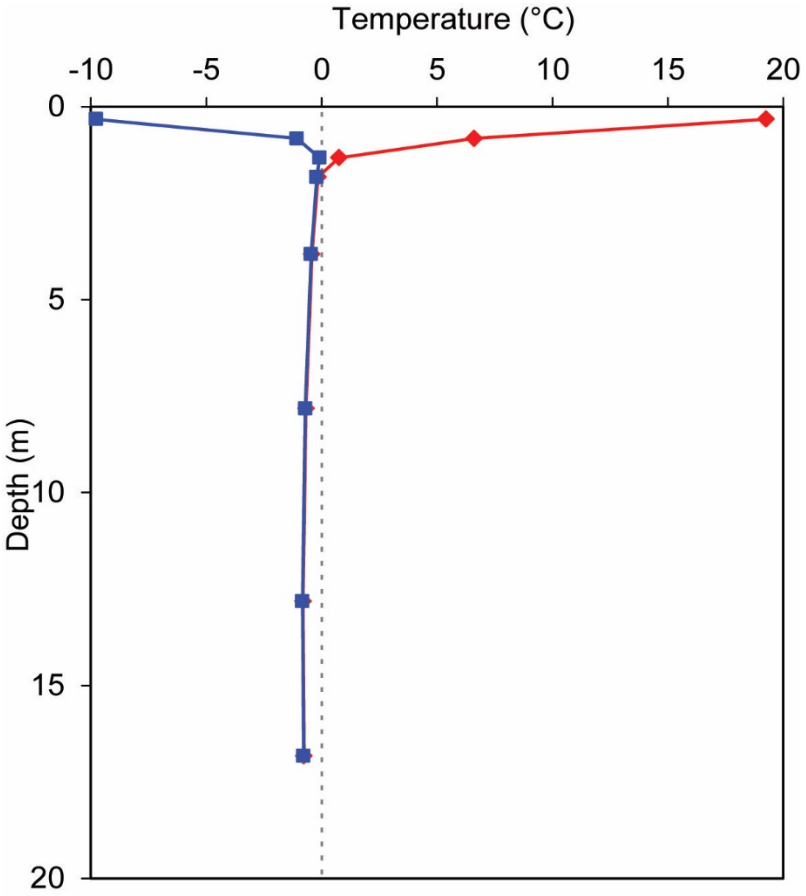


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.35	16.40	-6.76
0.85	7.96	-0.32
1.35	6.37	-0.16
1.85	5.22	-0.12
2.35	4.21	-0.04
2.85	2.56	-0.09
3.85	1.76	-0.27
4.85	1.02	-0.16

Snafu Creek — SC-01

Sahtu Settlement Region

Latitude: 66.00 N Longitude: 128.35 W
Elevation: 100 m a.s.l.
Landform: Moraine plain
Vegetation cover: Peat bog, open black spruce forest, and lichen cover
Thaw Depth: 1.39 m
Site visit: September 23, 2016

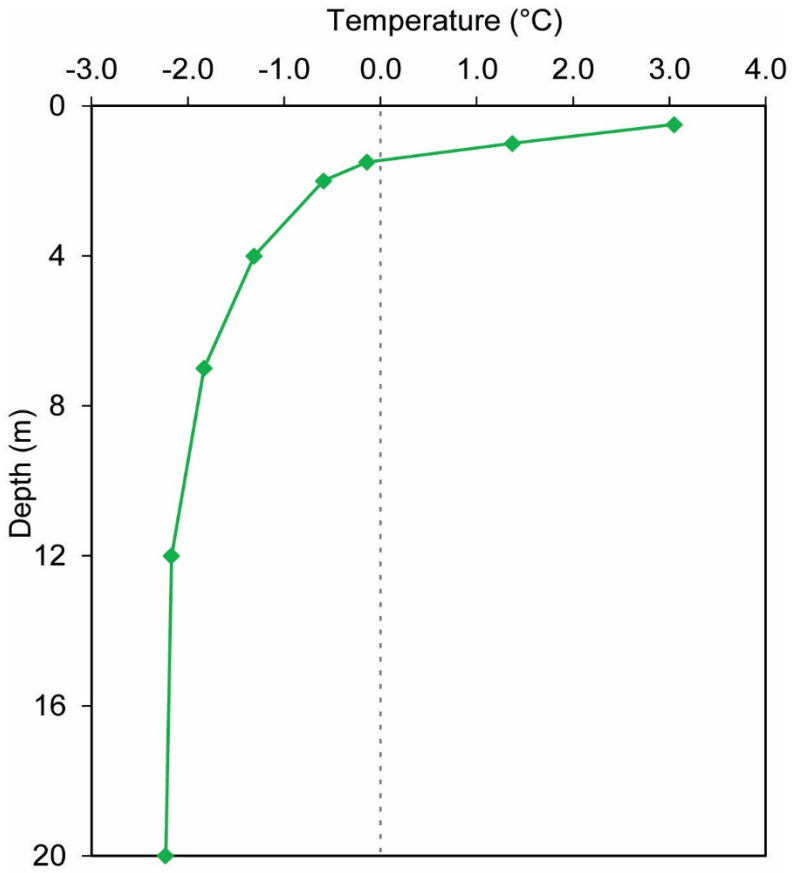


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.32	19.25	-9.78
0.82	6.62	-1.07
1.32	0.75	-0.10
1.82	-0.15	-0.22
3.82	-0.42	-0.45
7.82	-0.68	-0.71
12.82	-0.81	-0.83
16.82	-0.77	-0.78

Chick Lake — CL-01

Sahtu Settlement Region

Latitude: 65.90 N Longitude: 128.24 W
Elevation: 122 m a.s.l.
Landform: Moraine plain
Vegetation cover: Peat and organic soil with open black spruce forest and shrubs
Thaw Depth: 1.41 m
Site visit: September 23, 2016

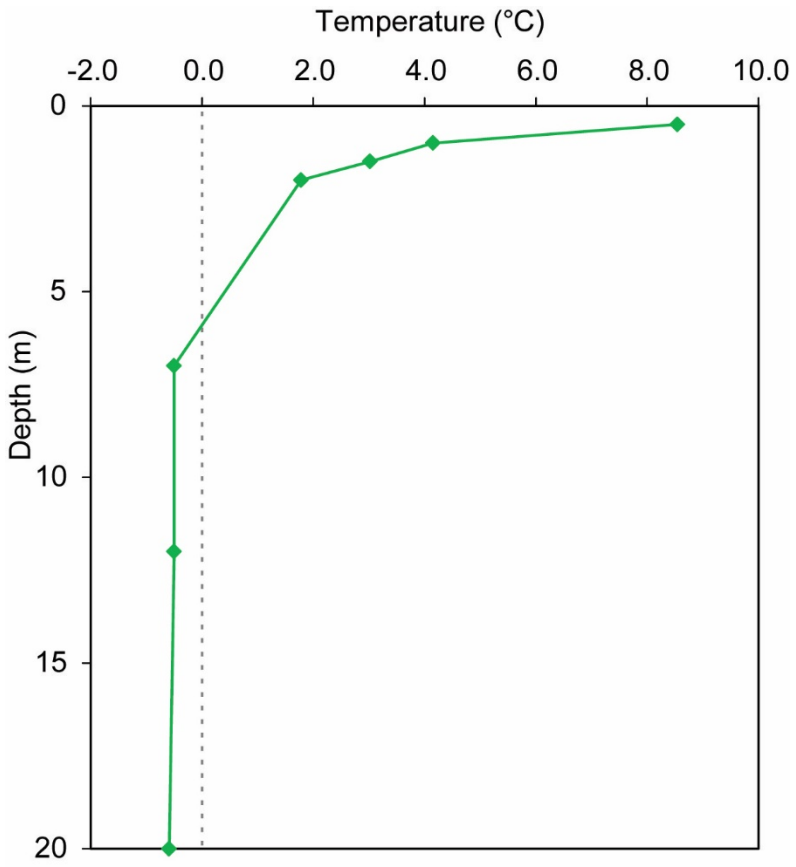


Depth (m)	Temp (°C)
0.5	3.05
1	1.37
1.5	-0.14
2	-0.59
4	-1.31
7	-1.83
12	-2.17
20	-2.23

Gibson Lake — GL-01

Sahtu Settlement Region

Latitude: 65.75 N Longitude: 127.89 W
Elevation: 228 m a.s.l.
Landform: Hummocky moraine plain
Vegetation cover: Recovering burnt area with peat and shrubs
Thaw Depth: 2.72 m
Site visit: September 23, 2016



Depth (m)	Temp (°C)
0.5	8.54
1	4.15
1.5	3.02
2	1.78
7	-0.5
12	-0.5
20	-0.59

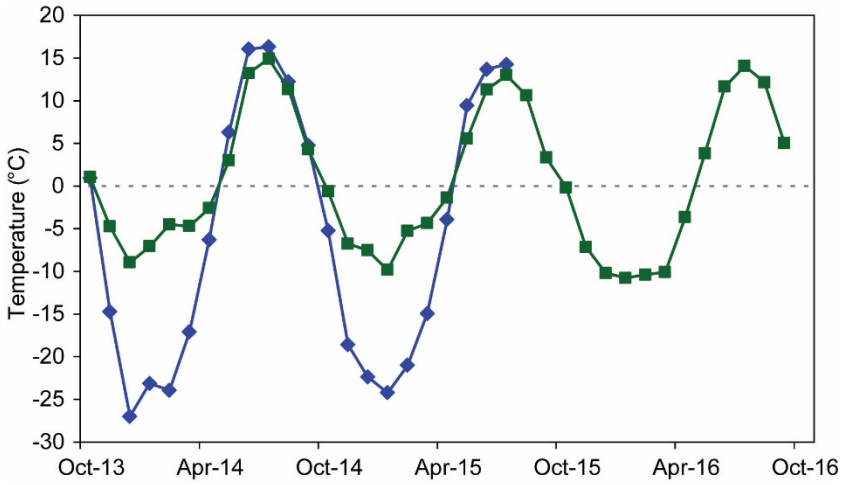
Gibson Lake — GL-01 (continued)

Note – no data acquisition for 3 years

Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2013	0.94	1.04
Nov / 2013	-14.72	-4.74
Dec / 2013	-27.01	-8.96
Jan / 2014	-23.14	-7.09
Feb / 2014	-23.94	-4.49
Mar / 2014	-17.12	-4.72
Apr / 2014	-6.31	-2.61
May / 2014	6.28	3.00
Jun / 2014	16.03	13.22
Jul / 2014	16.32	14.90
Aug / 2014	12.21	11.34
Sept / 2014	4.76	4.28

Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2014	-5.23	-0.63
Nov / 2014	-18.61	-6.75
Dec / 2014	-22.38	-7.53
Jan / 2015	-24.23	-9.85
Feb / 2015	-21.01	-5.27
Mar / 2015	-14.95	-4.35
Apr / 2015	-3.94	-1.35
May / 2015	9.44	5.54
Jun / 2015	13.69	11.32
Jul / 2015	14.25	12.97
Aug / 2015	n/a	10.62
Sept / 2015	n/a	3.32

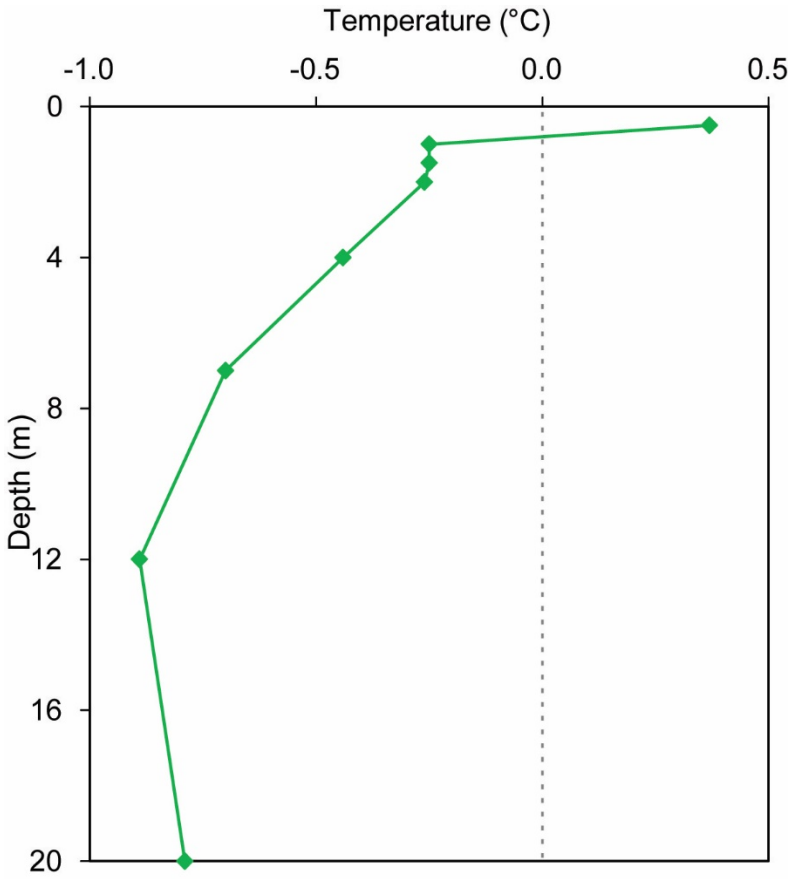
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	n/a	-0.18
Nov / 2015	n/a	-7.13
Dec / 2015	n/a	-10.20
Jan / 2016	n/a	-10.77
Feb / 2016	n/a	-10.40
Mar / 2016	n/a	-10.08
Apr / 2016	n/a	-3.65
May / 2016	n/a	3.80
Jun / 2016	n/a	11.64
Jul / 2016	n/a	14.06
Aug / 2016	n/a	12.15
Sept / 2016	n/a	5.04



Hanna River — HR-01

Sahtu Settlement Region

Latitude: 65.67 N Longitude: 127.83 W
Elevation: 104 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Boggy burnt area
Thaw Depth: 0.80 m
Site visit: September 23, 2016

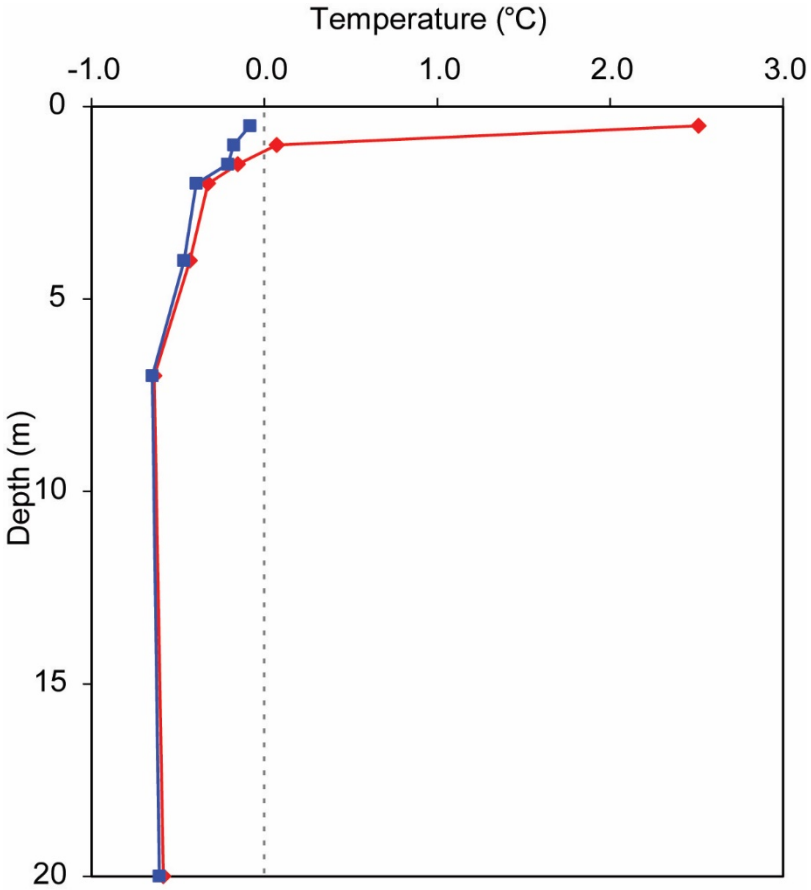


Depth (m)	Temp (°C)
0.5	0.37
1	-0.25
1.5	-0.25
2	-0.26
4	-0.44
7	-0.7
12	-0.89
20	-0.79

Elliot Creek — EC-01

Sahtu Settlement Region

Latitude: 65.52 N Longitude: 127.62 W
Elevation: 54 m a.s.l.
Landform: Lacustrine undulating plain, well-drained elevated area
Vegetation cover: Peat cover on edge of open, mature black spruce forest
Thaw Depth: 1.01 m
Site visit: September 23, 2016
Note: In 2015-2016, cable was displaced downwards ~75 cm. Shallow temperature data unreliable for that year. Clearing adjacent to site (along road right-of-way) due to fibre optic cable installation

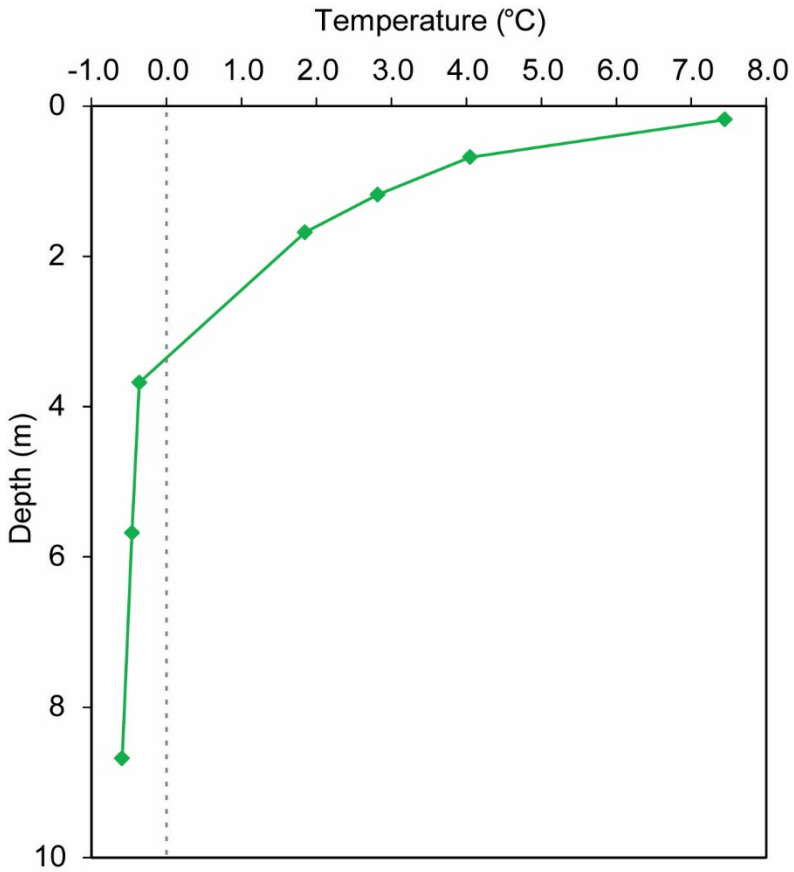


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	2.51	-0.08
1	0.07	-0.18
1.5	-0.15	-0.21
2	-0.33	-0.39
4	-0.43	-0.46
7	-0.64	-0.65
20	-0.58	-0.61

Elliot Creek — EC-02

Sahtu Settlement Region

Latitude: 65.52 N Longitude: 127.62 W
Elevation: 54 m a.s.l.
Landform: Lacustrine plain overlain by alluvial sediments
Vegetation cover: Peat cover on edge of dense, mature black spruce forest
Thaw Depth: 2.64 m
Site visit: September 23, 2016
Note: Site burned 2014

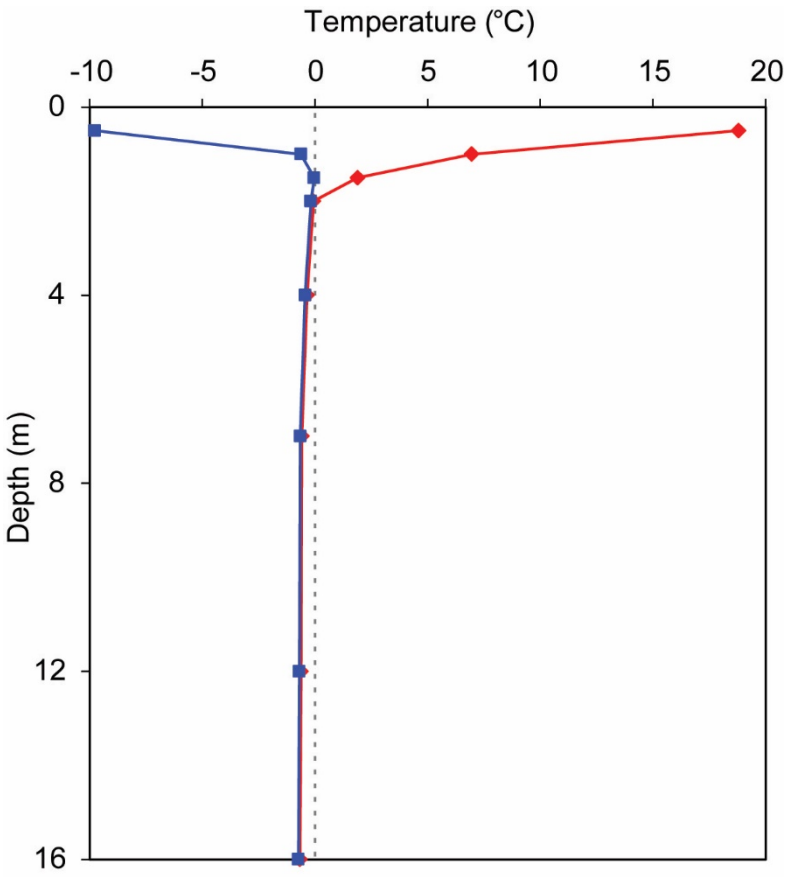


Depth (m)	Temp (°C)
0.18	7.45
0.68	4.05
1.18	2.82
1.68	1.85
3.68	-0.36
5.68	-0.46
8.68	-0.59

Oscar Creek — OC-01

Sahtu Settlement Region

Latitude: 65.44 N Longitude: 127.44 W
Elevation: 64 m a.s.l.
Landform: Undulating glaciolacustrine terrain overlain by alluvial sediments
Vegetation cover: Peat cover with dense-forested birch and black spruce
Thaw Depth: 1.69 m
Site visit: September 23, 2016

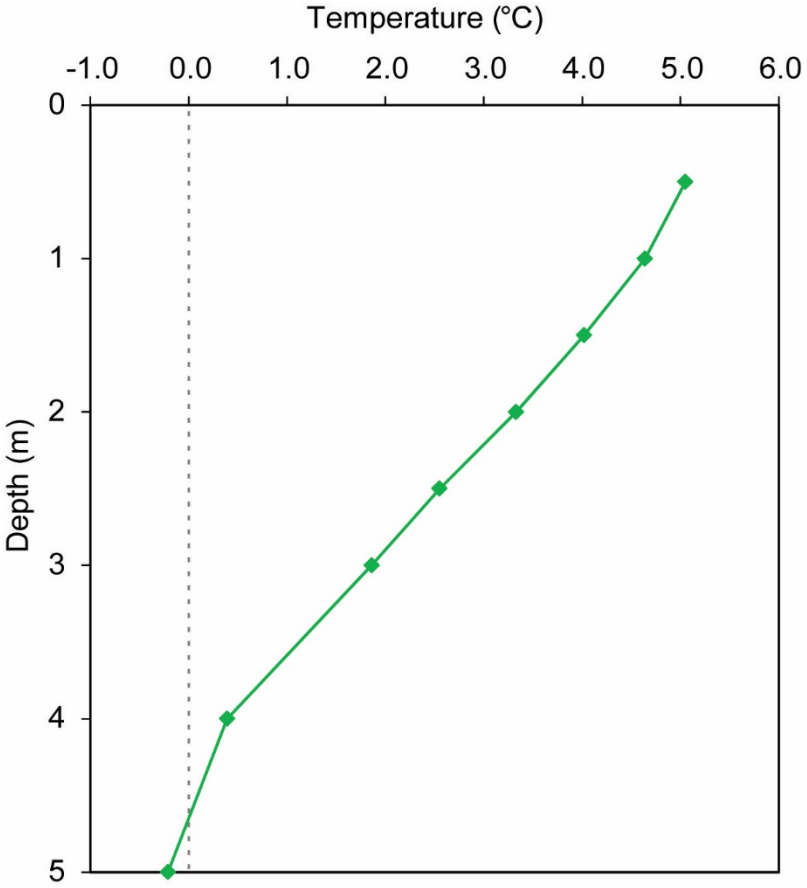


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	18.80	-9.78
1	6.96	-0.63
1.5	1.89	-0.04
2	-0.07	-0.18
4	-0.35	-0.44
7	-0.58	-0.65
12	-0.61	-0.69
16	-0.67	-0.73

Billy Creek North — BCN-01

Sahtu Settlement Region

Latitude: 65.40 N Longitude: 127.32 W
Elevation: 90 m a.s.l.
Landform: Alluvial and eolian sediments overlying low-lying lacustrine plain
Vegetation cover: Peat cover with dense-forested black spruce and mixed shrub
Thaw Depth: 4.27 m
Site visit: September 23, 2016

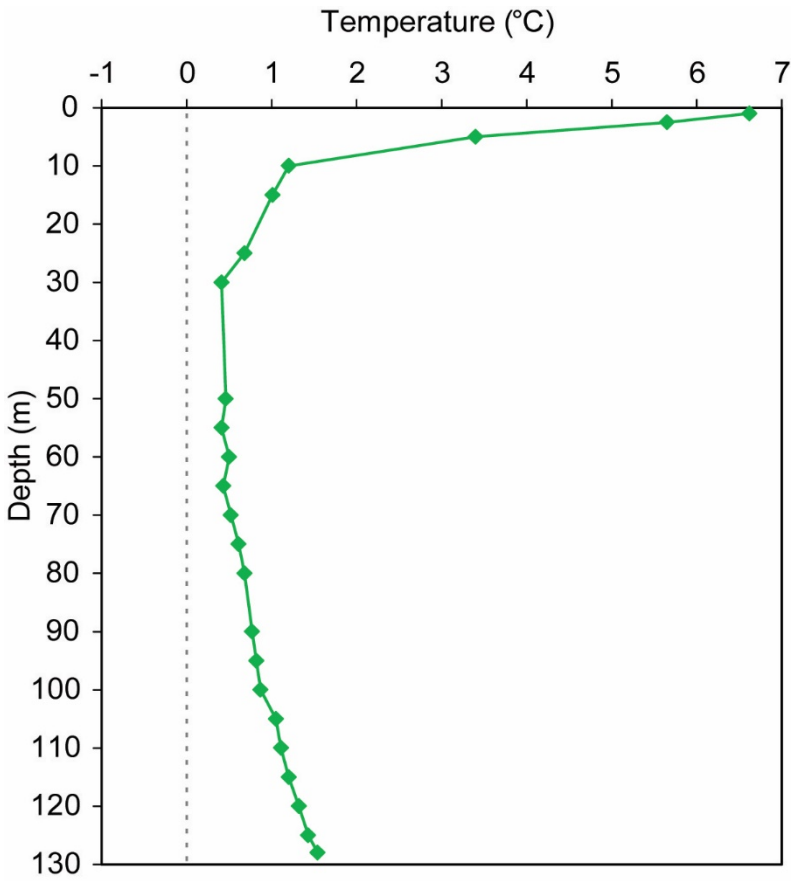


Depth (m)	Temp (°C)
0.5	5.05
1	4.64
1.5	4.02
2	3.33
2.5	2.55
3	1.86
4	0.39
5	-0.21

Kee Scarp HT

Sahtu Settlement Region

Latitude: 65.30 N Longitude: 126.72 W
Elevation: 270 m a.s.l.
Landform: Top of narrow ridge. Borehole is in shale (which is underlain by limestone) with 20 cm moss and organic cover at surface
Vegetation cover: Boreal forest, mixture aspen birch pine and spruce with ground cover of grasses and small shrub
Thaw Depth: n/a
Site visit: September 23, 2016

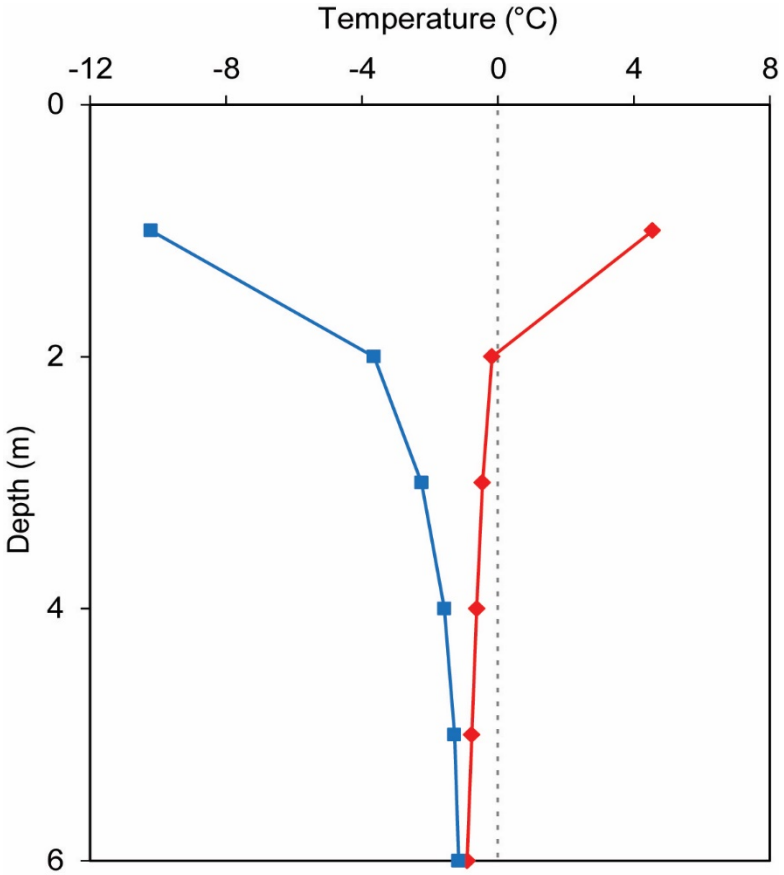


Depth (m)	Temp (°C)
1	6.62
2.5	5.65
5	3.4
10	1.2
15	1.01
25	0.68
30	0.41
50	0.46
55	0.41
60	0.5
65	0.43
70	0.52
75	0.61
80	0.68
90	0.77
95	0.82
100	0.87
105	1.05
110	1.11
115	1.2
120	1.32
125	1.43
128	1.54

84-1-T4

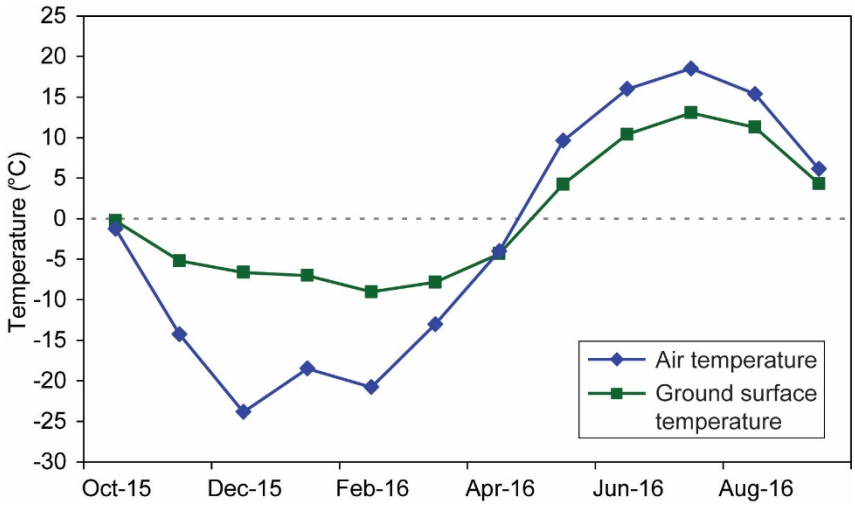
Sahtu Settlement Region

Latitude: 65.29 N Longitude: 126.89 W
Elevation: 61 m a.s.l.
Landform: Ground moraine
Vegetation cover: Moss, lichen, ericaceous shrubs with black spruce and tamarack
Thaw Depth: 1.96 m
Site visit: September 26, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
1	4.55	-10.21
2	-0.18	-3.65
3	-0.46	-2.25
4	-0.63	-1.58
5	-0.77	-1.28
6	-0.91	-1.16

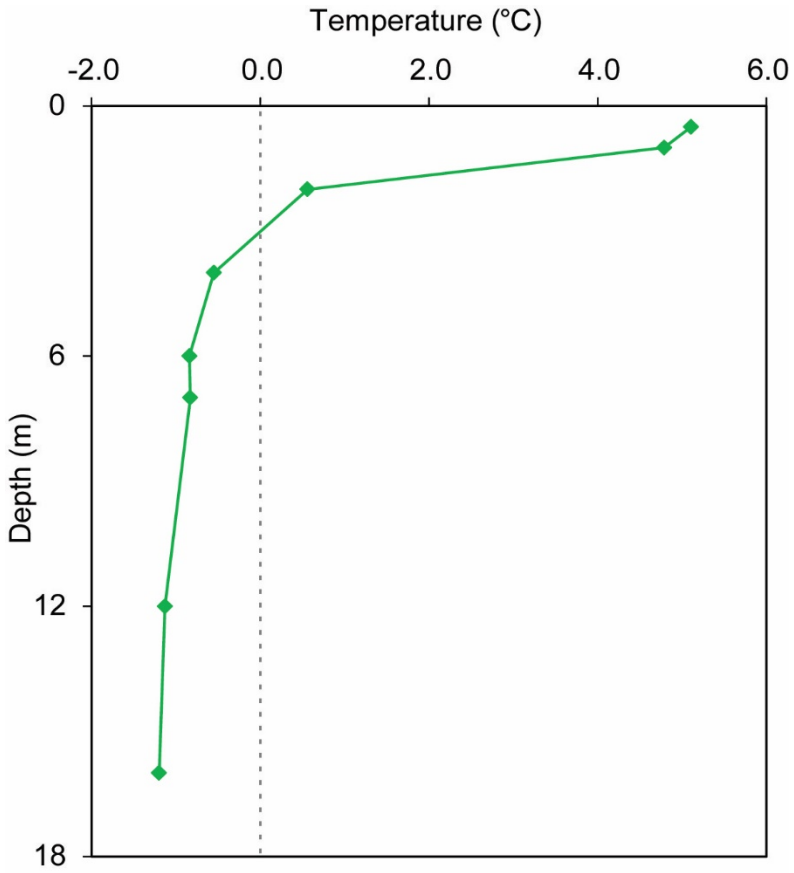
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	-1.25	-0.26
Nov / 2015	-14.25	-5.19
Dec / 2015	-23.84	-6.63
Jan / 2016	-18.48	-7.02
Feb / 2016	-20.78	-9.02
Mar / 2016	-13.02	-7.84
Apr / 2016	-4.02	-4.34
May / 2016	9.62	4.23
Jun / 2016	15.99	10.40
Jul / 2016	18.51	13.05
Aug / 2016	15.38	11.27
Sept / 2016	6.12	4.32



Norman Wells Arena

Sahtu Settlement Region

Latitude: 65.28 N Longitude: 126.83 W
Elevation: 80 m a.s.l.
Landform: Ground moraine
Vegetation cover: Disturbed area adjacent to parking lot
Thaw Depth: 2.13 m
Site visit: September 26, 2016

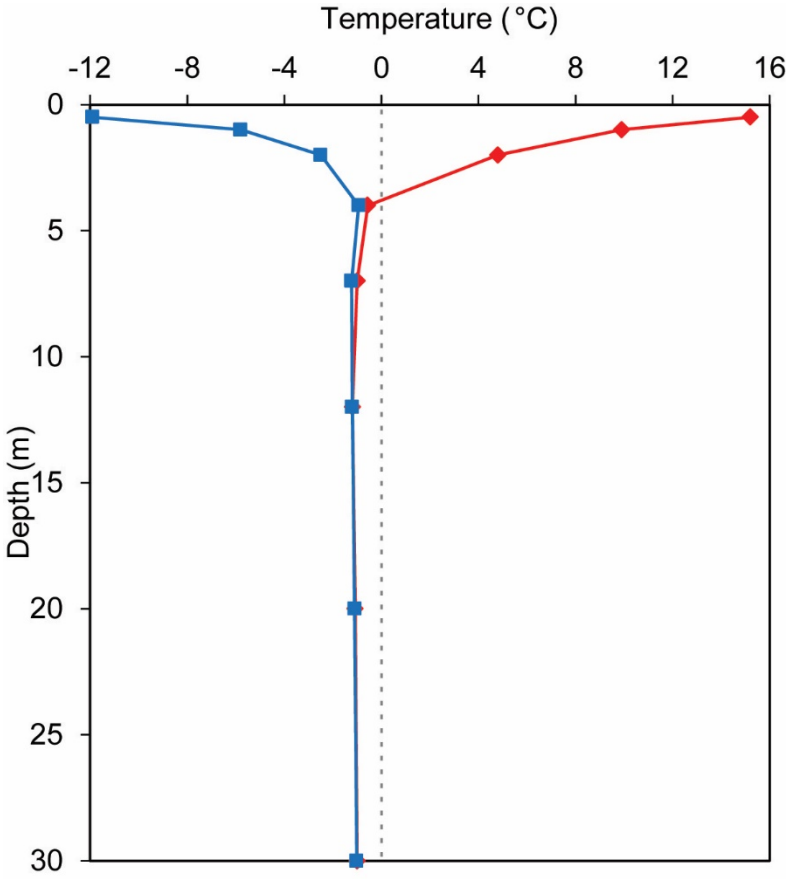


Depth (m)	Temp (°C)
0.5	5.11
1	4.79
2	0.56
4	-0.55
6	-0.84
7	-0.83
12	-1.13
16	-1.2

Norman Wells Water treatment plant

Sahtu Settlement Region

Latitude: 65.28 N Longitude: 126.84 W
Elevation: 80 m a.s.l.
Landform: Ground moraine
Vegetation cover: Disturbed area adjacent to parking lot
Thaw Depth: 2.94 m
Site visit: September 26, 2016

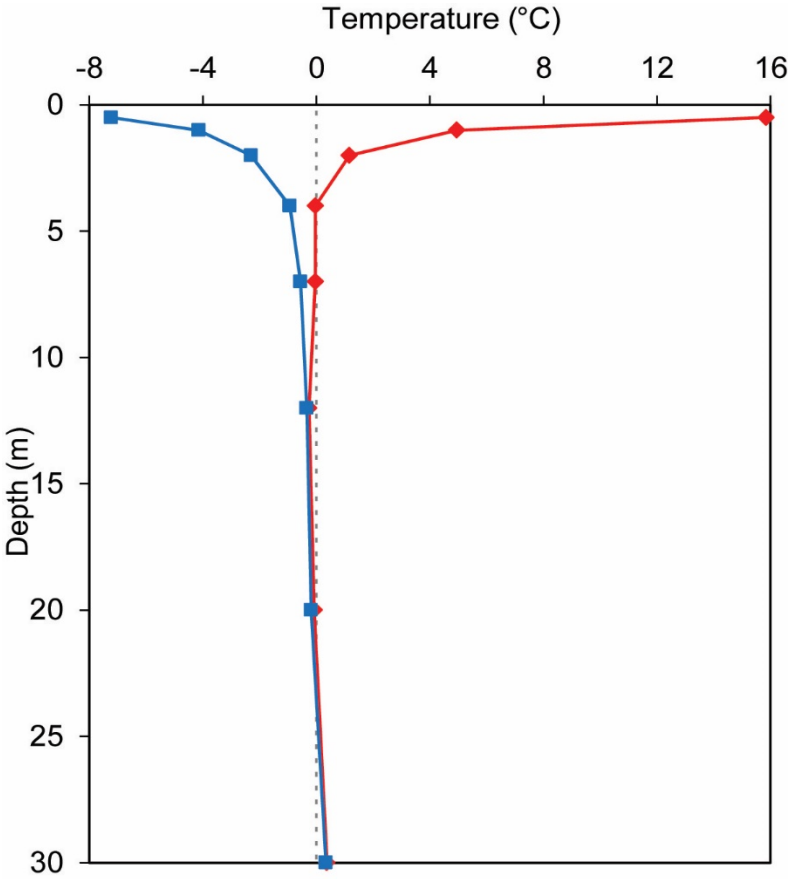


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	15.20	-11.90
1	9.90	-5.80
2	4.80	-2.50
4	-0.57	-0.93
7	-1.00	-1.23
12	-1.19	-1.20
20	-1.08	-1.10
30	-1.00	-1.02

Van Everdingen 30m

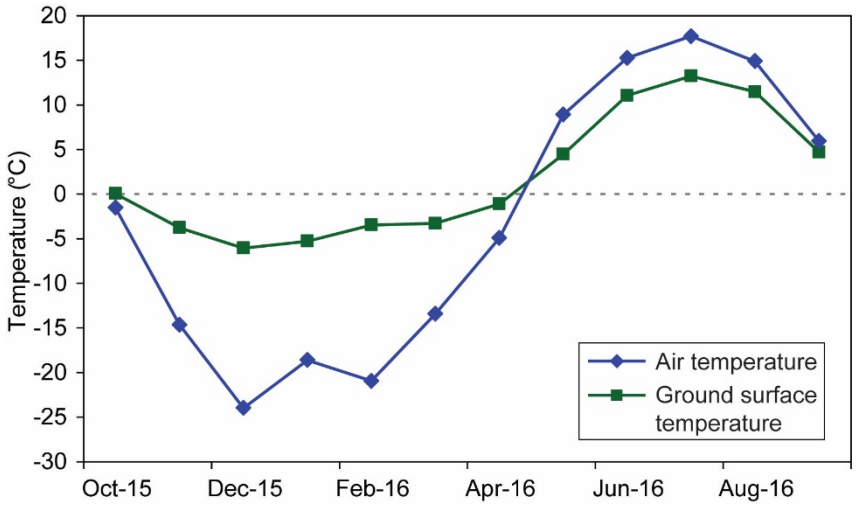
Sahtu Settlement Region

Latitude: 65.27 N Longitude: 126.75 W
Elevation: n/a
Landform: Lacustrine plain
Vegetation cover: Open forest, moss, shrub, spruce/tamarack
Thaw Depth: 2.32 m
Site visit: September 26, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	15.84	-7.23
1.0	4.96	-4.15
2.0	1.17	-2.31
4.0	-0.04	-0.93
7.0	-0.04	-0.56
12.0	-0.26	-0.34
20.0	-0.08	-0.19
30.0	0.38	0.34

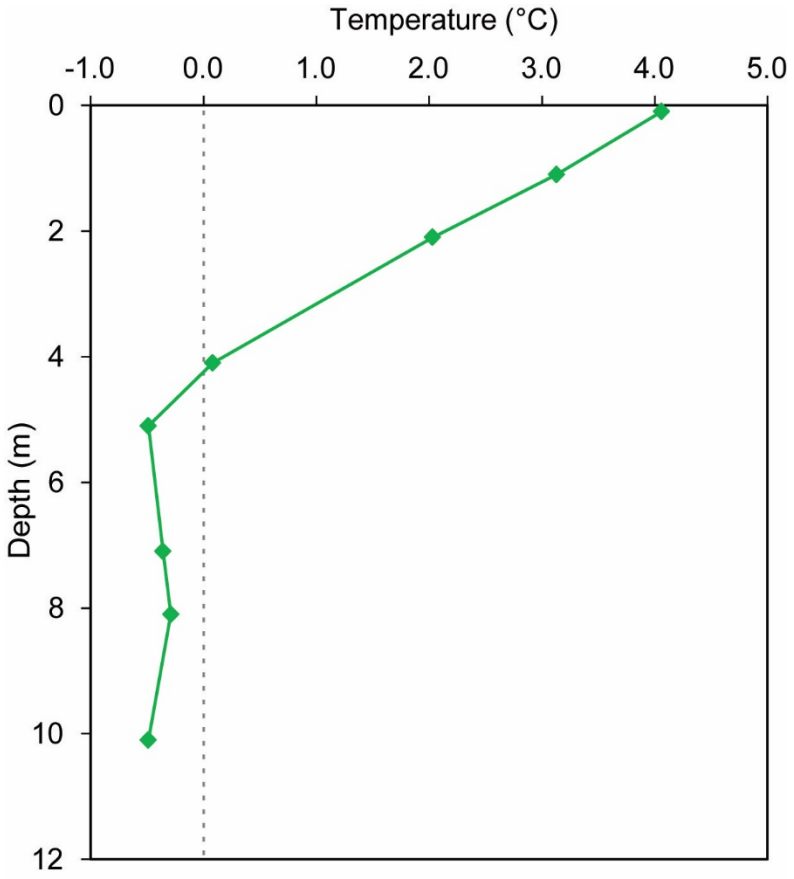
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	-1.53	0.05
Nov / 2015	-14.65	-3.77
Dec / 2015	-23.99	-6.04
Jan / 2016	-18.60	-5.27
Feb / 2016	-20.95	-3.46
Mar / 2016	-13.42	-3.28
Apr / 2016	-4.93	-1.09
May / 2016	8.90	4.47
Jun / 2016	15.27	11.06
Jul / 2016	17.70	13.25
Aug / 2016	14.89	11.48
Sept / 2016	5.95	4.71



84-2A-T4 Canyon Creek North A

Sahtu Settlement Region

Latitude: 65.23 N Longitude: 126.5 W
Elevation: 110 m a.s.l.
Landform: Ground moraine
Vegetation cover: Lichen, moss, ericaceous shrubs with black spruce and tamarack
Thaw Depth: 4.18 m
Site visit: September 25, 2016

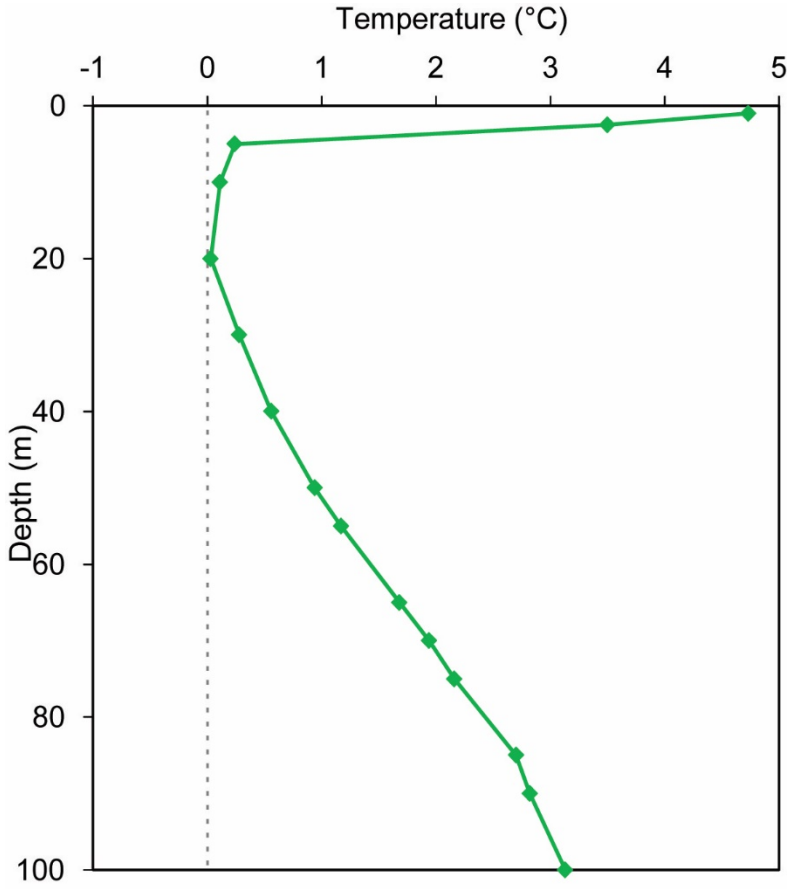


Depth (m)	Temp (°C)
0.1	4.06
1.1	3.13
2.1	2.03
4.1	0.08
5.1	-0.49
7.1	-0.36
8.1	-0.29
10.1	-0.49

84-2A-HT Canyon Creek North A

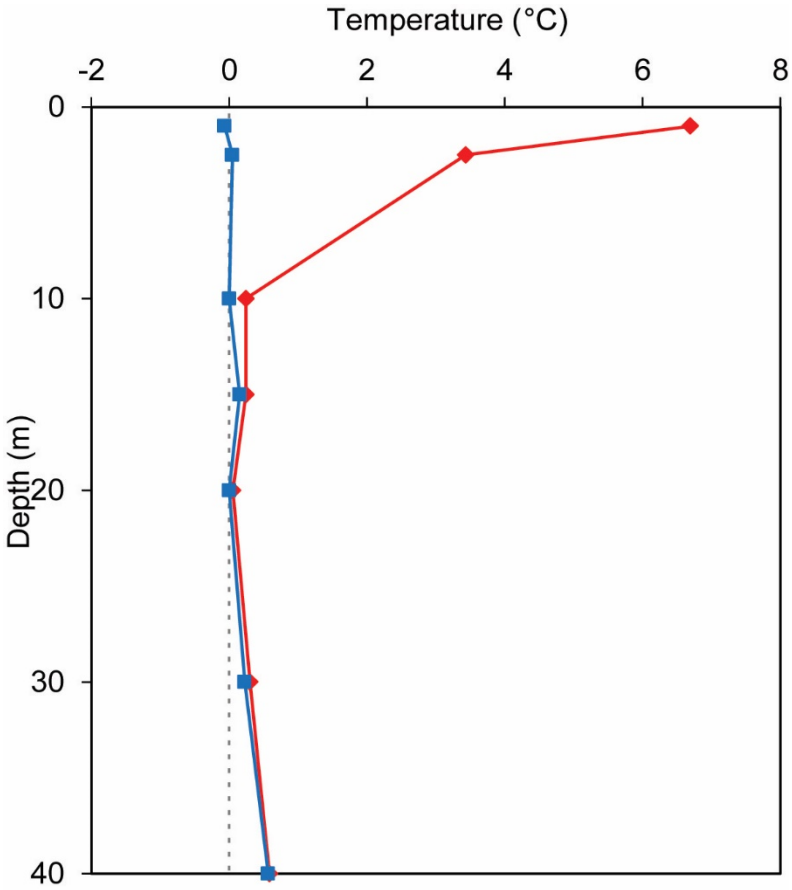
Sahtu Settlement Region

Latitude: 65.23 N Longitude: 126.5 W
Elevation: 110 m a.s.l.
Landform: Ground moraine
Vegetation cover: Lichen, moss, ericaceous shrubs with black spruce and tamarack
Thaw Depth: n/a
Site visit: September 25, 2016



Depth (m)	Temp (°C)
1	4.73
2.5	3.5
5	0.24
10	0.11
20	0.03
30	0.28
40	0.56
50	0.94
55	1.17
65	1.68
70	1.94
75	2.16
85	2.7
90	2.82
100	3.13

84-2A-HT Canyon Creek North A (Continued)

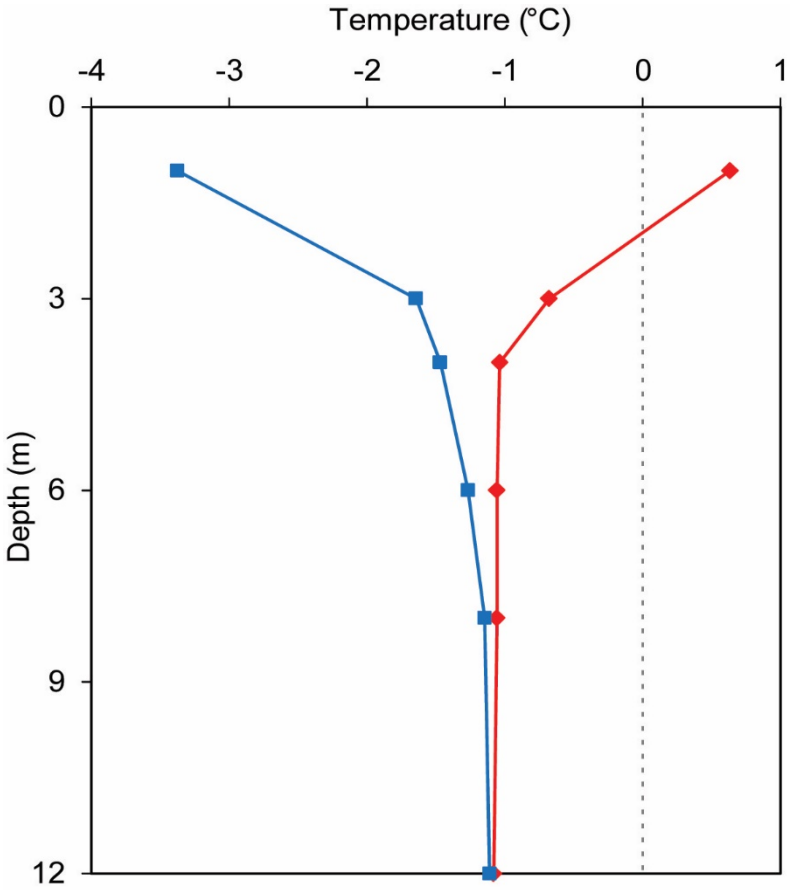


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
1	6.69	-0.07
3	3.43	0.05
10	0.24	0.00
15	0.24	0.15
20	0.05	0.00
30	0.30	0.23
40	0.58	0.56

84-2B-T4

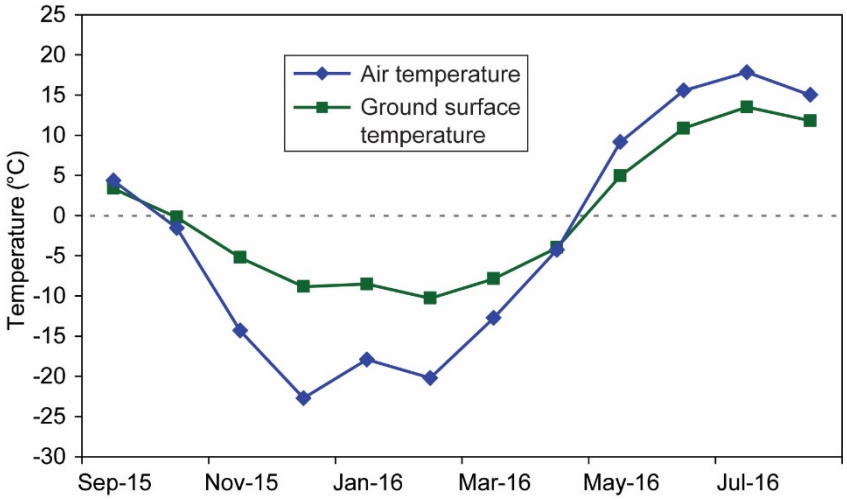
Sahtu Settlement Region

Latitude: 65.23N Longitude: 126.52 W
Elevation: 110 m a.s.l.
Landform: Ground moraine
Vegetation cover: Moss with white spruce
Thaw Depth: 1.96 m
Site visit: September 23, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
1	0.63	-3.37
3	-0.68	-1.64
4	-1.04	-1.47
6	-1.06	-1.27
8	-1.06	-1.15
12	-1.08	-1.11

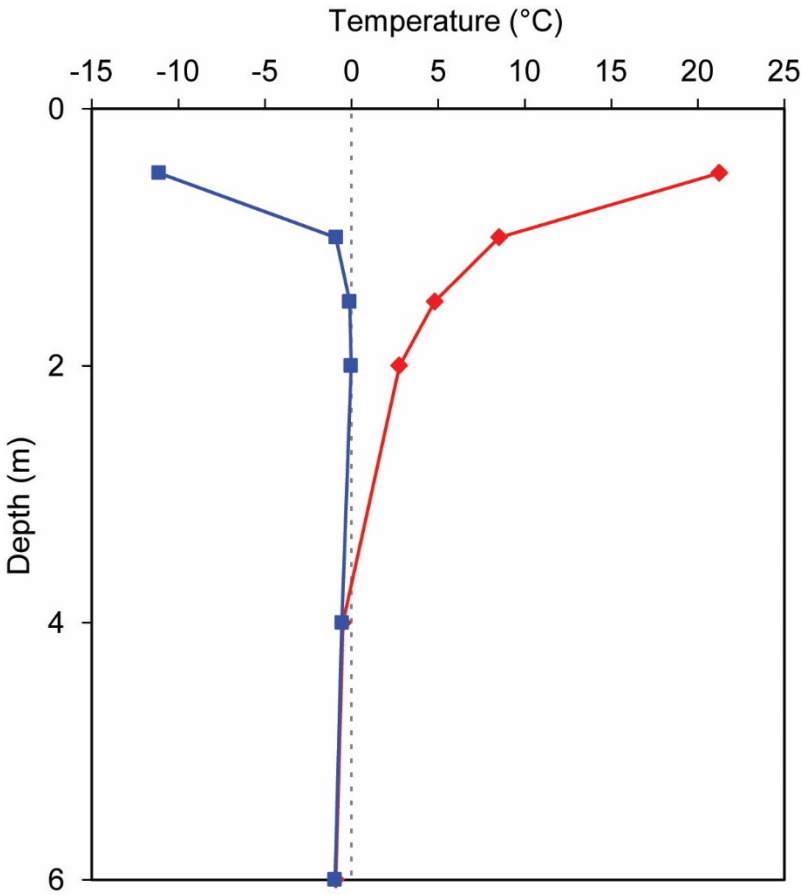
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	4.34	3.36
Oct / 2015	-1.55	-0.22
Nov / 2015	-14.33	-5.22
Dec / 2015	-22.71	-8.84
Jan / 2016	-17.91	-8.53
Feb / 2016	-20.20	-10.28
Mar / 2016	-12.76	-7.87
Apr / 2016	-4.27	-3.99
May / 2016	9.14	4.94
Jun / 2016	15.56	10.86
Jul / 2016	17.84	13.49
Aug / 2016	15.02	11.80



Vermillion Creek — VC-01

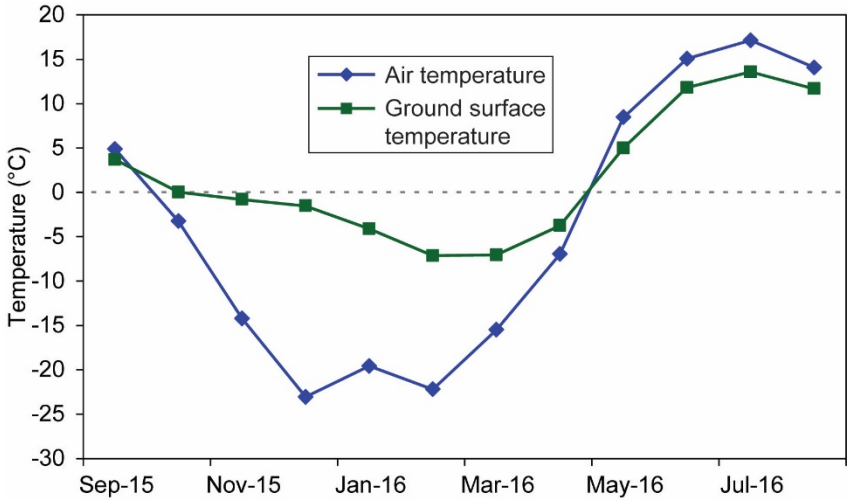
Sahtu Settlement Region

Latitude: 65.10 N Longitude: 126.14 W
Elevation: 92 m a.s.l.
Landform: Moraine plain (site at approach to water crossing)
Vegetation cover: NW side of creek, on top of ridge in black spruce forest
Thaw Depth: 2.68 m
Site visit: September 23, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	21.23	-11.11
1	8.52	-0.90
1.5	4.81	-0.12
2	2.77	-0.02
4	-0.49	-0.55
6	-0.90	-0.95

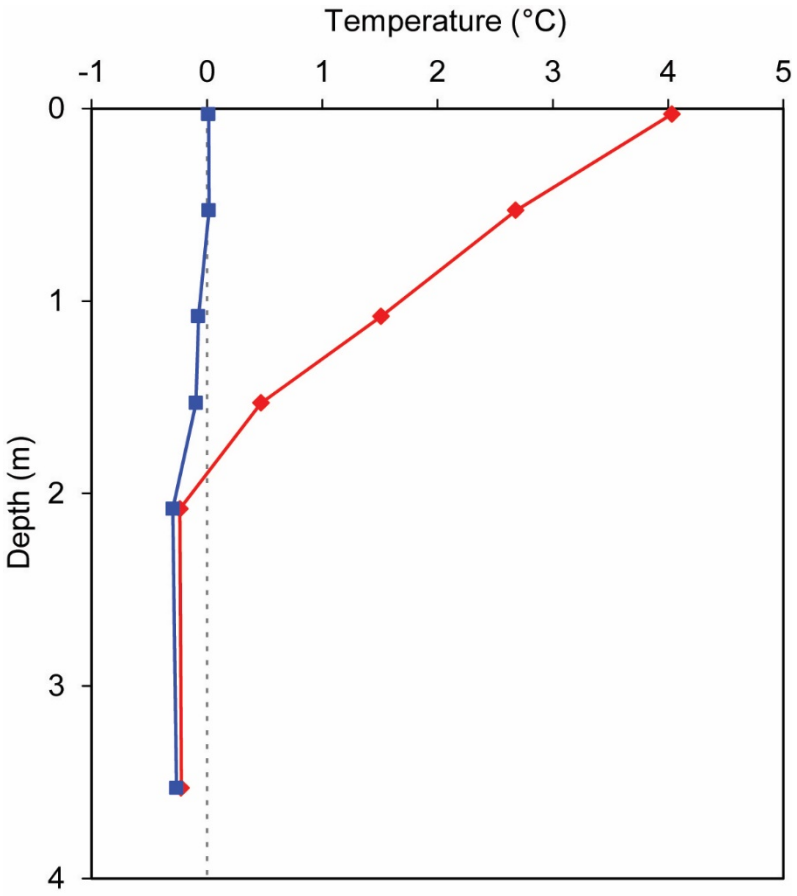
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	4.88	3.69
Oct / 2015	-3.26	0.01
Nov / 2015	-14.22	-0.80
Dec / 2015	-23.05	-1.53
Jan / 2016	-19.58	-4.12
Feb / 2016	-22.21	-7.13
Mar / 2016	-15.51	-7.07
Apr / 2016	-6.97	-3.75
May / 2016	8.45	5.00
Jun / 2016	15.06	11.81
Jul / 2016	17.12	13.58
Aug / 2016	14.07	11.68



Vermillion Creek — VC-02

Sahtu Settlement Region

Latitude: 65.10 N Longitude: 126.13 W
Elevation: 92 m a.s.l.
Landform: Moraine plain (site at approach to water crossing)
Vegetation cover: SE side of creek on plateau in area of burnt black spruce
Thaw Depth: 1.73 m
Site visit: September 23, 2016
Note: 0.03 to 0.53 m temperatures may be ~0°C (within measurement error)

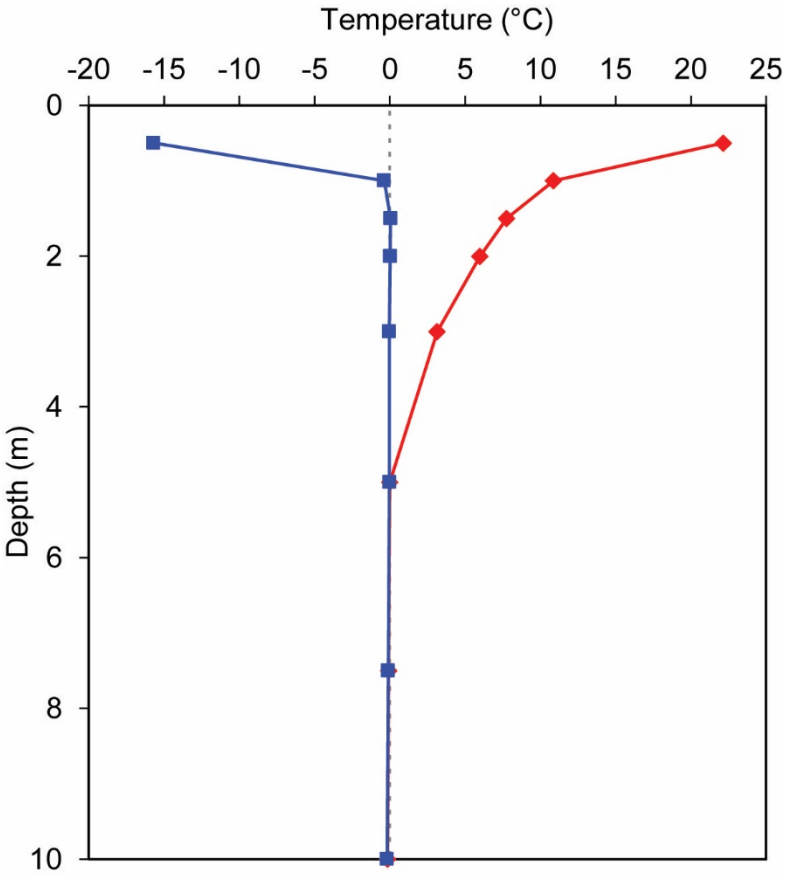


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.03	4.03	0.01
0.53	2.68	0.02
1.08	1.51	-0.07
1.53	0.47	-0.10
2.08	-0.24	-0.30
3.53	-0.22	-0.26

Police Island — PI-01

Sahtu Settlement Region

Latitude: 64.83 N Longitude: 125.02 W
Elevation: 113 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Recovering burn (burnt black spruce forest)
Thaw Depth: 4.10 m
Site visit: September 24, 2016

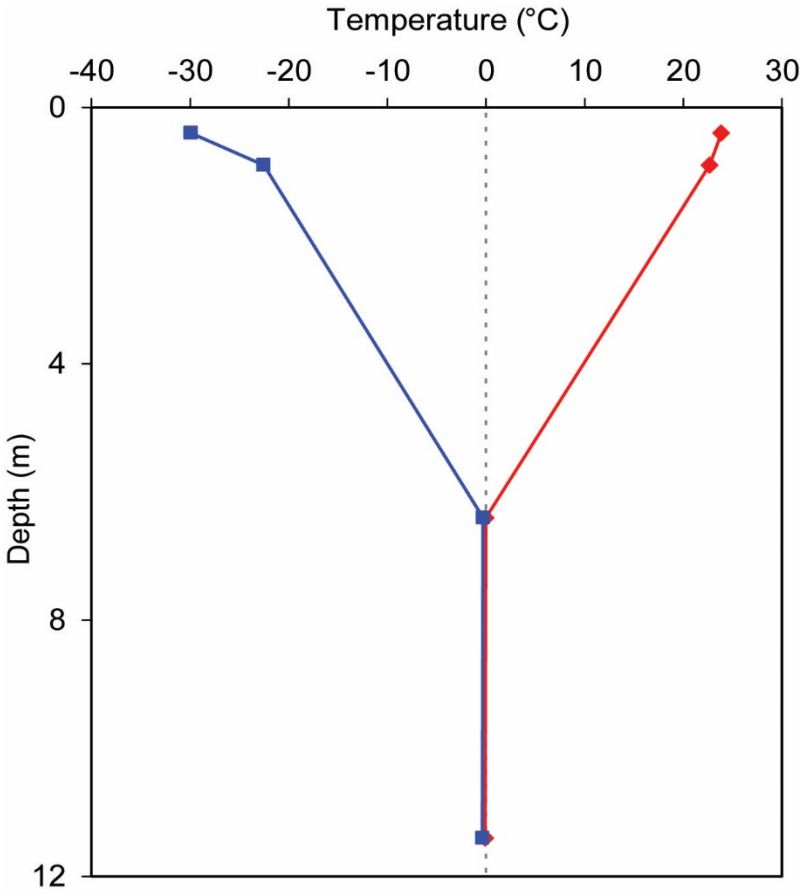


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	22.17	-15.71
1	10.88	-0.38
1.5	7.76	0.04
2	5.99	0.02
3	3.14	-0.04
5	0.00	-0.03
7.5	-0.07	-0.12
10	-0.15	-0.19

Police Island — PI-02

Sahtu Settlement Region

Latitude: 64.83 N Longitude: 125.01 W
Elevation: 113 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Unburnt, black spruce forest with moss and lichen ground cover
Thaw Depth: ≤ 6.4 m (lack of data does not allow proper interpolation)
Site visit: September 24, 2016
Note: Some damage to cable

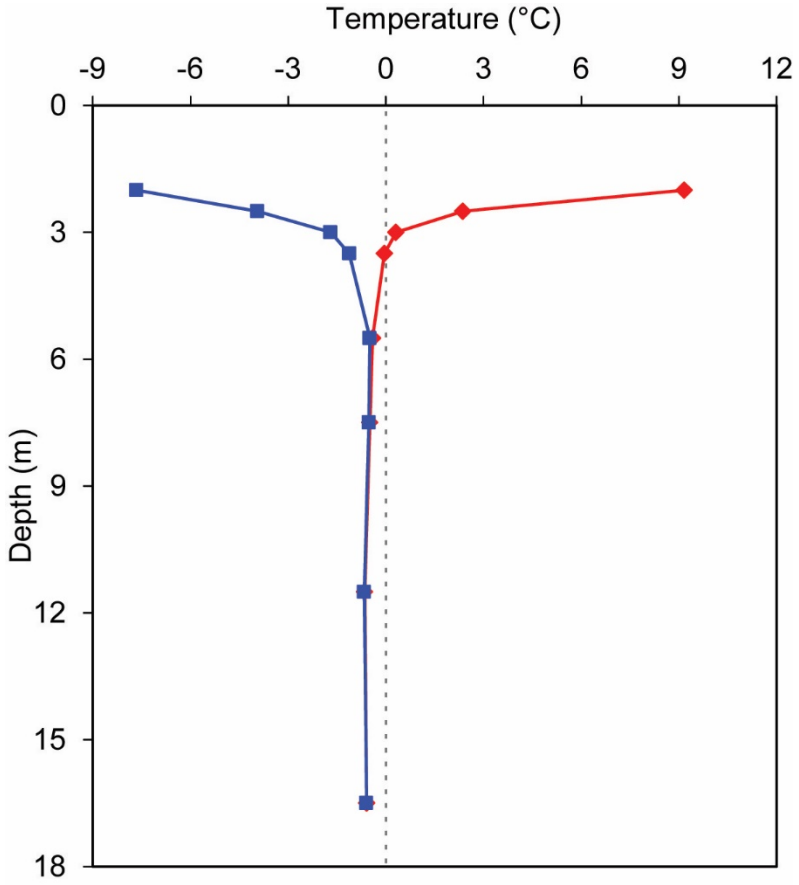


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.4	23.85	-29.94
0.9	22.65	-22.54
6.4	-0.03	-0.30
11.4	-0.09	-0.39

Old Fort Point — OFP-01

Sahtu Settlement Region

Latitude: 64.65 N Longitude: 124.84 W
Elevation: 112 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Open mixed spruce, pine deciduous forest adjacent to open, low-lying fen
Thaw Depth: 3.08 m
Site visit: September 24, 2016

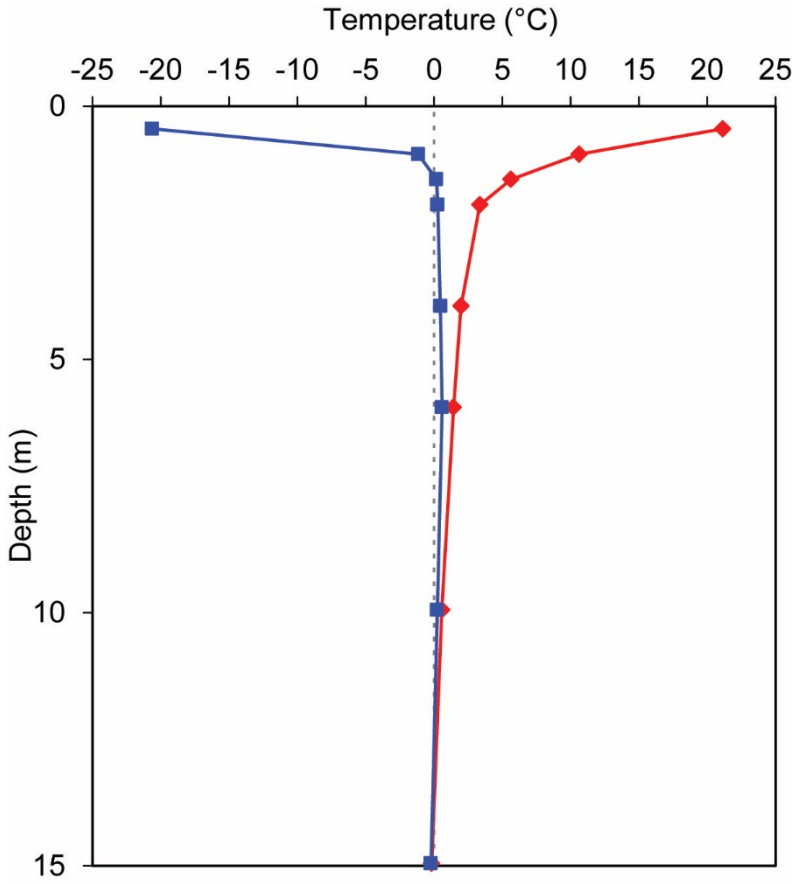


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
2	9.16	-7.66
2.5	2.37	-3.95
3	0.31	-1.70
3.5	-0.05	-1.12
5.5	-0.41	-0.49
7.5	-0.49	-0.52
11.5	-0.65	-0.66
16.5	-0.59	-0.60

Little Smith Creek — LS-01

Sahtu Settlement Region

Latitude: 64.43 N Longitude: 124.74 W
Elevation: 80 m a.s.l.
Landform: Alluvial flood plain
Vegetation cover: Open mature black spruce forest
Thaw Depth: 12.56 m
Site visit: September 24, 2016
Note: Site cleared winter 2016

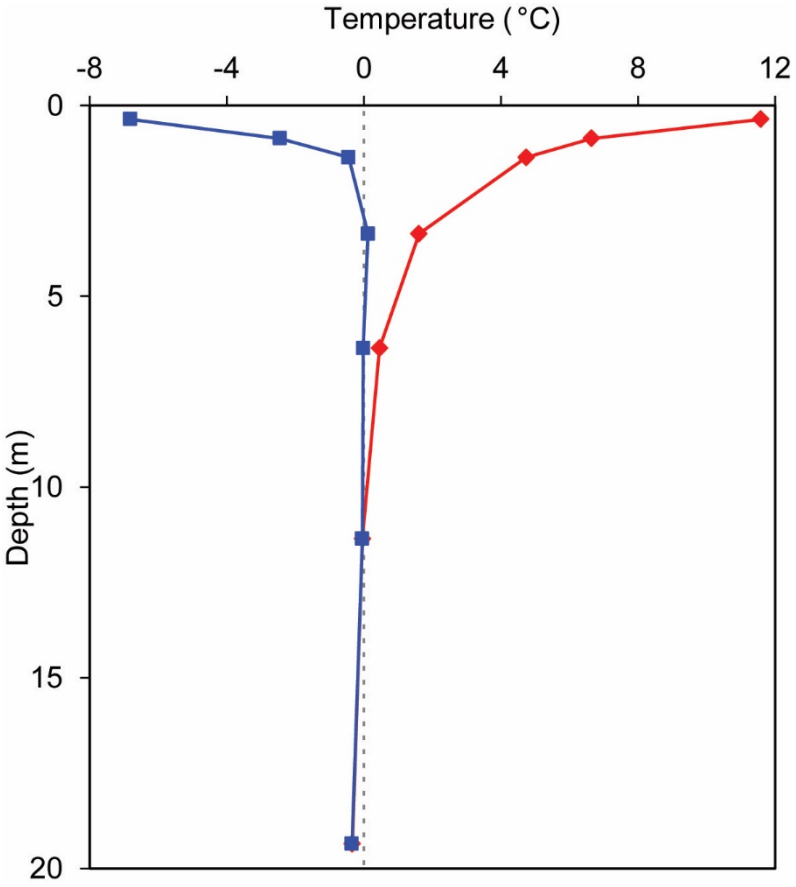


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.45	21.15	-20.65
0.95	10.64	-1.16
1.45	5.62	0.17
1.95	3.35	0.26
3.95	1.97	0.47
5.95	1.42	0.58
9.95	0.56	0.22
14.95	-0.17	-0.23

Little Smith Creek— LS-02

Sahtu Settlement Region

Latitude: 64.43 N Longitude: 124.73 W
Elevation: 112 m a.s.l.
Landform: Glaciofluvial outwash plain
Vegetation cover: Tamarack birch poplar, and pine forest transition to spruce
Thaw Depth: 7.54 m
Site visit: September 24, 2016

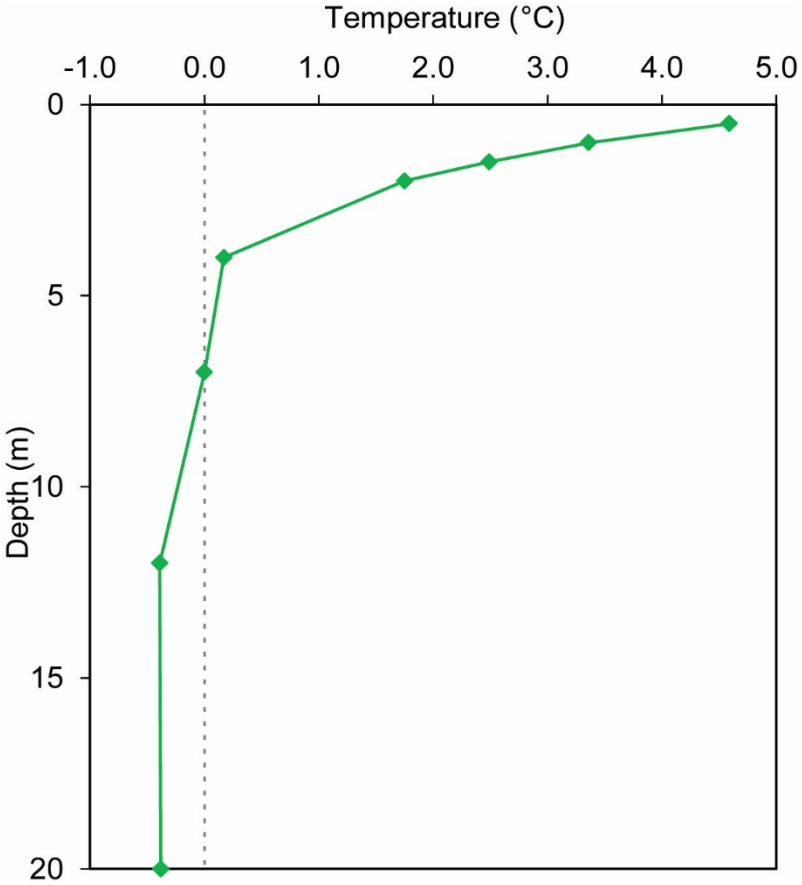


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.36	11.58	-6.81
0.86	6.64	-2.46
1.36	4.74	-0.45
3.36	1.61	0.12
6.36	0.45	-0.02
11.36	-0.05	-0.05
19.36	-0.34	-0.35

Saline River — SR-02

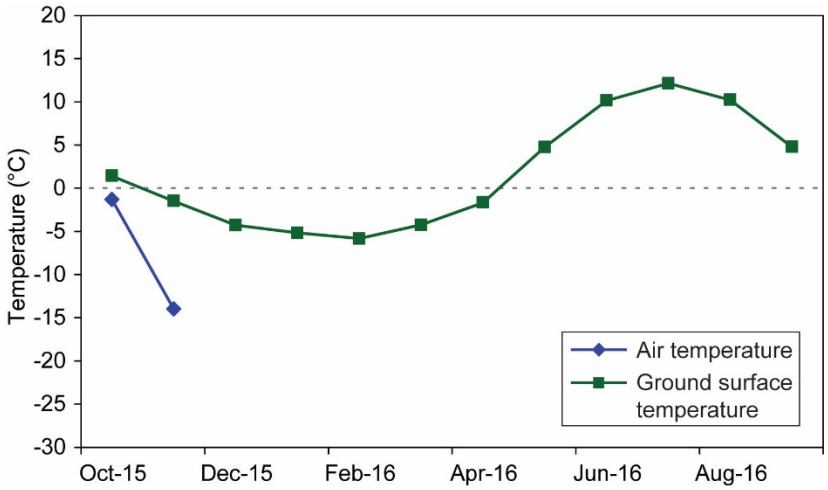
Sahtu Settlement Region

Latitude: 64.29 N Longitude: 124.49 W
Elevation: 140 m a.s.l.
Landform: Glaciofluvial veneer over lacustrine
Vegetation cover: Burnt black spruce forest
Thaw Depth: 4.22 m
Site visit: September 24, 2016



Depth (m)	Temp (°C)
0.5	4.59
1	3.36
1.5	2.49
2	1.75
4	0.17
7	0
12	-0.39
20	-0.38

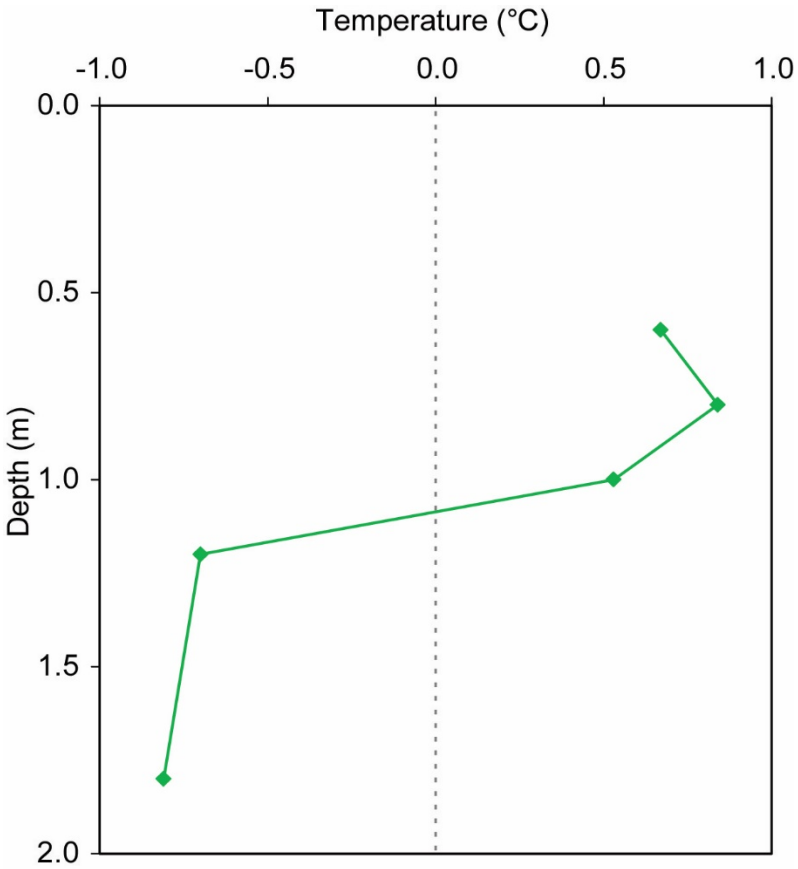
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	-1.30	1.41
Nov / 2015	-13.98	-1.49
Dec / 2015	n/a	-4.28
Jan / 2016	n/a	-5.18
Feb / 2016	n/a	-5.83
Mar / 2016	n/a	-4.25
Apr / 2016	n/a	-1.69
May / 2016	n/a	4.76
Jun / 2016	n/a	10.15
Jul / 2016	n/a	12.13
Aug / 2016	n/a	10.23
Sept / 2016	n/a	4.77



KP182 — Bottom

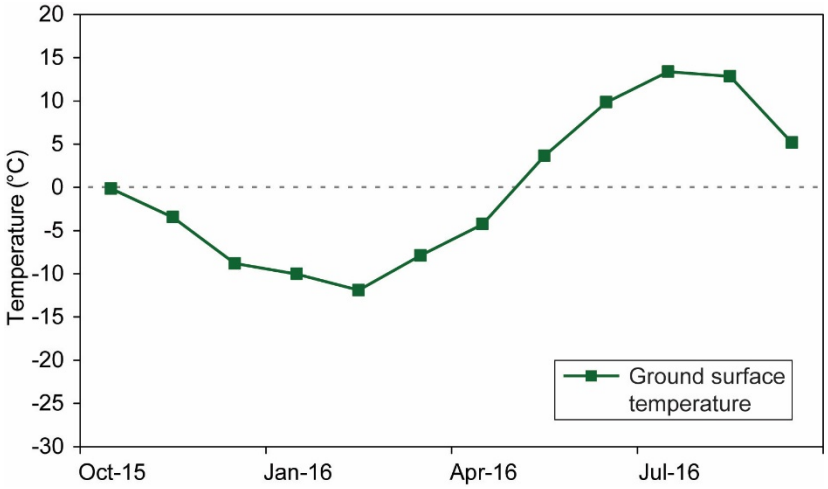
Sahtu Settlement Region

Latitude: 64.28 N Longitude: 124.47 W
Elevation: 133 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Forested (recovering burn, burned 1994)- Aspen, willow, birch, tamarack
Thaw Depth: 1.34 m
Site visit: September 25, 2016



Depth (m)	Temp (°C)
0.6	0.67
0.8	0.84
1	0.53
1.2	-0.7
1.8	-0.81

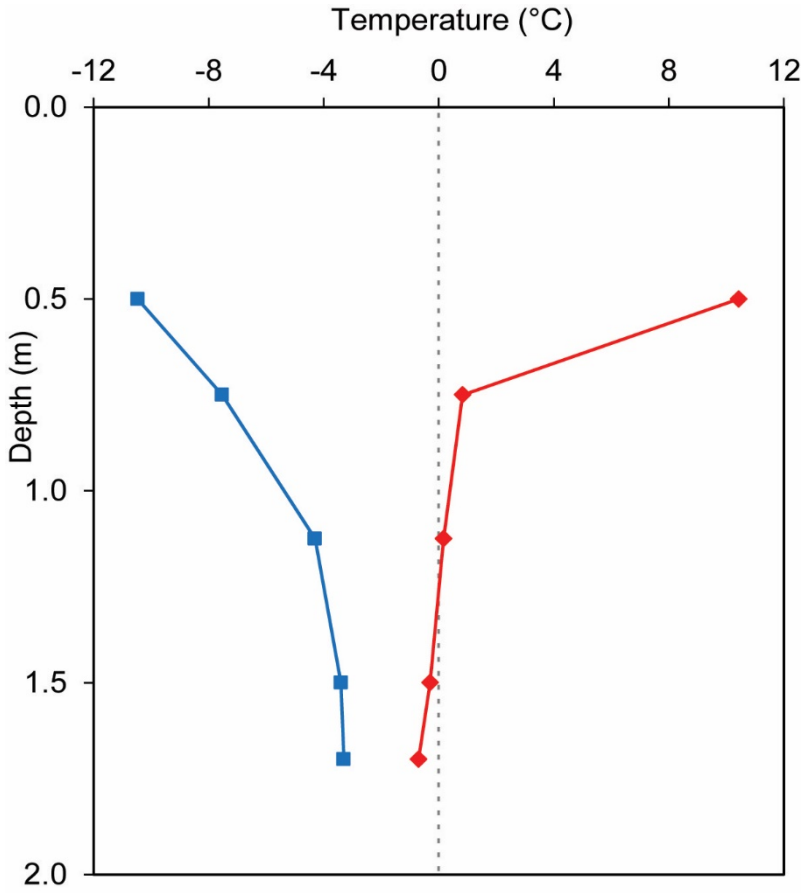
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	n/a	-0.16
Nov / 2015	n/a	-3.47
Dec / 2015	n/a	-8.82
Jan / 2016	n/a	-10.04
Feb / 2016	n/a	-11.91
Mar / 2016	n/a	-7.88
Apr / 2016	n/a	-4.27
May / 2016	n/a	3.64
Jun / 2016	n/a	9.84
Jul / 2016	n/a	13.37
Aug / 2016	n/a	12.84
Sept / 2016	n/a	5.15



KP182 — Mid Slope HT192

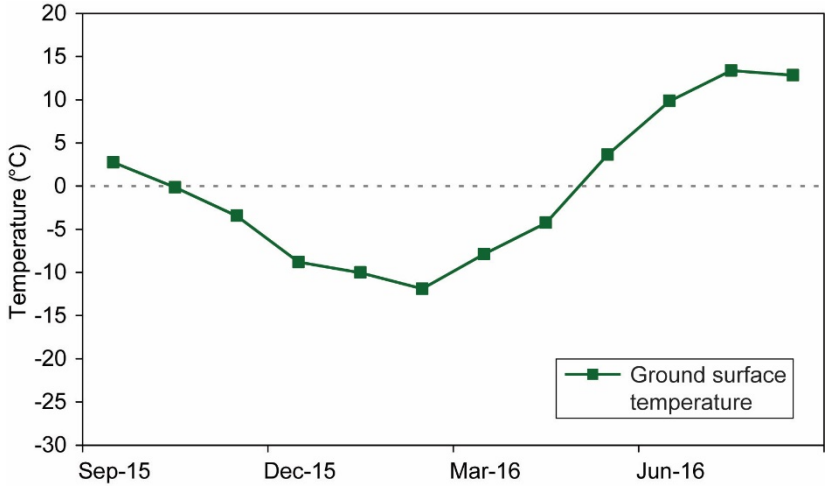
Sahtu Settlement Region

Latitude: 64.28 N Longitude: 124.47 W
Elevation: 138 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Forested (recovering burn, burned 1994) - aspen, willow, birch, tamarack
Thaw Depth: 1.22 m
Site visit: September 25, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	10.43	-10.47
0.75	0.83	-7.53
1.125	0.17	-4.30
1.5	-0.30	-3.40
1.7	-0.70	-3.30

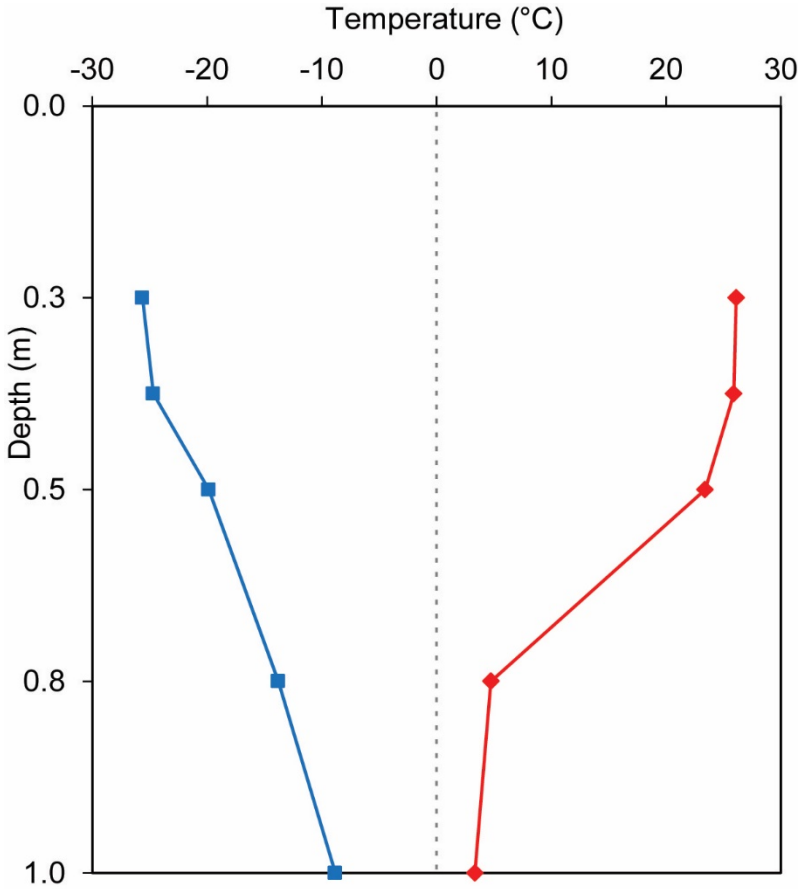
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	n/a	2.74
Oct / 2015	n/a	-0.16
Nov / 2015	n/a	-3.47
Dec / 2015	n/a	-8.82
Jan / 2016	n/a	-10.04
Feb / 2016	n/a	-11.91
Mar / 2016	n/a	-7.88
Apr / 2016	n/a	-4.27
May / 2016	n/a	3.64
Jun / 2016	n/a	9.84
Jul / 2016	n/a	13.37
Aug / 2016	n/a	12.84



KP182 — Crest of Slope

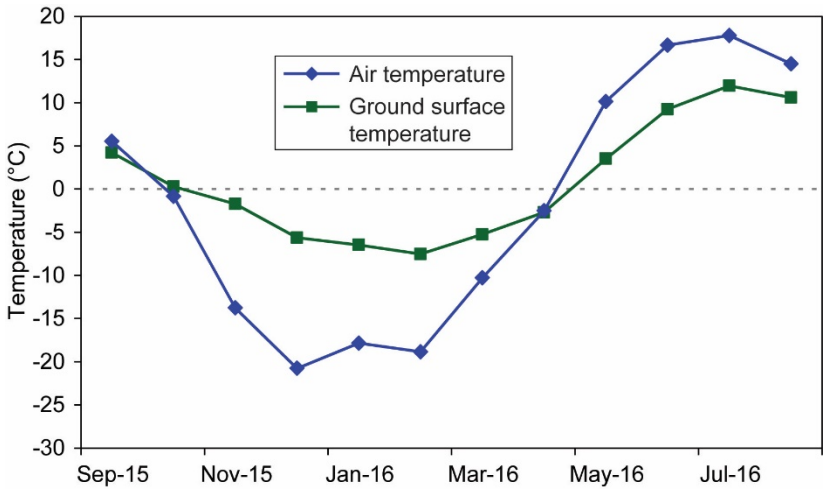
Sahtu Settlement Region

Latitude: 64.28 N Longitude: 124.47 W
Elevation: 139 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Forested (recovering burn, burned 1994) – aspen, willow, birch, tamarack
Thaw Depth: 1.60 m
Site visit: September 25, 2016



Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.25	26.12	-25.63
0.375	25.89	-24.72
0.50	23.40	-19.87
0.75	4.72	-13.81
1	3.32	-8.86

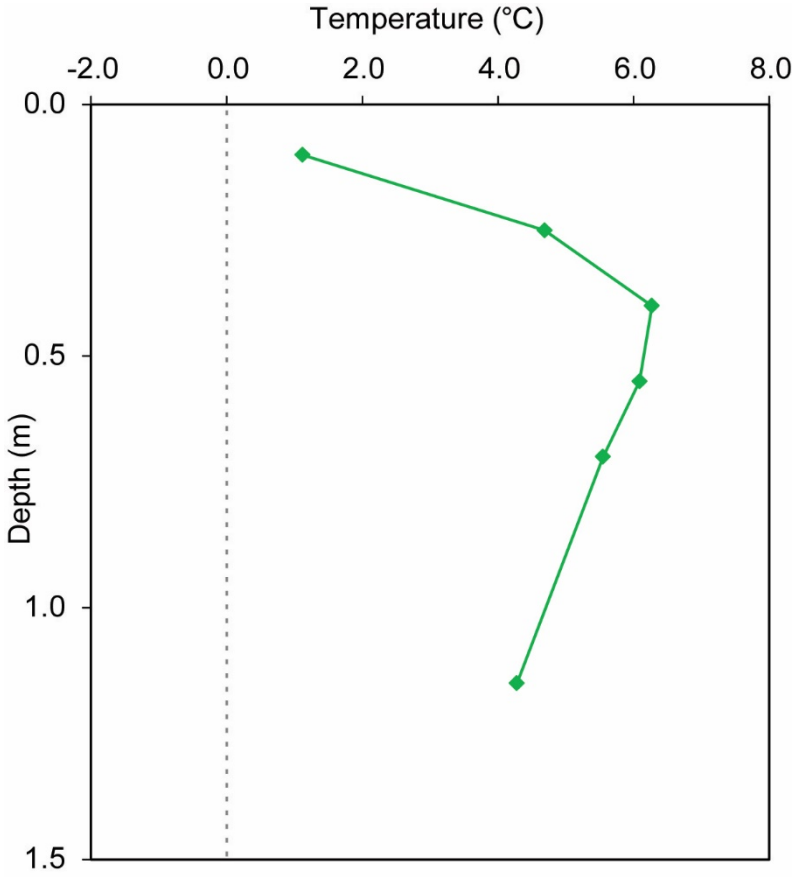
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	5.52	4.22
Oct / 2015	-0.84	0.26
Nov / 2015	-13.78	-1.74
Dec / 2015	-20.77	-5.65
Jan / 2016	-17.85	-6.47
Feb / 2016	-18.86	-7.53
Mar / 2016	-10.30	-5.25
Apr / 2016	-2.52	-2.70
May / 2016	10.12	3.49
Jun / 2016	16.67	9.23
Jul / 2016	17.78	11.94
Aug / 2016	14.49	10.58



KP182 — Top of Slope

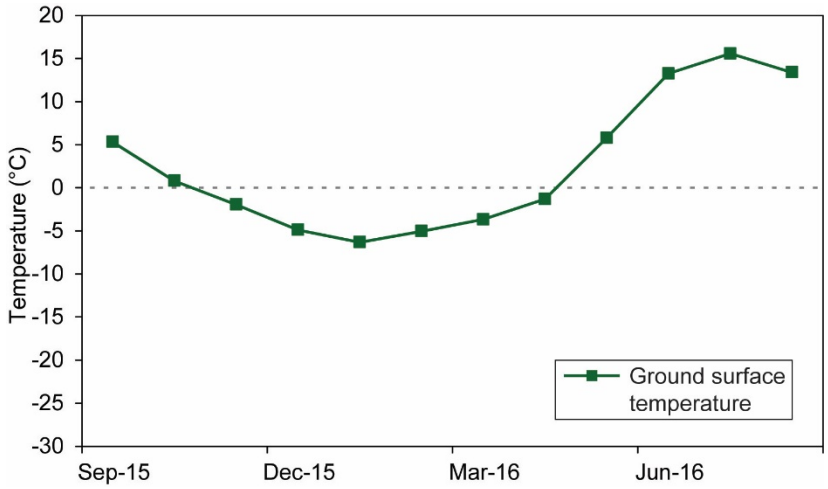
Sahtu Settlement Region

Latitude: 64.28 N Longitude: 124.47 W
Elevation: 144 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Forested (recovering burn, burned 1994)- Aspen, willow, birch, tamarack
Thaw Depth: n/a
Site visit: September 25, 2016



Depth (m)	Temp (°C)
0.1	1.12
0.25	4.69
0.4	6.27
0.55	6.09
0.7	5.55
1.15	4.28

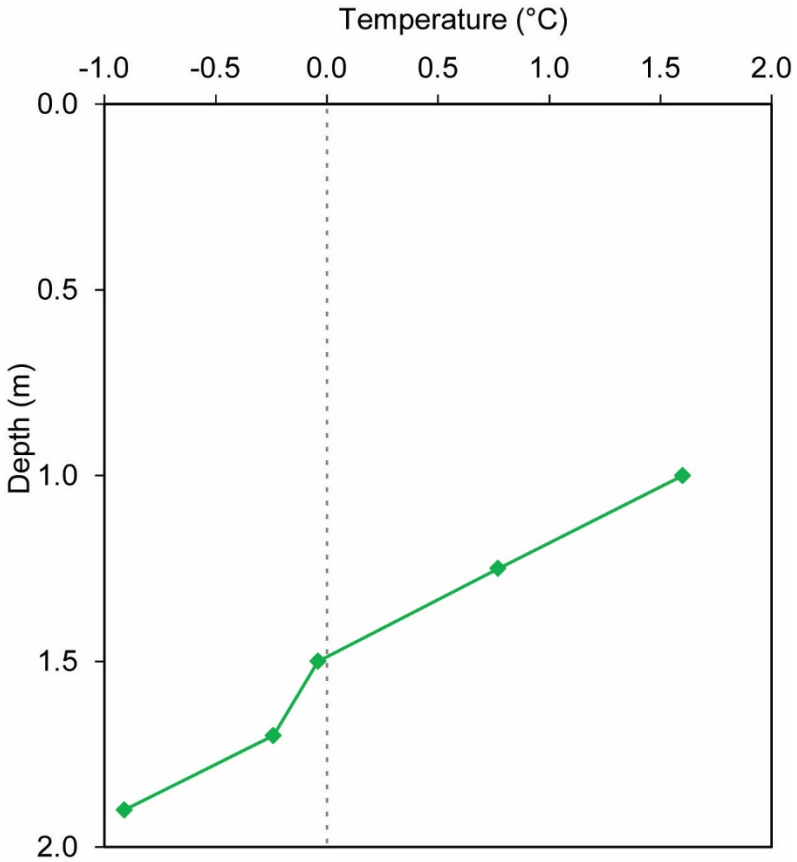
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	n/a	5.31
Oct / 2015	n/a	0.79
Nov / 2015	n/a	-1.94
Dec / 2015	n/a	-4.88
Jan / 2016	n/a	-6.31
Feb / 2016	n/a	-5.04
Mar / 2016	n/a	-3.68
Apr / 2016	n/a	-1.31
May / 2016	n/a	5.80
Jun / 2016	n/a	13.26
Jul / 2016	n/a	15.58
Aug / 2016	n/a	13.40



KP182 Unburnt

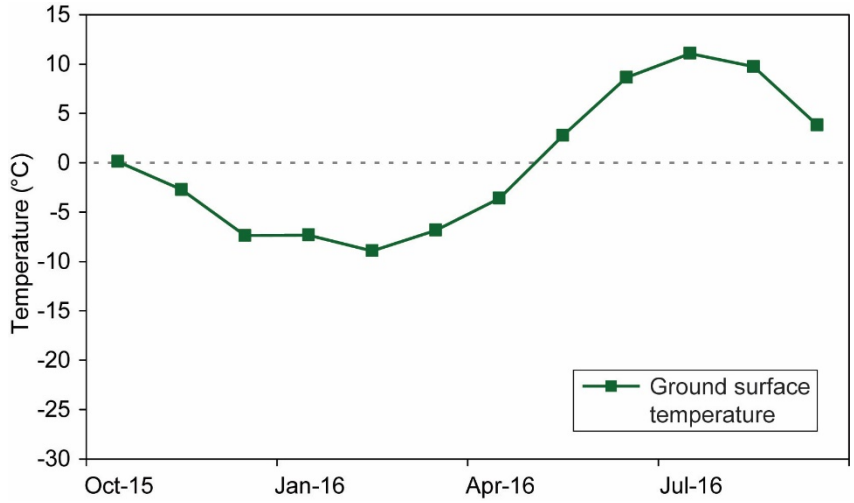
Sahtu Settlement Region

Latitude: 64.28 N Longitude: 124.47 W
Elevation: 200 m a.s.l.
Landform: Lacustrine plain
Vegetation cover: Forested - white spruce, white birch with black spruce, moss and peat ground cover
Thaw Depth: 1.48 m
Site visit: September 25, 2016



Depth (m)	Temp (°C)
1	1.6
1.25	0.77
1.5	-0.04
1.7	-0.24
1.9	-0.91

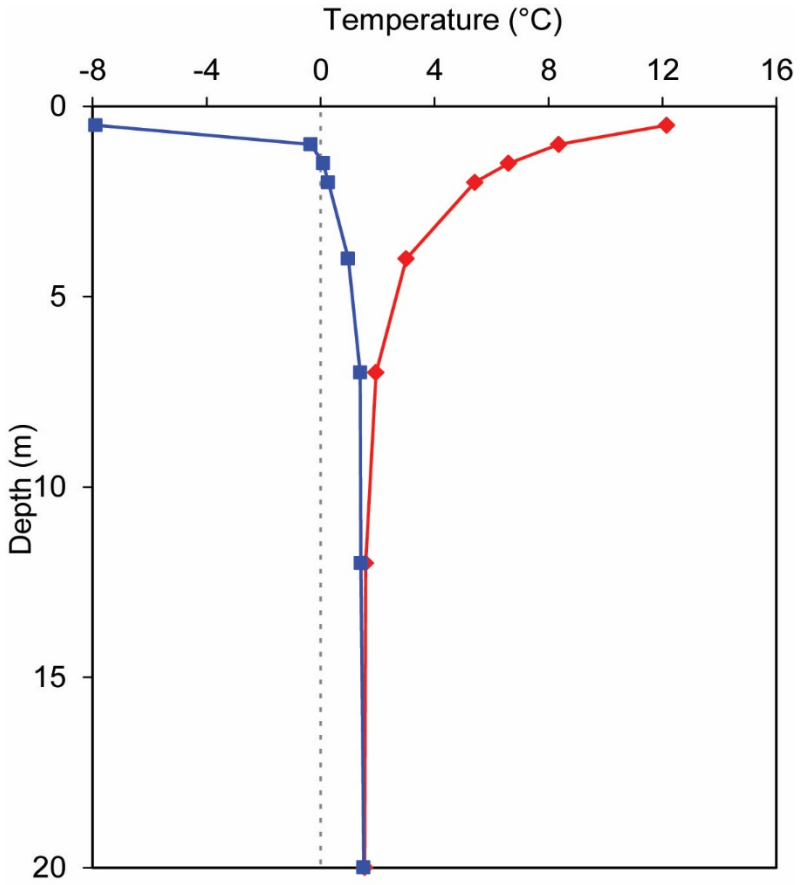
Month / Year	Temperature (°C)	
	Air	Surface
Oct / 2015	n/a	0.11
Nov / 2015	n/a	-2.72
Dec / 2015	n/a	-7.39
Jan / 2016	n/a	-7.33
Feb / 2016	n/a	-8.94
Mar / 2016	n/a	-6.84
Apr / 2016	n/a	-3.60
May / 2016	n/a	2.75
Jun / 2016	n/a	8.64
Jul / 2016	n/a	11.06
Aug / 2016	n/a	9.73
Sept / 2016	n/a	3.81



Steep Creek Top — Steep-02

Sahtu Settlement Region

Latitude: 64.18 N Longitude: 124.38 W
Elevation: 134 m a.s.l.
Landform: Alluvial and colluvial, north facing slope of stream valley (site at edge of cleared right-of-way)
Vegetation cover: Mixed, white spruce, jackpine, aspen, birch
Thaw Depth: n/a
Site visit: September 24, 2016

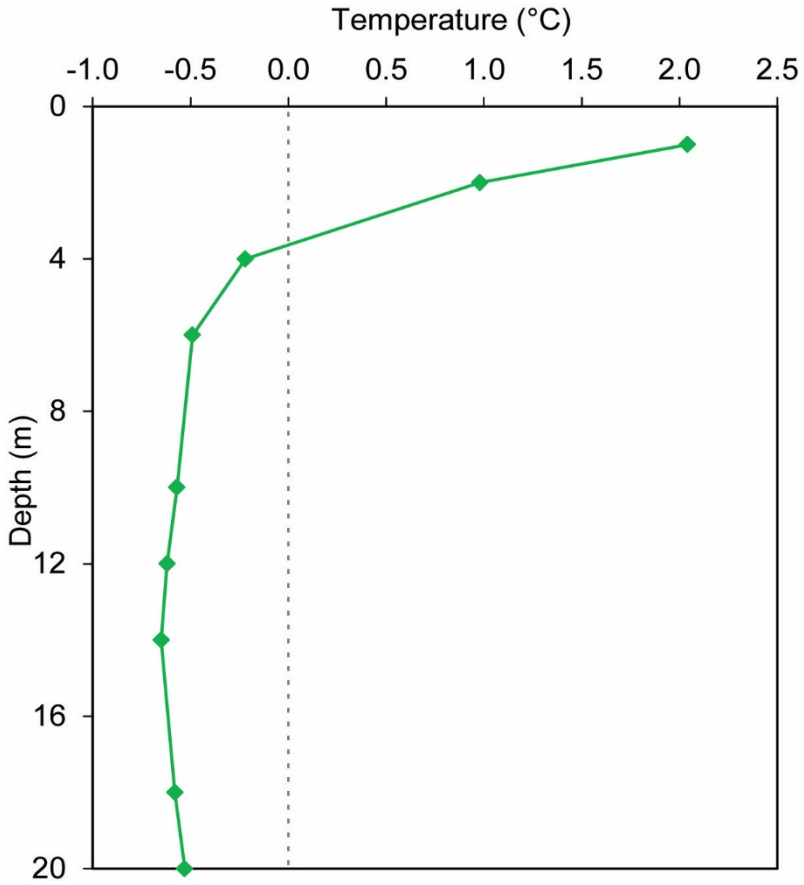


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	12.15	-7.89
1	8.36	-0.34
1.5	6.60	0.09
2	5.41	0.27
4	3.01	0.97
7	1.95	1.40
12	1.58	1.42
20	1.55	1.52

85-7A-HA108

Deh cho Settlement Region

Latitude: 63.61 N Longitude: 123.64 W
Elevation: 255 m a.s.l.
Landform: Ground moraine
Vegetation cover: Lichen, moss, ericaceous shrubs with black spruce and alder
Thaw Depth: 2.93 m
Site visit: September 24, 2016

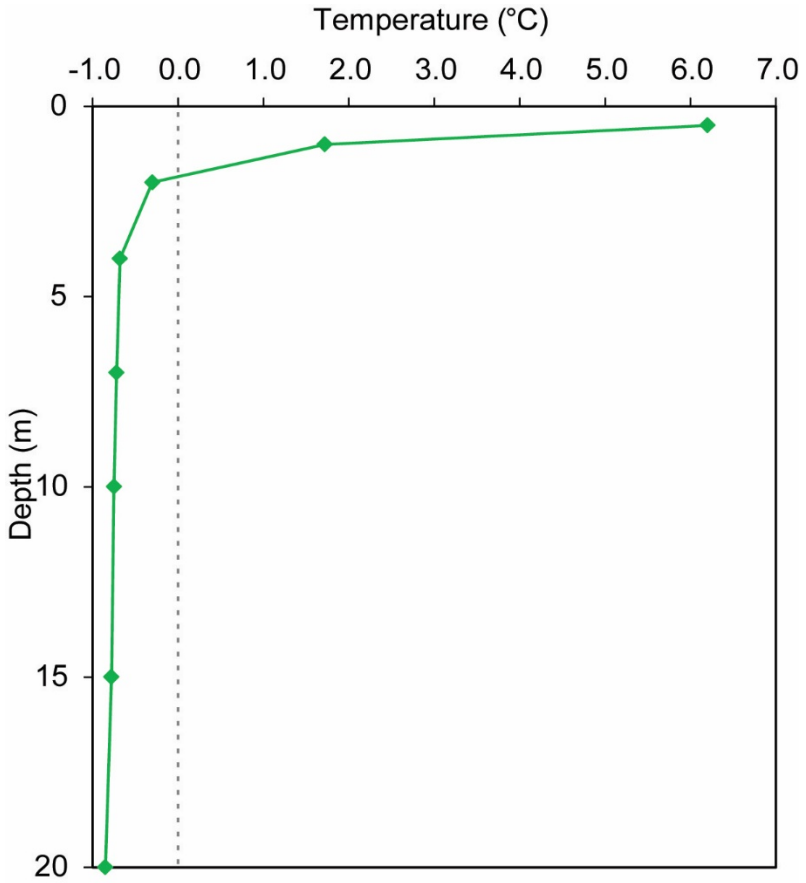


Depth (m)	Temp (°C)
1	2.04
2	0.98
4	-0.22
6	-0.49
10	-0.57
12	-0.62
14	-0.65
18	-0.58
20	-0.53

KP313 T2

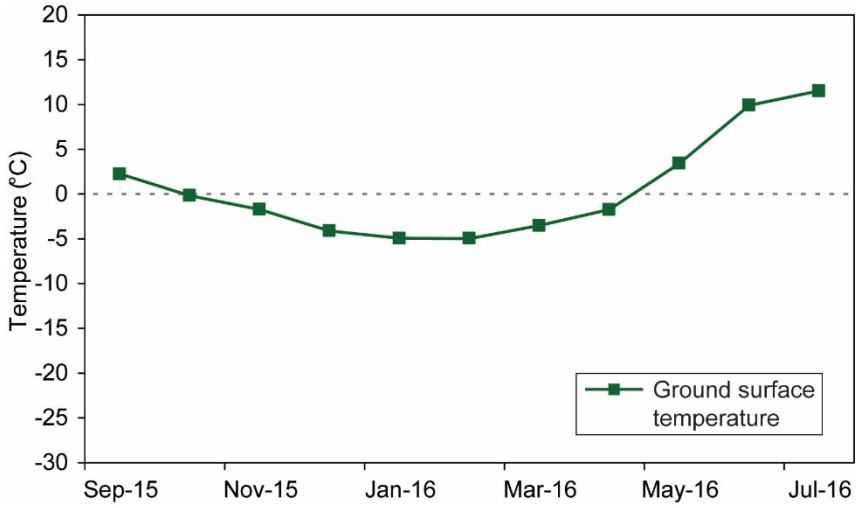
Deh cho Settlement Region

Latitude: 63.26 N Longitude: 123.43 W
Elevation: 250 m a.s.l.
Landform: Lacustrine plain, bottom of slope
Vegetation cover: Moss cover and peat, forested, mix of birch and spruce
Thaw Depth: 1.19 m
Site visit: September 24, 2016



Depth (m)	Temp (°C)
0.5	6.2
1	1.72
2	-0.3
4	-0.68
7	-0.72
10	-0.75
15	-0.78
20	-0.85

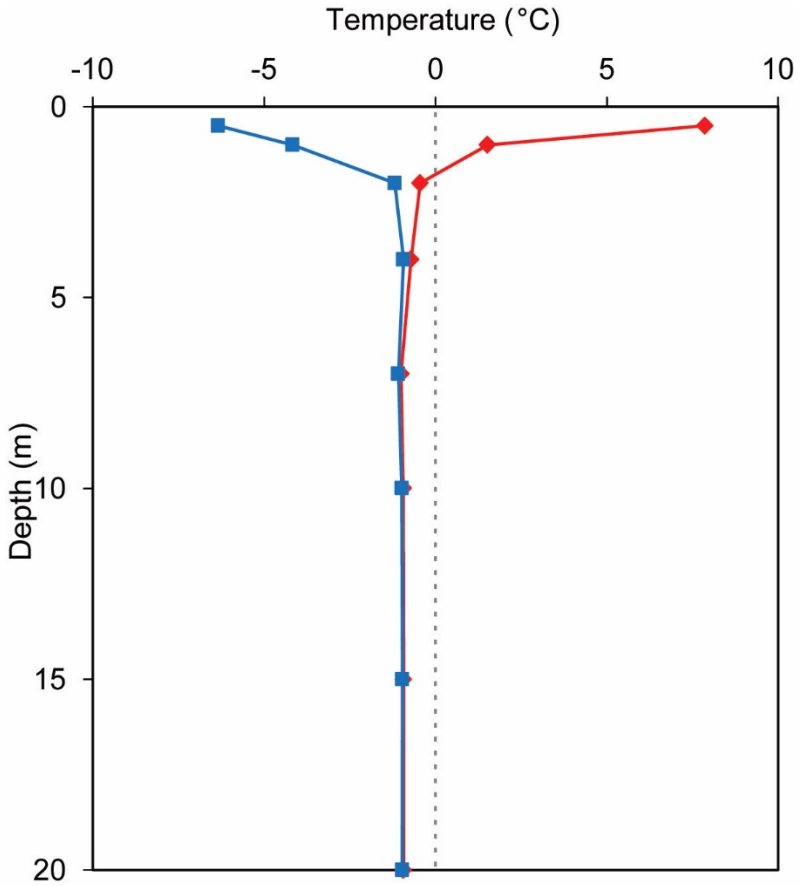
Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	n/a	2.24
Oct / 2015	n/a	-0.17
Nov / 2015	n/a	-1.72
Dec / 2015	n/a	-4.13
Jan / 2016	n/a	-4.95
Feb / 2016	n/a	-4.97
Mar / 2016	n/a	-3.51
Apr / 2016	n/a	-1.75
May / 2016	n/a	3.41
Jun / 2016	n/a	9.91
Jul / 2016	n/a	11.52
Aug / 2016	n/a	9.33



KP313 T4

Deh cho Settlement Region

Latitude: 63.26 N Longitude: 123.43 W
Elevation: 250 m a.s.l.
Landform: Lacustrine plain, mid slope, W side of ROW
Vegetation cover: Moss cover and peat, forested, mix of birch and spruce
Thaw Depth: 1.12 m
Site visit: September 24, 2016

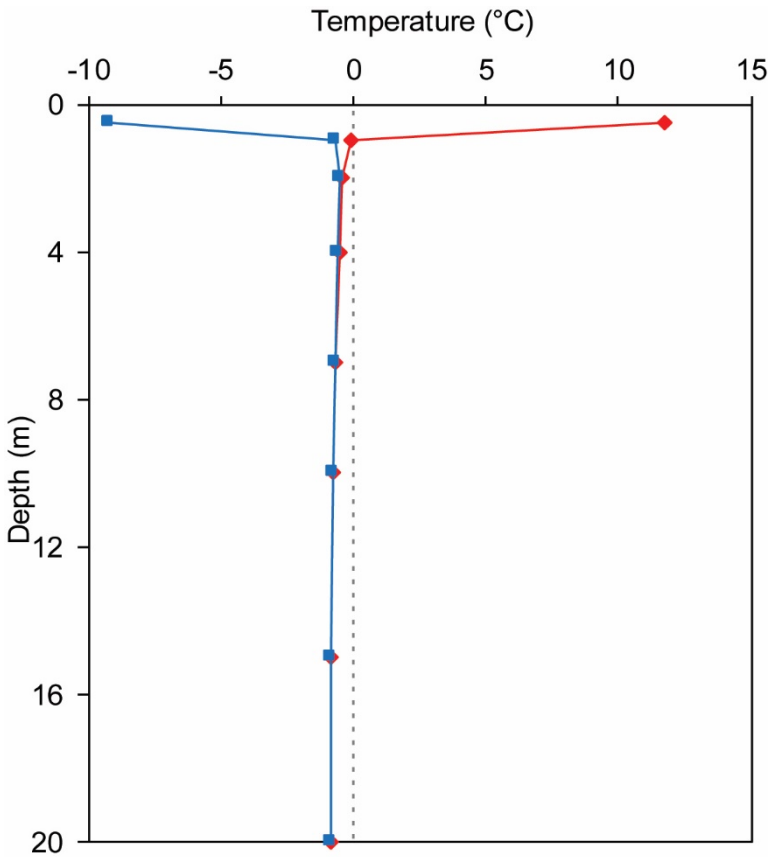


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	7.86	-6.35
1	1.52	-4.17
2	-0.45	-1.19
4	-0.72	-0.93
7	-1.00	-1.09
10	-0.94	-0.98
15	-0.93	-0.97
20	-0.93	-0.97

KP313 T5

Deh cho Settlement Region

Latitude: 63.26 N Longitude: 123.43 W
Elevation: 250 m a.s.l.
Landform: Lacustrine plain, mid slope, E side of ROW
Vegetation cover: Moss cover and peat, forested, mix of birch and spruce
Thaw Depth: 1.00 m
Site visit: September 24, 2016

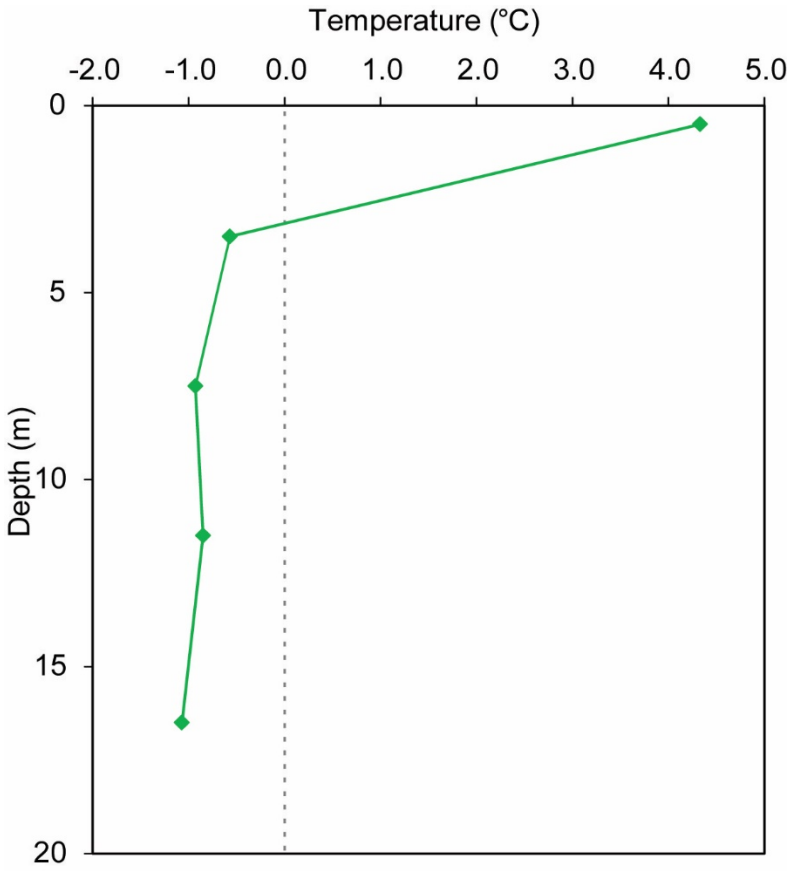


Sep 2015 – Aug 2016		
Depth (m)	Max (°C)	Min (°C)
0.5	11.77	-9.17
1.0	-0.04	-0.69
2.0	-0.41	-0.52
4.0	-0.52	-0.60
7.0	-0.64	-0.67
10.0	-0.75	-0.79
15.0	-0.85	-0.86
20.0	-0.82	-0.82

KP313 T6

Deh cho Settlement Region

Latitude: 63.26 N Longitude: 123.43 W
Elevation: 250 m a.s.l.
Landform: Lacustrine plain, top of slope
Vegetation cover: Thin moss and organic cover, forested, mix of birch and spruce
Thaw Depth: 3.15 m
Site visit: September 24, 2016



Depth (m)	Temp (°C)
0.5	4.33
3.5	-0.57
7.5	-0.93
11.5	-0.85
16.5	-1.07

Month / Year	Temperature (°C)	
	Air	Surface
Sept / 2015	n/a	3.99
Oct / 2015	-1.37	0.31
Nov / 2015	-14.87	-2.33
Dec / 2015	-21.44	-4.44
Jan / 2016	-18.68	-5.25
Feb / 2016	-17.93	-5.32
Mar / 2016	-9.20	-3.30
Apr / 2016	-2.20	-1.07
May / 2016	9.44	5.21
Jun / 2016	17.01	12.48
Jul / 2016	17.67	14.50
Aug / 2016	14.77	12.82