Northern Cross (Yukon) Limited
Eagle Plain Matting Test Report
Vegetation, Soil and Permafrost Monitoring Results

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Submitted: May 5, 2010

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Reference:	**Land Use Application at Camp 204, Eagle Plains, Yukon** Permit Issue Date: April 25, 2008; extended March 2, 2009 until June 23, 2011
Test Period:	**April 2008 to September 2009**
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Acknowledgement:

Portions of this report are extracted and adapted from Interim Reports prepared for NCY by EBA staff Whitehorse, including Richard Trimble, Jack Dennett, Chris Jastrebski, and David Scott-McQuinn; Project design was by Peter Moignard in collaboration with environmental scientists at EBA Edmonton.

IMPORTANT NOTE and LIMITATIONS OF TEST

This project was designed to be a static test of matting application on Eagle Plain, Yukon, terrain without operational traffic or weight applied on the static mat surface. It is emphasized that such a static test was not expected to provide comprehensive results which would define the response of vegetation and the upper active layer to dynamic loading and transit of heavy trucks and equipment under normal oilfield operating conditions during the drilling of a well. The observations and conclusions of this study are consequently limited in their value in predicting the specific response of vegetation and surface soils to dynamic, operational loading and traffic conditions on the matting surface.

SUMMARY of OBSERVED RESULTS of MATTING TEST

When applied to vegetated terrain in the Eagle Plain, Yukon, and under static no-load conditions:

- wooden mats had no affect on seasonal temperature variation in the active layer or on the vertical position of the base of the frozen ground. While perennial permafrost was not monitored due to drill-hole depths, the active layer temperature provided convincing evidence that permafrost was unaffected by matting;
- sensitive vegetation such as lichens under matting was affected by crushing in small areas where surface contact between vegetation and the mat base occurred. This was the most significant damage caused by the matting test;
- light deprivation for a summer growing season did not affect recovery of most individuals or populations, provided they were not physically crushed;
- the study duration of 15 months and one complete growing season was adequate to determine seasonal temperature profile response in the active soil layer under matted and non-matted conditions;
- in less than one full growing season, field observations allowed determination of the extent of vegetation damage, and showed that recovery of all species except those cut or crushed had commenced to some extent; the length of time required for recovery, or whether injured populations may be replaced by pioneer species is still uncertain.

INTRODUCTION

Northern Cross (Yukon) Limited (NCY) retained EBA Engineering Consultants Ltd. (EBA) to jointly develop a field program with NCY for monitoring the effects of laying industrial wooden matting on typical Eagle Plain terrain to assess the affects on the soil, permafrost and vegetation. NCY considered that the use of wooden mats may reduce the potential impact of access to and operation of drill sites at Eagle Plains. EBA was to provide permafrost, soil and vegetation expertise to evaluate the proposed use of mats for access to exploratory oil and gas well sites in the Eagle Plains area, Yukon.

NCY is committed to conducting a drilling program in Eagle Plains in a manner which allows drilling operations in locations remote from existing access trails, so the testing of matting as one method of mitigating environmental impact was proposed for evaluation.

Wooden access mats have been used in other jurisdictions, such as Alberta, B.C., NWT in Canada and at various locations in Alaska to reduce ground surface disturbance. A variety of surface conditions including muskeg, swamp, coastal wetlands, soft soils and sand have all been matted to allow access by heavy equipment for haulage and drilling operations; Spring, summer and fall seasonal ground conditions access using mats has had favourable results. This test set out to evaluate the specific effects of wooden mats on vegetation, active layer soils and permafrost in the Eagle Plain so that NCY's operations could integrate the use of matting where appropriate to its operations, and understand the environmental effects of matting, both positive and negative, in order to conduct its operations with mitigation measures based on real and applicable test data.

The original NCY matting program is outlined in a report (EBA, February 2008) included in the 2008 Summer Drilling Program submission to YESAB (February 15, 2008); that program was set out based on the best understanding of matting use that NCY had at the time of the submission, before the data was available from this matting test.
NCY tried to anticipate potential environmental response and worked with EBA's soil and vegetation scientists to design operational practices which might reduce potential impacts associated with the physical deployment of wooden mats, but the actual impact of the mats on vegetation, soil and permafrost was unknown for Eagle Plain.
Accordingly, NCY initiated a test program to monitor the impact of mat placement at Camp 204 (situated at km 325 on Dempster Highway, Yukon) (Figure 1) in late April 2008. The test matting site is located at the north-eastern edge of Camp 204, which is presently used by NCY as a staging area under a current land use permit issued by the Yukon Government.

The access mat test program was principally designed to evaluate the condition of vegetation before and immediately after mat removal, then to monitor recovery of any vegetation damage incurred. It was also designed to compare the difference between temperature profiles under mats with those at control stations over all seasons for a period long enough to see if the active soil layer or permafrost depth was negatively affected, and if so, what was the period required for recovery.

Further site visits were proposed to collect field data until it was evident that effects and recovery cycles were reasonably well understood, then to produce a report interpreting the results and setting out conclusions and recommendations.

BACKGROUND

As part of the original study, mat placement at the access mat test site at Camp 204 and three operational drilling sites was proposed during the 2008 summer season. The 2008 summer drilling program was postponed and this report addresses an access mat test installation at the Camp 204 site only. The monitoring program for access mat placement focused on three key areas of study: structural (soil), thermal (permafrost) and biological (vegetation). The Camp 204 test mat program was designed to test the effects of mat placement for two specific applications: matting on snow-covered ground and matting on ice-covered ground. The test program was proposed by Northern Cross (Yukon) to emulate mat placement on a winter trail during late winter or early spring to reduce maintenance and potential impact.

OBJECTIVES

The objectives for this study and monitoring program for a wooden mat test site at Eagle Plain were set out in NCY's application for a Land Use Permit for the Camp 204 matting test site dated April 2, 2008. The LUP for the Camp 204 area was issued on April 25, 2008, and extended on March 2, 2009; Expiry is June 23, 2011. The objectives set out for the LUP for the matting test in the Land Use Application letter were:
"Objectives of Mat MONITORING

> *The goal of the mat monitoring program is to provide soil and vegetation information to aid NCY in minimizing impacts related to the use of wooden mats. To meet this goal there are a number of objectives:*
>
> - *Evaluate the response of vegetation communities to matting*
> - *Evaluate the response of the active soil layer in relation to matting*
> - *Evaluate the response of permafrost depth and temperature*
> - *To interpret the observed responses to determine best practice for matting in the Eagle Plains, Yukon.*
>
> *At the Camp 204 site, four (4) mats will be installed in total.*
>
> *One set of 2 mats will be over snow and a second set of 2 mats will be over iced snow. This test will expand the data collected to meet our goal by investigating the responses when mats are laid in the late winter and early spring. The other evaluations to meet NCY's objectives will involve summer and late summer matting events."*

SPECIFIC OBJECTIVES

The goals of the test program at the Camp 204 site were specifically:
1. To observe and record environmental conditions before and following mat placement, then to interpret the data and prepare conclusions and recommendations regarding the effects of mat use in Eagle Plain.

2. To determine, if possible, if there were any measurable long-term effects to the environment due to mat placement and the temporal nature of these effects (i.e., if any effects are long-term or residual).

3. To further the understanding of the response of the soil, the vegetation, the active layer and permafrost in Eagle Plain to wooden mat installation.

4. To monitor and record environmental variables directly affected by matting, including:
   - vegetation population health
   - vegetation species changes
   - soil active layer and permafrost response
   - soil compaction

5. To evaluate whether there were differences where, prior to mat installation:
   i. Heavy watering of the ground surface to form an ice layer occurred; or
   ii. The ground surface was snow covered.

   The intent here anticipated that mat installation for summer use may be initiated in the spring to allow winter operations on frozen ground to proceed through into summer on matted surfaces.

The intent was to record field data over a period of time sufficient to interpret the data to provide recommendations for the design of planning and mitigation options for future matting applications. Through the evaluation and interpretation of the response to the matting application, conclusions drawn from this baseline data will aid in determination of best practices for terrain management during operations at Eagle Plain.

The initial concept behind this monitoring program was to generate a set of scientific data that could provide a knowledge base for the planning of operations requiring travel of vehicles and equipment across Eagle Plain terrain.

Early expectations of NCY were that this could be achieved by collecting data during the use of mats at three LUP sites issued for summer drilling operations at three locations along the Dempster Highway, but those wells were delayed for other reasons. The monitoring program planned for the access to those sites (EBA, February 2008) was modified to apply to the simple static installation of mats in this smaller mat test application at Camp 204 on the Dempster Highway (see IMPORTANT NOTE at beginning of this report).

METHODS AND WORK SUMMARY

The access mat test program was designed with three phases:
1. Baseline assessment of environmental conditions prior to mat placement;
2. Assessment of environmental conditions immediately following mat removal;
3. Subsequent assessments to monitor environmental conditions for rate of recovery and long-term effects, if any.

The test area is located on natural ground next to an abandoned borrow site (Camp 204) at about km 325 on the Dempster Highway. Conditions at the site are similar to that expected at proposed well sites and access roads. Site visits were undertaken to set-up the site, characterize vegetation and terrain in different seasons and as time elapsed, download soil temperature data from thermistor probes and also download meteorological data from the on-site weather station. Details of the work completed at the site are summarized on Table 1. Preparation of the test mat site included limited brushing/tree removal, snow compaction by snowmobile and preparation of simulated ice-road conditions. One of the two test-mat sites was prepared to simulate ice-road conditions by adding water to the snow pack. Water was sourced from the Eagle River and delivered by a water truck contracted from Eagle Plains Lodge. Kryotech Arctic Innovations (KAI) was retained by NCY to hand-drill boreholes for thermistor cable installation. KAI also installed EBA-manufactured thermistor cables and NCY's button type (*i*-Button) thermistors to monitor ground temperature at tubing-lined borehole locations at the test site. EBA thermistor cables, data loggers and switch boxes are capable of providing readings without recovery from the boreholes, so they were installed to collect ground temperature data from the cable monitoring sites located directly beneath the access mats. The *i*-button strings must be directly accessed individually to be read, so they were installed as controls and to monitor temperature "edge-effects" adjacent to each mat.

SITE VISITS and ACTIVITY LOG

Table 1

April 8-9, 2008

- Site preparation (snow compaction, tree removal, addition of water for simulated ice-road conditions).
- Initial vegetation/site survey.
- Initial soil information collection
- Drilling of shallow boreholes for thermistor placement, and installation of PVC liners.
- Thermistor cable installation for under mat, edge and control locations.
- Access mat placement.

May 6-8, 2008

- Install NCY *i*-Button strings, and commence thermistor readings.
- Install dataloggers on EBA-manufactured thermistor cables (installed April 8-9) and commence under-mat thermistor data collection.

May 27-28, 2008

- Install weather station and initial data collection.
- Download thermistor data from all i-Button strings.
- Download from EBA thermistor cables connected to re-installed data-logger switch boxes (which had failed due to damaged cables).

June 1, 2008

- Thermistor cable data logger switch boxes found to have damaged wiring.
- Switch boxes with data loggers removed for repair.

September 5, 2008

- Removal of access mats.
- Second Vegetation Survey, including photographic documentation of vegetation condition.

September 29, 2008

- Retrieve data from weather station;
- re-install ground temperature cables and data loggers;
- soil assessment and percolation test at north end of Camp 204 site.

July 18, 2009

- Third Vegetation Survey, including photographic documentation of vegetation condition.
- Download thermistor data from all i-Button strings.
- Download from EBA thermistor cables connected to re-installed data-logger switch boxes
- Attempt to download HOBO weather station data.

August 5 & 7, 2009

- Camouflage of EBA thermistor cables and data-logger switch boxes.
- HOBO weather station fixed and returned to service.

The original access mat monitoring methods prescribed in the monitoring plans (EBA memo, dated March 4, 2008- Schedule 1) designed for monitoring the full program of drilling at 4 large area well sites were not entirely applied in this test program at the Camp 204 site because no operations were in progress on the mats during this static test, so loading or rocking of the mats did not occur, except for brief traffic by the front-end loader and a fully-loaded water truck. However, the mats were left in place for at least the period required to prepare a drill site and drill a well and test it, so the effect of mat cover on the vegetation and active layer temperatures was the principal accomplishment of this Mat Test Application Study.

OBSERVATIONS

Site characterization commenced with a preliminary vegetation survey; 0.5 m of snow was cleared from an area of approximately 1 square metre, and plant species, condition and abundance were assessed.
Over the area where the mats were to be installed, packing by snowmobile and tramping by foot reduced the natural snow depth of 0.5 m to 0.6 m to about 0.1 m to 0.15 m. The site was then marked out for installation of four (4) mats in sets of 2, with one set to be laid on tamped snow and the other set to be installed over watered snow.
A small existing trail was used to access the natural area which had been selected to place the test mats. Additional mats were used on the short access trail to protect the ground during placement of the test access mats. Figure 4 shows the final access mat placement locations.

After site preparation, mat placement sites were located and shallow holes were drilled into soil and permafrost for placement of EBA thermistor cables. Thermistor cables were placed in PVC tubing istalled into the boreholes and sealed to prevent water entry from above. Watering of the “ice-road” simulation mat set was then carried out, and consisted of application of about 25-30,000 litres by hose from the Eagle Plains Hotel water truck. Mat placement was directed by Peter Moignard of NCY on April 8 and 9, 2008. A Caterpillar 966 wheel loader with a fork attachment was used for mat placement and removal. For mat transport and placement, chains attached to fixed rings on the mats were hooked by the loader for transport and vertical placement. Repositioning of mats was done with vertical movement; in order to reduce the probability of ground disturbance during placement of the access mats. A small careful horizontal slide of the mats on the snow or ice to abut them was necessary, but no gouging of the ground surface was permitted.

Photographs are included after Figure 4 (at the end of this written report) to illustrate the mat placement layout, operations to install and remove the mats, thermistor installation locations and vegetation response to matting.

VEGETATION ASSESSMENT

The vegetation monitoring program consisted of characterization of the vegetation species and plant health and composition both prior to mat placement and immediately following mat removal. Subsequent proposed vegetation inspections (three weeks after mat removal and at the end of the summer growing season in the year following mat removal) were completed. Initial characterization of the vegetation species, plant health and composition was carried out on April 8, 2008 by David-Scott McQuinn (EBA). Winter conditions (snow cover) at the site precluded a thorough characterization of vegetation; however, dormant ground-cover plant species were recorded by exposing a 1 square metre area of ground beneath the 0.5 m snow cover in a snow-pit located about 20 m northeast of the northeast corner of the compacted-snow test mat site. This assessment of ground vegetation was performed in conjunction with a 25 square metre plot to record tree and bush vegetation. The foregoing assessment was completed to contribute to baseline data that could be used to monitor changes in composition and health over the life of the matting application. Vegetation species are listed in Table 2 and field notes are included as Appendix A. Regional vegetation consists of glade spruce in heavy permafrost areas, white spruce and paper birch in moderately-well to well drained sites, some balsam poplar and aspen in floodplain and riparian areas, heavy moss and lichen growth resident as ground cover understory of shrub willow, open and forest fringe areas of willow and scrub birch, and various flowering plant species. On September 5, 2008 the mats were removed from the test site; David-Scott McQuinn of EBA monitored mat removal and completed the second vegetation assessment. Minimum daily air temperatures were below 0degC and vegetation was in pre-winter dormancy.

Table 1 compares the species list from the April 8, 2008 Initial Assessment and September 2008 site visits.

A greater level of detail for vegetation response is shown in Table 2, where the detailed vegetation assessment done in September 2008 is compared with the mid-summer detailed assessment conducted by David Scott-McQuinn of EBA in July 2009.

Table 1: Vegetation Species List – Camp 204 Access Mat Test Site, Eagle Plains, YT

PLANT	COMMON NAME	SPECIES	April 8, 2008 site visit	Sept 5, 2008 site visit
1	black spruce	picea mari	x	x
2	bog cranberry	vaccinium oxycoccos	x	x
3	(bog?) blueberry	vaccinium sp	x	x
4	horsetail	equisetum	x	x
5	various grasses	graminoids	x	x
6	sphagnum moss	sphagnum sp	x	x
7	reindeer lichen	cladina sp	x	x
8	"leaf" lichen	peltigera sp	x	
9	northern labrador tea	ledum palustre var.decumbens	x	x
10	dwarf or bog birch	betula sp		x

The general structural condition of vegetation where mats had been placed for about 5 months (April 9 to September 5, 2009) was good. Some minor flattening due to compression in high micro-relief areas was evident. There was no ground disturbance observed, e.g., soil exposure due to gouging, scraping, sliding or other lateral movement (Appendix B – field notes). Insect webs and vole paths (Photo 10) were developed in large parts of the mat placement area, indicating that the access mats provided protected habitat for insects and small mammals. Drill cuttings from thermistor boreholes were observed to have some affect on vegetation underlying the access mats. Apparent bare patches shown in Photo 9 are areas where accumulated drill cuttings have covered vegetation and may impede growth and recovery. In future tests, drill cuttings should be carefully removed as they have compounded effects being observed and slightly reduced the vegetation area available for this study. The vegetation assessment was scheduled at the test site three weeks following access mat removal was postponed to a mid-summer assessment in July 2009 due to the late scheduling of mat removal and the onset of winter conditions.

Field assessment work requirements for the test site were evaluated by NCY in the spring of 2009, and a "punch list" of items that were to be completed on site was prepared and discussed with EBA. Vegetation assessment, thermistor downloads and equipment maintenance was performed by David Scott-McQuinn of EBA in July 2009; Greg Charlie represented NCY on site. NCY considers that the same scientist doing each assessment allowed generation of the most consistent scientific vegetation data possible. The work performed was at the direction of NCY (Peter Moignard). Thermistor dataloggers were exposed to casual visitors, so on August 7th, 2009, Chris Jastrebski of EBA applied camouflage coverings to the cables and boxes when he was correcting problems with the HOBO weather station.

The following tasks were undertaken at the Camp 204 test site on July 18, 2009:

SOIL TEST PITS

A soil pit was dug approximately 3m from control vegetation site No. 2 to record shallow soil conditions at the site. The pit was dug to 75cm below ground surface (permafrost was not encountered) and a soil log is appended to this memo. The location of the soil pit was recorded, and changes in the pit will be documented if any future reporting on the exposed active layer is required.

VEGETATION SAMPLING

The vegetation assessment completed on July 18, 2009, represented observations of recovery after a time period of roughly one (1) full growing season after the vegetation was exposed after mat removal.

As part of the vegetation assessment 6 plots were assessed (2 control plots; 2 plots under snow matting test area; and 2 plots under ice matting test area). At each plot, vegetation species, plant condition, incidences of mortality, breakage, flattening, ground compression and recovery were recorded. As part of the assessment, representative photographs, notes of plots and comparisons between under ice versus under snow matting areas were recorded, with the intent of using this data for summary reporting and overall program assessment. A photographic record of the vegetation and ground condition is appended to this memo, as is a representative plot of photo locations (Figure 1).

The results of all the vegetation field observations are shown in Table 2.

TABLE 2: VEGETATION CONDITION RESPONSE					(PREPARED BY CHRIS JASTREBSKI , EBA WHITEHORSE- JAN 2010)			
		Vegetation Condition / Response Qualitative Indicators				Indices of Vegetation Damage or Recovery (0 = Low to 5 = High)		
Taxonomic Group	Species	Pre-Treatment or in Control Plots		Following Mat Removal (September 2008)	First Growing Season (July 2009)	Physical Damage (breaking, crushing, flattening)	Environmental Damage (Lack of light, temperature, disease)	Recovery Ability (observed level)
	Black Spruce	• Occurs frequently throughout study area with moderate distribution.	Ice Treatment	• Removed by physical means.	• No regrowth.	5	N/A	0
			Snow Treatment	• Removed by physical means.	• No regrowth.	5	N/A	0
	Dwarf Birch (Photo 3)	• Patchily distributed in test plot area.	Ice Treatment	• Bare stems observed, lacking leaves, and pressed to the ground.	• Most large stems still lacking leaves and signs of growth. Some smaller stems live and with leaves, small patches of leaves on larger stems (mostly adjacent to edges of mats)	3	5	2
			Snow Treatment	• Limited number of bare stems observed, lacking leaves.	• Most large stems still lacking leaves and signs of growth. Some smaller stems live and with leaves, small patches of leaves on larger stems.	3	5	2
	Willow (Photo 4)	• Limited and patchy distribution in the test plot area.	Ice Treatment	• Willow beneath mats flattened, leaves absent, and stems bare.	• Larger stems observed to be dead/lacking leaves. Moderate new growth observed from root.	3	5	3
			Snow Treatment	• Willow beneath mats flattened, leaves absent, and stems bare.	• Larger stems observed to be dead/lacking leaves. Moderate new growth observed from root.	3	5	3

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Taxonomic Group	Species	Pre-Treatment or in Control Plots		Following Mat Removal (September 2008)	First Growing Season (July 2009)	Physical Damage (breaking, crushing, flattening)	Environmental Damage (Lack of light, temperature, disease)	Recovery Ability (observed level)
	Labrador Tea (Photo 5)	• Observed frequently in test plot area, ubiquitous species in test area. • Patchy distribution, observed to be healthy in control plots both pre- and post-treatment.	Ice Treatment	• No live specimens observed in test plot areas. • Stalks/stems present, but leaves were all lost or dead/dried.	• Signs of damage still apparent in observed clumps. • Dead stalks still visible, many patches still in damaged condition. • Small, patchy areas of regrowth observed, primarily through new shoots.	2	5	2
			Snow Treatment	• No live specimens observed in test plot areas. • Stalks/stems present, but leaves were all lost or dead/dried.	• Signs of damage still apparent in observed clumps. • Dead stalks still visible, many patches still in damaged condition. • Small, patchy areas of regrowth observed, primarily through new shoots.	2	5	2

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	Blueberry (Photo 6)	• Observed more frequently in the test plot areas compared to control areas (microsite differences).	Ice Treatment	• Specimens of mixed health. • Some observed primarily without leaves, or brown and dormant/dead. • Noticeable patches of small plants that survived beneath the mat structures (in spaces that were not crushed, and where light may have infiltrated).	• Live specimens found in 1 of two plots. Small degree of growth, appears to be from root. • Note: blueberry is a pioneering/post-disturbance species.	1	4	4
			Snow Treatment	• Specimens observed primarily without leaves, or brown and dormant/dead.	• Live specimens observed on both plots, from new shoots. Existing stems dead. • Note: blueberry is a pioneering/post-disturbance species.	1	4	4

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Taxonomic Group	Species	Pre-Treatment or in Control Plots		Following Mat Removal (September 2008)	First Growing Season (July 2009)	Physical Damage (breaking, crushing, flattening)	Environmental Damage (Lack of light, temperature, disease)	Recovery Ability (observed level)
	Reindeer Lichen (Photos 6 and 7)	• Ubiquitous in test area and control area. Forms much of the ground cover (15-25%).	Ice Treatment	• Physical damage observed, but patchy – damage primarily restricted to edge or elevated areas that contacted mats. No noticeable difference from snow treatment. • Due to the stable nature and lack of colour, it was difficult to determine whether other lichen was affected.	• Physical damage to lichen still apparent, with no observable regrowth of affected areas (crush points). • No damage, rotting, or other loss of lichen that was covered by the mat. Appears to be live and out of dormancy.	3	1	3
			Snow Treatment	• Physical damage observed, but patchy – damage primarily restricted to edge or elevated areas that contacted mats. No noticeable difference from snow treatment. • Due to the stable nature and lack of colour, it was difficult to determine whether other lichen was affected.	• Physical damage to lichen still apparent, with no observable regrowth of affected areas (crush points). • No damage, rotting, or other loss of lichen that was covered by the mat. Appears to be live and out of dormancy.	3	1	3

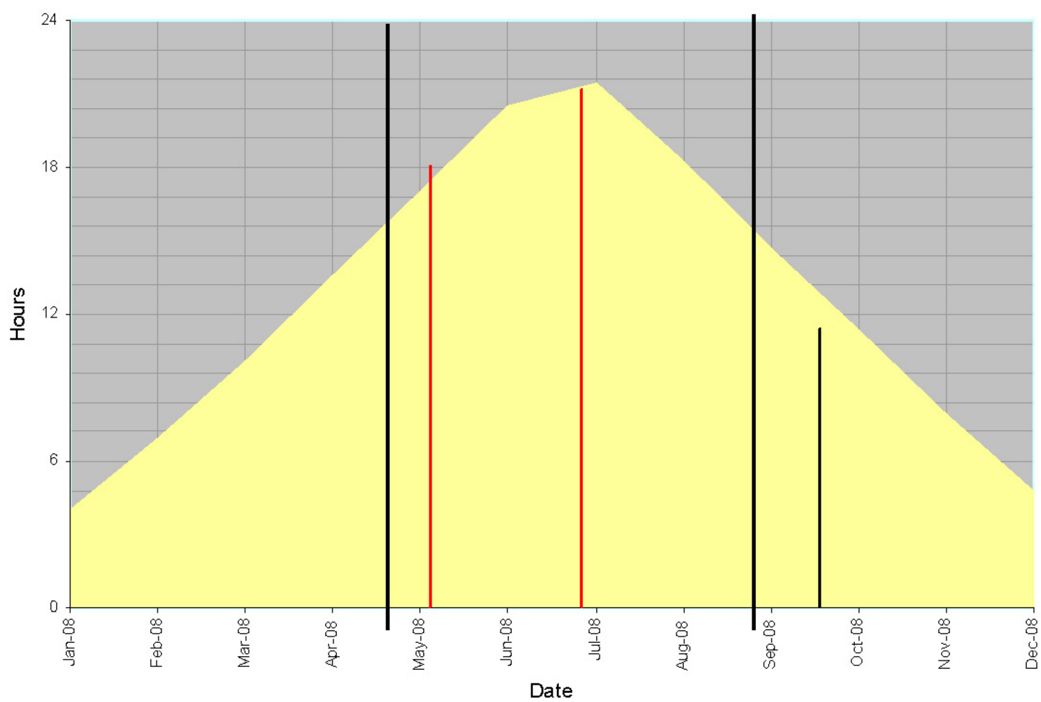
SOIL DESCRIPTION

The typical soil profile in the region consists of ground vegetation, moss, grass, humus and/or peat overlying clayey, sandy silt to gravelly sand-sandy gravel in the active layer and shallow permafrost, overlying weathered bedrock grading to competent bedrock at 0.5 m to 2.5 m. Bedrock is fine to medium-grained, light grey sandstone, siltstone and shale of the Eagle Plains Formation. The site appears to be moderately to imperfectly drained. Lateral flow of near-surface groundwater on the gentle slopes (6% gradient) is slow and standing water was observed in depressions in the micro-topography. Eagle Plains is located in the zone of widespread discontinuous permafrost. Shallow soils are often wet to saturated as groundwater is restricted to the near surface-layer above permafrost with mostly lateral flow and topographically-controlled gradient.

GROUND TEMPERATURE MONITORING: SOIL AND ACTIVE LAYER

General solar influence on terrain surface temperature and the context of the mat installation test and is shown by the plot of annual sunlight data and key test dates and events below:

Date	Event	Interval (days)	Elapsed days	Comment
8-Apr-08	Mats down	0	0	
10-May-08		32	32	Under mats cooler than Summer Ambient
4-Jul-08	June 21 Summer Solstice	55	87	Under mats cooler than Summer Ambient
5-Sep-08	Mats removed	63	150	
1-Oct-08		26	113	
1-Jan-09	Mid-Winter	92	205	
1-Jul-09		181	386	end of test study



Hours of Sunlight at Rock Creek, 100 km north of Camp 204

THERMISTOR PROCEDURE

NCY contracted Kryotek Arctic Innovations ("KAI"- Jim Coates) to drill boreholes with a hand-held heavy duty electric impact drill at various locations across the test mat site for installation of thermistors. Thermistor placement was chosen to monitor directly under the wooden mats, at the mat edge and at control sites located outside the influence of mat placement. The drilling equipment provided by KAI was hand portable with a consequent reduced environmental impact; however, drilling in frozen ground and bedrock was problematic for the light drill equipment, which initially met refusal at depths of about 0.5 m to 0.8 m. KAI subsequently deepened shallow holes and completed drilling of the required holes on a subsequent trip to Eagle Plain with redesigned drill equipment. On April 9, 2008 *i*-Button thermistors and thermistor cables were initially installed at all drilled locations (Figure 4).
EBA considers that the depth capacity of the hand-held drill unit used by KAI was inadequate for optimum installation of the thermistors to produce a full profile of the active layer and permafrost; instrumentation a the desired depth (2-3 m) would have been more definitive, since the bottom thermistors were still within the active layer. However, EBA believes the conclusions reached regarding the temperature profiles are still valid.
Later in April 2008, the EBA thermistor cable switch boxes were found to be inoperative and were retrieved by C. Cowan of EBA and taken to Whitehorse for repair. On May 27, 2008 the repaired thermistor cable switch boxes were returned to the test site and attached to the cables. On May 28, 2008, ground temperature data was downloaded to confirm that the thermistor cables were operative.
A total of eight EBA thermistor cables were installed under mats at the two test matting applications: (four each for packed snow and simulated ice-road applications). i-Button thermistors were placed at three edge effect locations and four control stations in undisturbed areas (Figure 4 and 5).

FIELD DATA DOWNLOADS

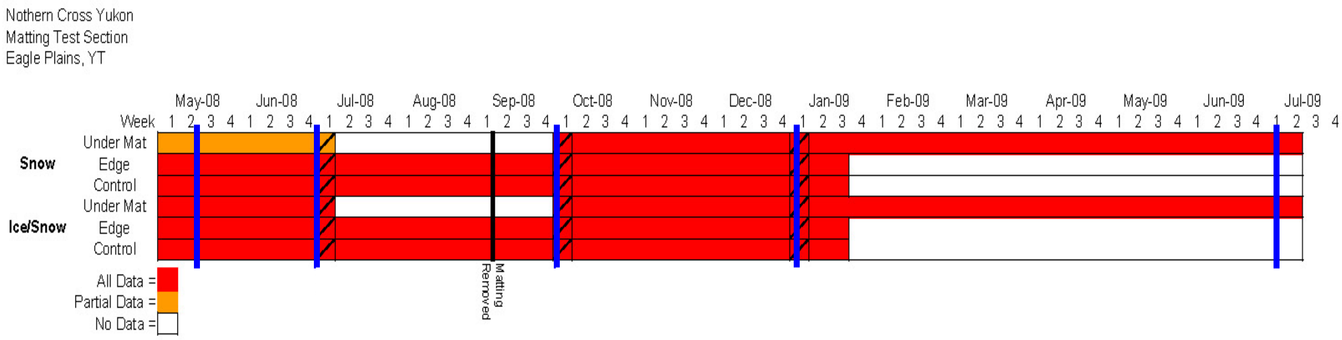
During the on-site program, data was downloaded from the following data loggers at the Camp 204 test site:

- EBA's ground temperature cable boxes
- iButton thermistors
- the Onset weather station

All the thermistor data logger units were successfully downloaded.

Following a review of the i-Button data downloads, it was noted by EBA that the i-Button units had filled their memory capacity by January 17, 2009 and they were not programmed to overwrite their data-log as expected. Consequently, the i-buttons had been unable to record data from January 18 until July 18, 2009 when the i-buttons were downloaded. Because the i-buttons were recording temperature control (TC) data, this required that the EBA thermistor cables be re-assigned as TC stations, since they were now not covered by mats and interpretation of the data presented below shows that the under-mat temperatures were not affected by the presence of the mats to an extent exceeding the range of values within the range of natural variation of the temperature data at the site.

The temperature profiles and discussion of results is presented below.



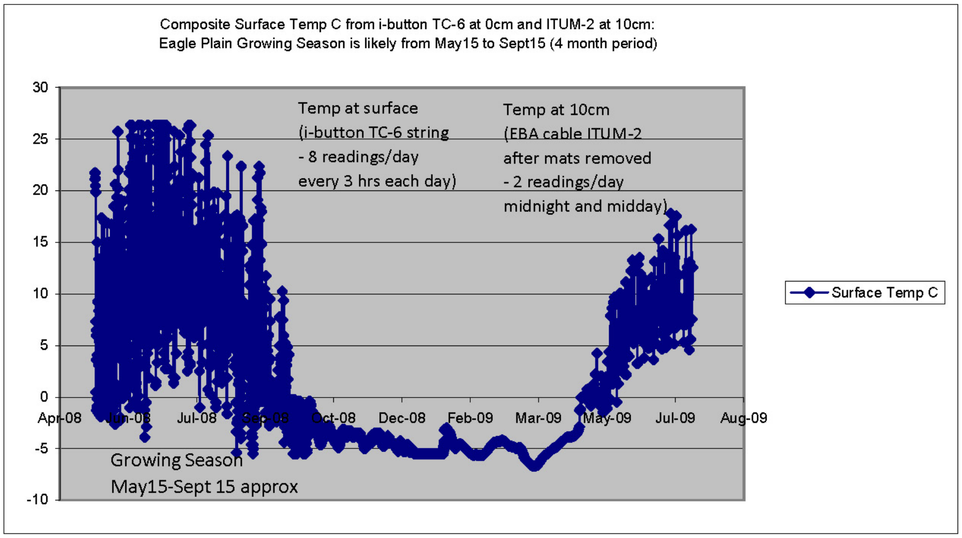
THERMISTOR DATA RECORDING
The diagram above indicates the periods for which thermistor data was recorded in the study, and the locations of the thermistor probes relative to the matting applications.
Plots are presented in the next section for the representative dates shown in blue on the diagram. Note that after the mats were removed in fall, 2008(black line), thermistor readings from sites previously under mats have become normal control profiles by the summer of 2009.

DATA PREPARATION, PLOTS and PRESENTATION
EBA reviewed data from both the NCY *i*-Button units and the EBA thermistor cable loggers, and made adjustments for calibration where necessary.
That data is appended to this technical report as a digital data file in MS Excel format.

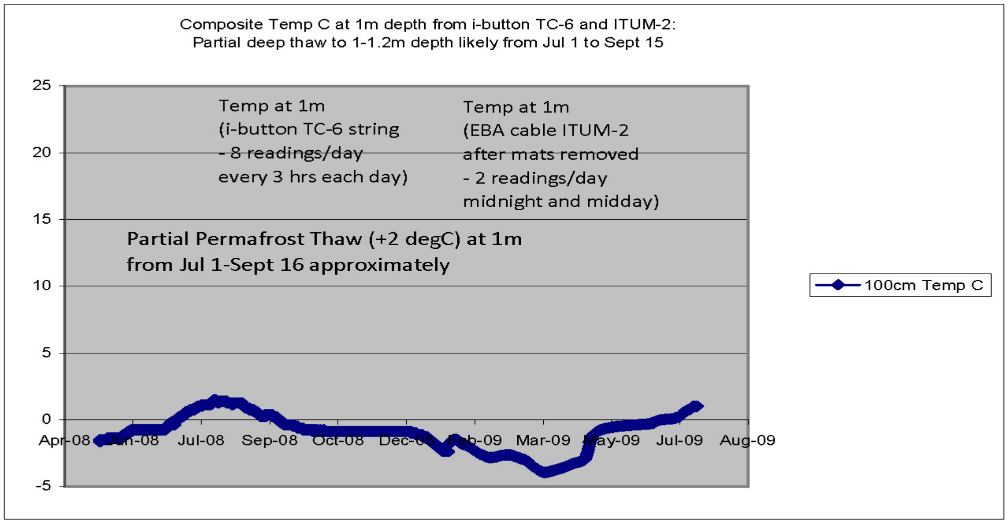
Various temperature-depth profiles have been plotted for select dates within the test period.

TEMPERATURE-DEPTH PLOTS

1. Ground Surface temperature composite plots from thermistors indicate daily temperature variation and the period when soil temperatures are above 0 degC, the period when plant root growth may occur. This plot shows that the Eagle Plain vegetation growing season runs approximately from May15 to September 15 annually.



2. Seasonal Permafrost Profile: The plot below shows that the base of the unfrozen active layer is deeper than 1m (estimated at approximately 1.2m) during mid-summer, and at a depth of approximately 1m for 2 weeks from June until early December. From the first week of December to the first week of June, much of the active layer soil profile is frozen to shallow depths.
This timetable is important for optimizing travel across Eagle Plain terrain without causing deep rutting of soft surface soil layers. Note that the ground surface is frozen from approximately September 15 to May 15 annually. Thermistor profile data shows that surface thaw at the test site had penetrated from frozen at surface on May 15 to thawed active layer soil to a depth of 15-20 cm by June 1st, 2008, a 2 week period
The individual thermistor temperature – depth plots may therefore be used for determination of the approximate depth to top of frozen soil horizons at various times of the year, as well as to determine the effect of matting on the seasonal temperature profile variation by comparison of profiles from matted areas with control station profiles.

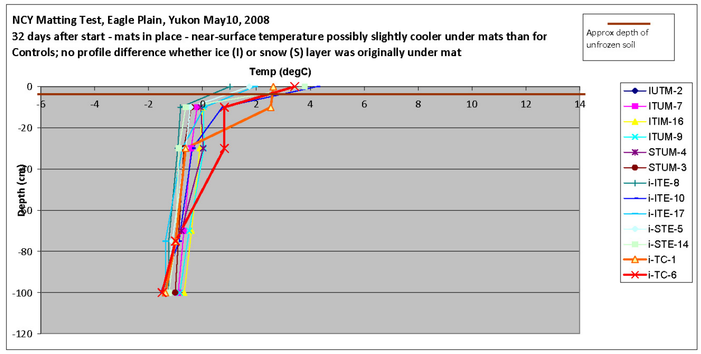


Eagle Plain, Yukon.
Thermistor Data: Camp 204 Test Site

Temperature-Depth Plots

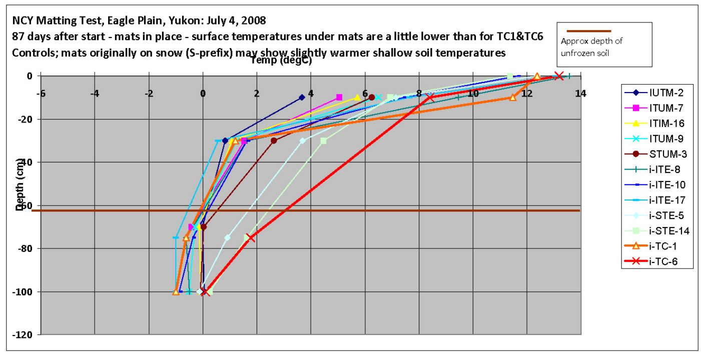
May 10, 2008: MATS - spring

- **Matted areas are slightly cooler than controls**
- **Active layer frozen to near surface (approx 5cm)**



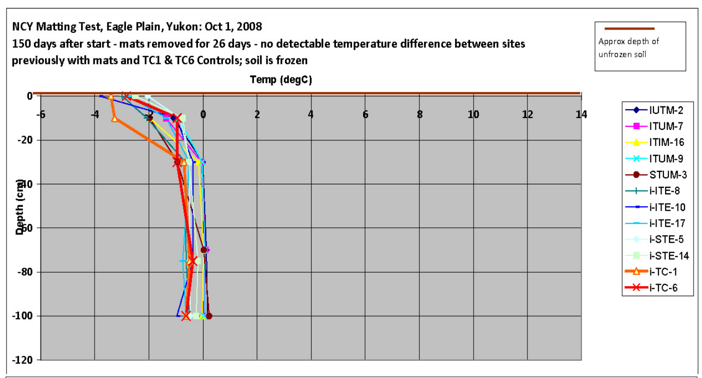
July 4, 2008: MATS - mid-summer

- **Matted areas may be slightly cooler than controls, but range of values includes both. No discernable effect of matting on profile**
- **Active layer thawed to +/- 60 cm**



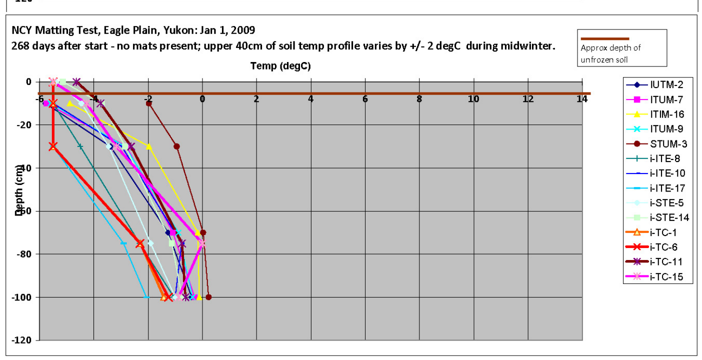
October 1, 2008: NO MATS
late fall-start winter

- **No difference between control and all other stations 1 month after mats removed**
- **Active layer frozen at surface**



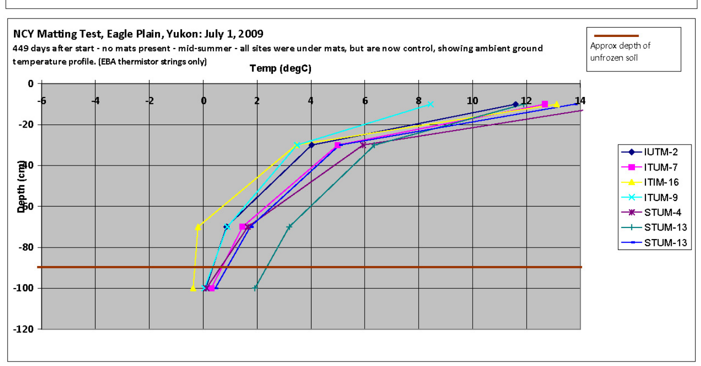
Jan 1, 2009: NO MATS
mid-winter

- **No difference between control and all other stations in middle of first winter following mat removal**
- **Active layer frozen to surface**



July 1, 2009: NO MATS
mid-summer

- **No difference between control and all other stations in middle of first summer following mat removal**
- **Active layer thawed to over 80 cm**



OBSERVATIONS regarding effect of Matting on Active Layer Temperature Profiles

Although EBA considers that the depth capacity of the hand-held drill unit used by KAI was inadequate for optimum installation of the thermistors to produce a full profile of the active layer and permafrost (instrumentation a the desired depth (2-3 m) would have been more definitive) the general conclusions reached by NCY and EBA regarding the temperature profiles in the active layer are still useful and valid. The observations are as follows:

1. The temperature – depth plots when mats were in place show that the average control temperatures (TC-1 &TC-6) are equal to or warmer than the average temperature profiles both under and at the edge of the mats. This means that the mats have had an approximate 2degreeC insulative effect on the underlying active layer soil profile, and tend to suppress the normal seasonal thaw of the lower active layer and underlying permafrost.
2. After the mats were removed, there were no discernable differences in ground temperature between the previously mat-covered locations and the control profile data.
3. There is no difference between the "snow only" and "ice/snow" scenarios. This is most likely due to the rapid thaw of those snow and ice layers as ambient temperature increased. Soil moisture under the “ice” mats did not produce a detectable difference in temperature profiles either.
4. Placement of the mats had no detrimental effect on the permafrost at the test site; if anything, it somewhat protected the permafrost from as great a thaw depth as would have naturally occurred. The mats were generally neutral in their influence on soil temperature.

METEOROLOGICAL DATA

EBA installed a HOBO Onset Weather Station at Camp 204 for NCY on May 28, 2008 (Photo 6). Component instruments making up the weather station are connected to a data logger to record baseline environmental conditions at 15 minute intervals for the following parameters:

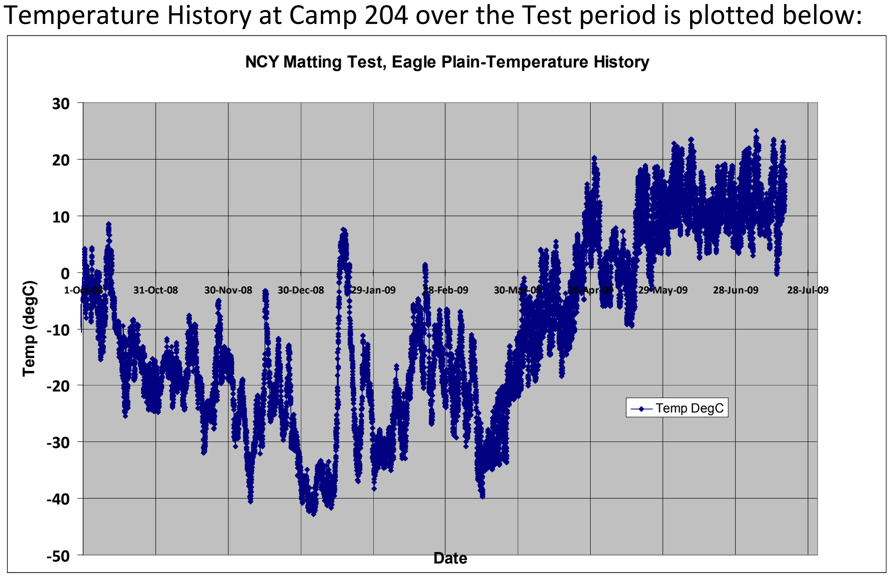
- Air Temperature
- Barometric Pressure
- Precipitation
- Solar Radiation
- Wind Speed and Direction

The key purpose of the weather station was to serve as a control to correlate with the results of the ground temperature and vegetation monitoring. Information from the weather station is periodically downloaded to a computer during irregular site visits. Meteorological data was downloaded smoothly on May 28, 2008 and September 29, 2008 (Appendix C).

There was, however, a problem with the weather station data retrieval during the July 18, 2009 site inspection. During download, the weather station was accidentally re-launched prior to download of data, and data from the weather station was not immediately available for download. EBA consequently stopped the data logger, removed it from the weather station and transported it back to Whitehorse so that a forced readout could be performed. This file was sent to Onset Computer Corporation for debugging on July 20, 2009, and was returned to EBA on August 18, 2009. Chris Jastrebski of EBA successfully re-installed and re-launched the weather station at Camp 204 on August 5th while in the area on other business. All gauges of the weather station were checked and correct operation of the data unit was confirmed after 2 hours.

On August 7th, 2009, the HOBO unit was again checked for correct operation (roughly 42 hours post-launch), and all instruments were confirmed to be working correctly.

The weather station data is also included as a digital data attachment in MS Excel format: the Temperature History at Camp 204 over the Test period is plotted below:



DISCUSSION OF RESULTS

VEGETATION

Period of Matting Cover: April 8, 2008 to September 5, 2008: 5 months or 150 days

Initial observations of Vegetation Condition on September 5, 2008 - the day Matting was removed:
Snow conditions during the post-mat removal vegetation assessment on September 8, 2008 reduced the level of detail possible and made a species by species comparison with the baseline vegetation survey on April 8, 2008 difficult. However, observations were that:

- Vegetation was relatively well preserved
- Mechanical damage due to mat placement or removal appeared minor
- Species characterization under the mat and in the control areas did not change
- Insect webs and evidence of increased small mammal habitat and use occurred under the mats
- Drill cuttings from thermistor boreholes compromised species identification and appeared to have a significant impact on vegetation health where present.
- Vegetation at the site had already entered winter dormancy at the time of mat removal and site assessment, so population and individual health was difficult to assess.

Vegetation Condition on July 18, 2009, 316 days after Matting was removed.
This represents a single growing season period from May 15, 2009 to July 18, 2009, or **64 days of growing season**;
Thermistor data shows that ground surface temperatures were below 0 degC until May15, 2009. NCY Weather station data at the site (previous page) shows high short term diurnal and weekly variation, especially in the winter season.
Observations overall were that:

- Physically damaged trees and large bushes had not regrown, but lateral branches were growing new leaves and some roots had new shoots. Residual damage, but new growth likely.

- Physical damage to Reindeer lichen was still apparent at "crush points" under mats, with no observable regrowth of those areas. Slow recovery for crushed individuals which are on local high points appears likely.

- Reindeer lichen which was protected by mats (in low areas under mats) was recovering well; Appear to be live and out of dormancy.

- Pioneer species (e.g. Blueberry); live specimens found in 1 of two plots. Small degree of growth, appears to be from root. New shoots forming, showing good recovery.

- Labrador tea and small bush species are slow to recover; Dead stalks are still visible, with many patches still in damaged condition. Small, patchy areas of regrowth observed, primarily through new shoot development. Regrowth of shoots directly from roots evident.

CONCLUSIONS

1. VEGETATION

Vegetation monitoring at the access mat test site to assess potential impacts on plant health in after 64 days of the first growth period after mat removal appears encouraging.
The major damage is associated with:

- Tree and shrub cutting to prepare for mat installation. This is unavoidable to some extent, but even cut individuals are showing some new leaves and shoots 64 days after commencement of the spring-summer growing season.

- "Crush Point" mechanical damage under the mat where contact between the vegetation and the mat occurs. This area would be larger when mats were in operational use, so this may be the largest factor in damage to easily crushed species, particularly reindeer lichens.

2. ACTIVE LAYER and PERMAFROST

The mats were generally neutral in their influence on soil temperature in the active layer and placement of the mats had no detrimental effect on the permafrost at the test site. No difference was detected between matted and control areas as far as the soil temperature profiles were concerned. Specifically:

- Mats had slight insulation effect on the underlying active layer soil profile, and tended to suppress the normal seasonal spring thaw of the lower active layer and underlying permafrost.
- After mats were removed, there were no discernable differences in ground temperature between the previously mat-covered locations and the control profile data.
- No difference between the "snow only" and "ice/snow" scenarios was detected. This was most likely due to the rapid thaw of those snow and ice layers as ambient temperature increased. Soil moisture from extreme watering under the "ice" mats did not produce a detectable difference in temperature profiles either.

3. SURFACE COMPACTION UNDER MATS

A survey of matting edge elevations using a plane table survey instrument was undertaken, but differential settling and mat attitude changes from snow and ice melt were not possible to resolve from soil surface compaction under the mats. Field observations suggest that the contact areas under the mats were the slightly higher, bulging portion of the active layer; the bulge is part of the geometry of patterned ground cells caused by seasonal free-thaw cycles and ice wedge formation at cell perimeters.
The area of contact under the mat was the area subject to crushing, which was the single most significant damage caused to reindeer/caribou lichens. The area of crushing was variable, but visually estimated at 25% of the matted area. Other vegetation species less affected by crushing than the lichens, and showed a better prognosis for recovery via shoots emerging from root structures.
Thermistor profiles were used to identify seasonal soil temperature profiles, and depth to the top of the frozen upper surface within the active layer.

It is important to note that this was a NO LOAD static matting test: No vehicular traffic or heavy load was applied to the mats after installation.

However, observations of the static test response suggest that under vehicular load in summer use, when soil temperatures are above freezing for the upper 10-80cm of the active layer, it may be expected that flattening of the contact areas under the mats would progressively increase, spreading the surface area of the crushed zone outwards away from the high areas of patterned ground occupied by each mat. As the contact surface area increased, the tendency to settle further would diminish. The crushed zone may eventually occupy approximately 50% - 70% of the area matted which was subject to heavy loads and vehicular traffic, but wheel rutting would be unlikely. Rigid wood matting has been shown to be very effective in laterally redistributing axle load, but under dynamic and heavy load conditions which would occur on mats under actual drilling operations, the crushing effect under the mat would be increased.

4. POSSIBLE ALTERNATIVES TO MATTING USE for LOAD DISTRIBUTION

Thermistor data based seasonal soil temperature profiles, and depth to the top of the frozen upper surface within the active layer allowed interpretation of the degree of rutting of the surface that is likely from heavy equipment on tires, and sets the time frame for access without surface soil compaction or rutting from September 20th to May 15th (approximately) each year.

The use of tracks or balloon tires or other means to distribute or lower surface pressure other than matting may also be an alternative to matting; the width of wheel tracked areas may not affect a much greater overall percentage of impacted area than the aggregate crush zones under mats subjected to frequent vehicular loads and traffic. In the case of tires, however, direct contact with the soil surface may add active disruption of surface vegetation. Careful use of balloon tires or rubber tracks may mitigate such surface disruption, and reduce surface rutting.

Such transportation and dynamic load distribution options and their effects were not studied in this test.

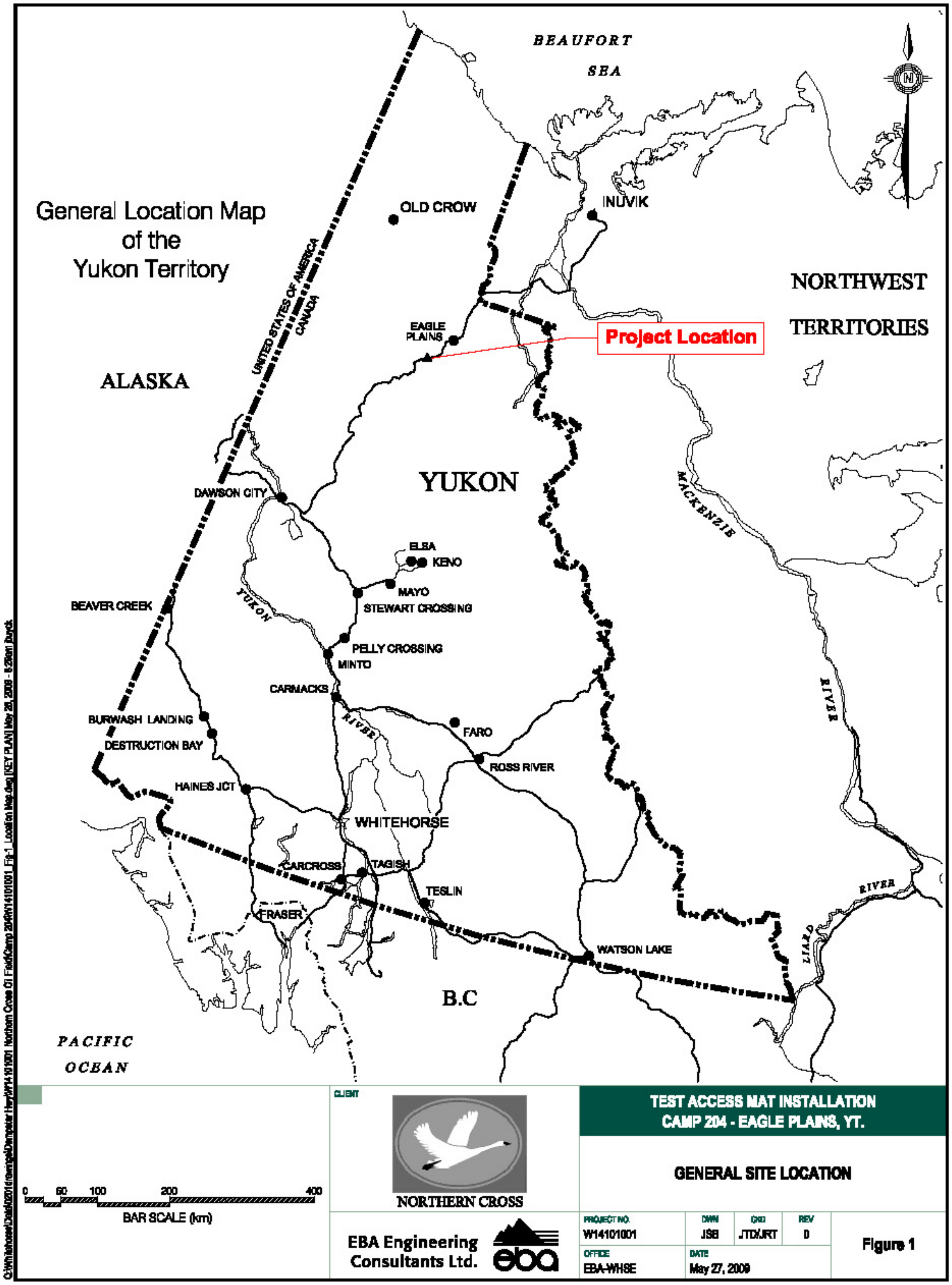
OVERALL CONCLUSIONS

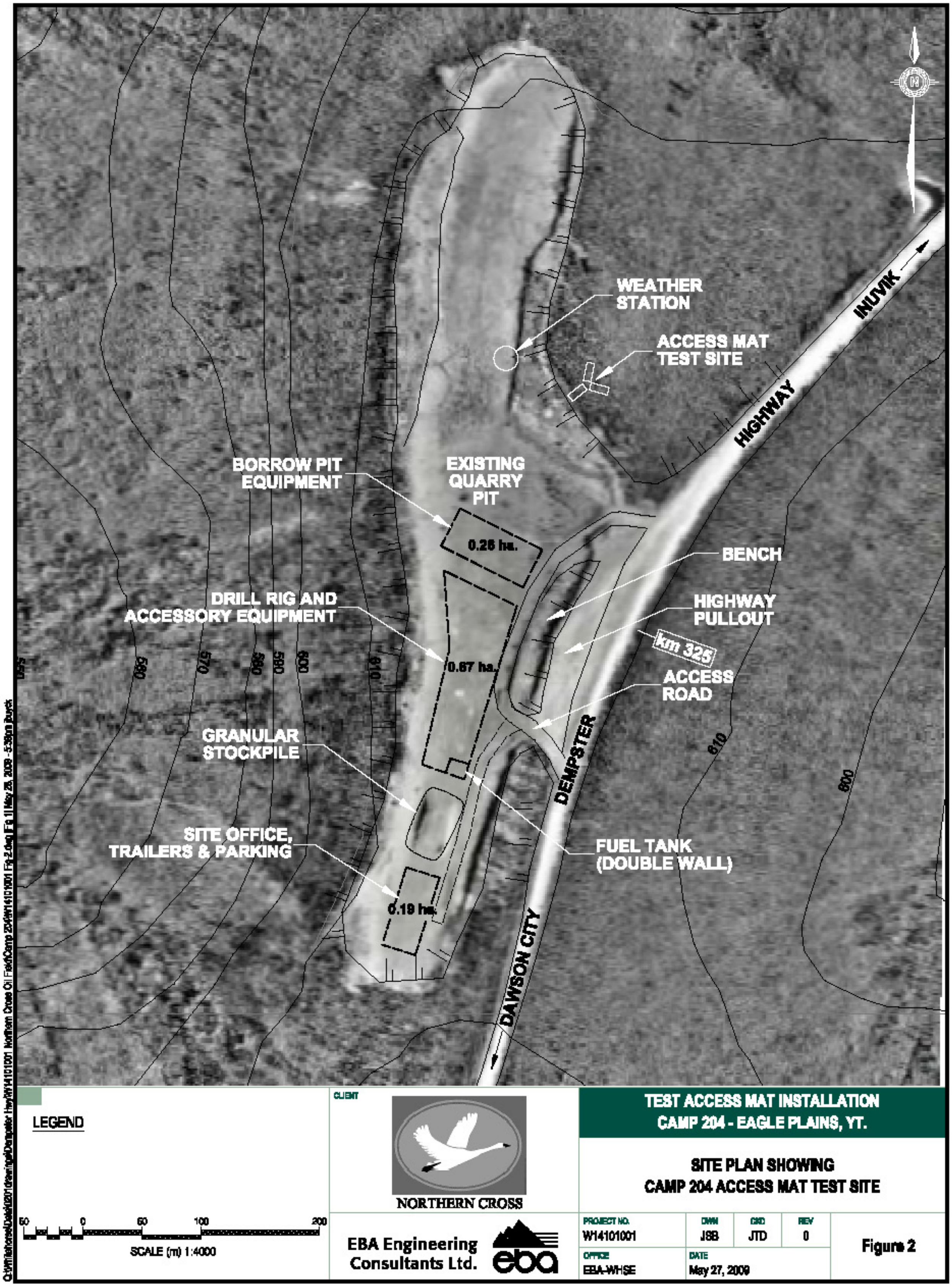
The matting test in a static, no-load application (which is not representative of dynamic and heavy load conditions which would occur on mats under actual drilling operations) established that:

- wooden mats had no affect on seasonal temperature variation in the active layer or on the vertical position of the base of the frozen ground. While perennial permafrost was not monitored due to drill-hole depths, the active layer temperature provided convincing evidence that permafrost was unaffected by matting;
- sensitive vegetation such as lichens under matting was affected by crushing in small areas where surface contact between vegetation and the mat base occurred. This was the most significant damage caused by the matting test;
- light deprivation for a summer growing season did not affect recovery of most individuals or populations, provided they were not physically crushed;
- the study duration of 15 months and one complete growing season was adequate to determine seasonal temperature profile response under matted and non-matted conditions;
- even in less than one full growing season, field observations allowed determination of extent of vegetation damage, and showed that recovery of all species except those cut or crushed had commenced; the length of time required for recovery, or whether injured populations may be replaced by pioneer species is still uncertain.

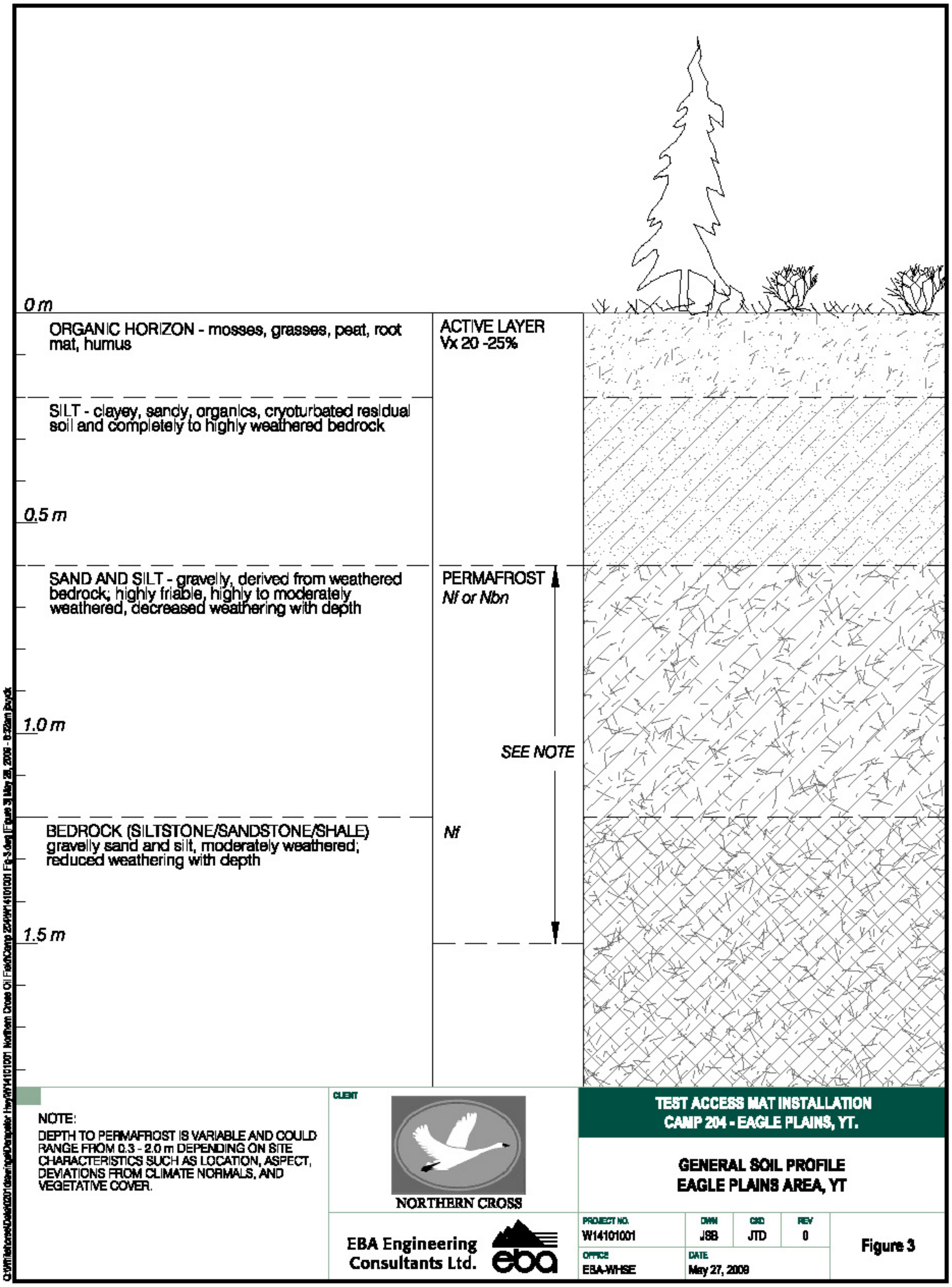
FIGURES

GENERAL LOCATION MAP FOR TEST SITE

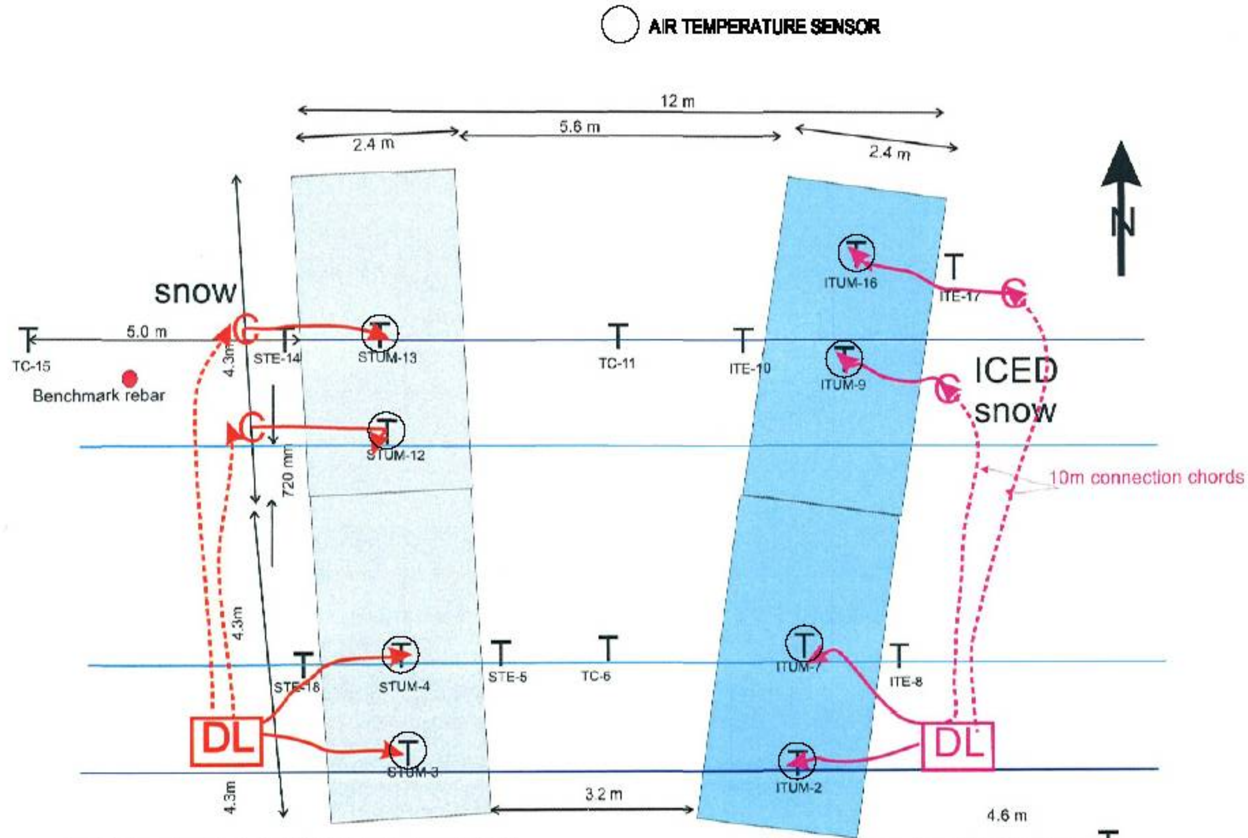




WEATHER STATION
ACCESS MAT TEST SITE
INUVIK
HIGHWAY
BORROW PIT EQUIPMENT
EXISTING QUARRY PIT
0.26 ha.
BENCH
DRILL RIG AND ACCESSORY EQUIPMENT
0.67 ha.
HIGHWAY PULLOUT
km 325
ACCESS ROAD
GRANULAR STOCKPILE
DEMPSTER
SITE OFFICE, TRAILERS & PARKING
FUEL TANK (DOUBLE WALL)
0.19 ha.
DAWSON CITY
560
570
580
590
600
610
610
600
LEGEND
SCALE (m) 1:4000
CLIENT
NORTHERN CROSS
EBA Engineering Consultants Ltd.
TEST ACCESS MAT INSTALLATION
CAMP 204 - EAGLE PLAINS, YT.
SITE PLAN SHOWING
CAMP 204 ACCESS MAT TEST SITE
PROJECT NO. W14101001
DWN JSB
CKD JTD
REV 0
OFFICE EBA-WHSE
DATE May 27, 2009
Figure 2



0 m
0.5 m
1.0 m
1.5 m
ORGANIC HORIZON - mosses, grasses, peat, root mat, humus
SILT - clayey, sandy, organics, cryoturbated residual soil and completely to highly weathered bedrock
SAND AND SILT - gravelly, derived from weathered bedrock; highly friable, highly to moderately weathered, decreased weathering with depth
BEDROCK (SILTSTONE/SANDSTONE/SHALE) gravelly sand and silt, moderately weathered; reduced weathering with depth
ACTIVE LAYER
Vx 20 -25%
PERMAFROST
Nf or Nbn
SEE NOTE
Nf
NOTE:
DEPTH TO PERMAFROST IS VARIABLE AND COULD RANGE FROM 0.3 - 2.0 m DEPENDING ON SITE CHARACTERISTICS SUCH AS LOCATION, ASPECT, DEVIATIONS FROM CLIMATE NORMALS, AND VEGETATIVE COVER.
CLIENT
NORTHERN CROSS
EBA Engineering Consultants Ltd.
eba
TEST ACCESS MAT INSTALLATION
CAMP 204 - EAGLE PLAINS, YT.
GENERAL SOIL PROFILE
EAGLE PLAINS AREA, YT
PROJECT NO.
W14101001
DWN
JSB
CKD
JTD
REV
0
OFFICE
EBA-WHSE
DATE
May 27, 2009
Figure 3



Installation: April 8 & 9, 2008: Peter Moignard NCY
Characterization of Undisturbed Vegetation: moss &caribou lichen from small cleared area- David Scott-McQuinn (EBA)
Snow Thickness prior to compaction: 40-50cm; After compaction & prior to matting 10-20cm; Avge 15 cm
Active layer had some minor ice lenses; soil is sandy silts; bedrock of fine red-brn sst at 1.1-1.4m.
18 Thermistors: 4 control (button incl datalogger); 6 edge effect (button incl datalogger); 8 under mat to depth of 1.2 metres with 4x10m extension cables as shown and 2 dataloggers recording 4 thermistor cables each, 1 for snow set, 1 for ice set.

INDEX
○ AIR TEMPERATURE SENSOR
T *i* BUTTON THERMISTOR
Ⓣ THERMISTOR CABLE

0 — 5
Scale: 1: 125 (metres)

Northern Cross (Yukon) Limited
Wood Matting Test: Actual Layout at Camp 204Test Site
Snow and Iced Snow Substrate Evaluation
Four Mats to laid April 9, 2008 for approximately10 week period

CLIENT
NORTHERN CROSS

EBA Engineering Consultants Ltd.

TEST ACCESS MAT INSTALLATION
CAMP 204 - EAGLE PLAINS, YT.

ACCESS MAT TEST - SITE PLAN

PROJECT NO.	DWN	CKD	REV
W14101001	JSB	JTD	0
OFFICE	DATE		
WHSE	May 25, 2009		

Figure 4

Photo 1
April 8, 2009. Camp 204 Access mat application area prior to site preparation.

Photo 2
April 8, 2009. Camp 204 Access mat application showing final mat footprint of packed snow application.

Photo 3
April 9, 2009. Camp 204. Access mat site preparation with water being added for simulated ice-road conditions.

Photo 4
April 9, 2009. Camp 204 Matting Application showing mat placement.

Photo 5
April 9, 2009. Camp 204 access mat application showing final mat placement.

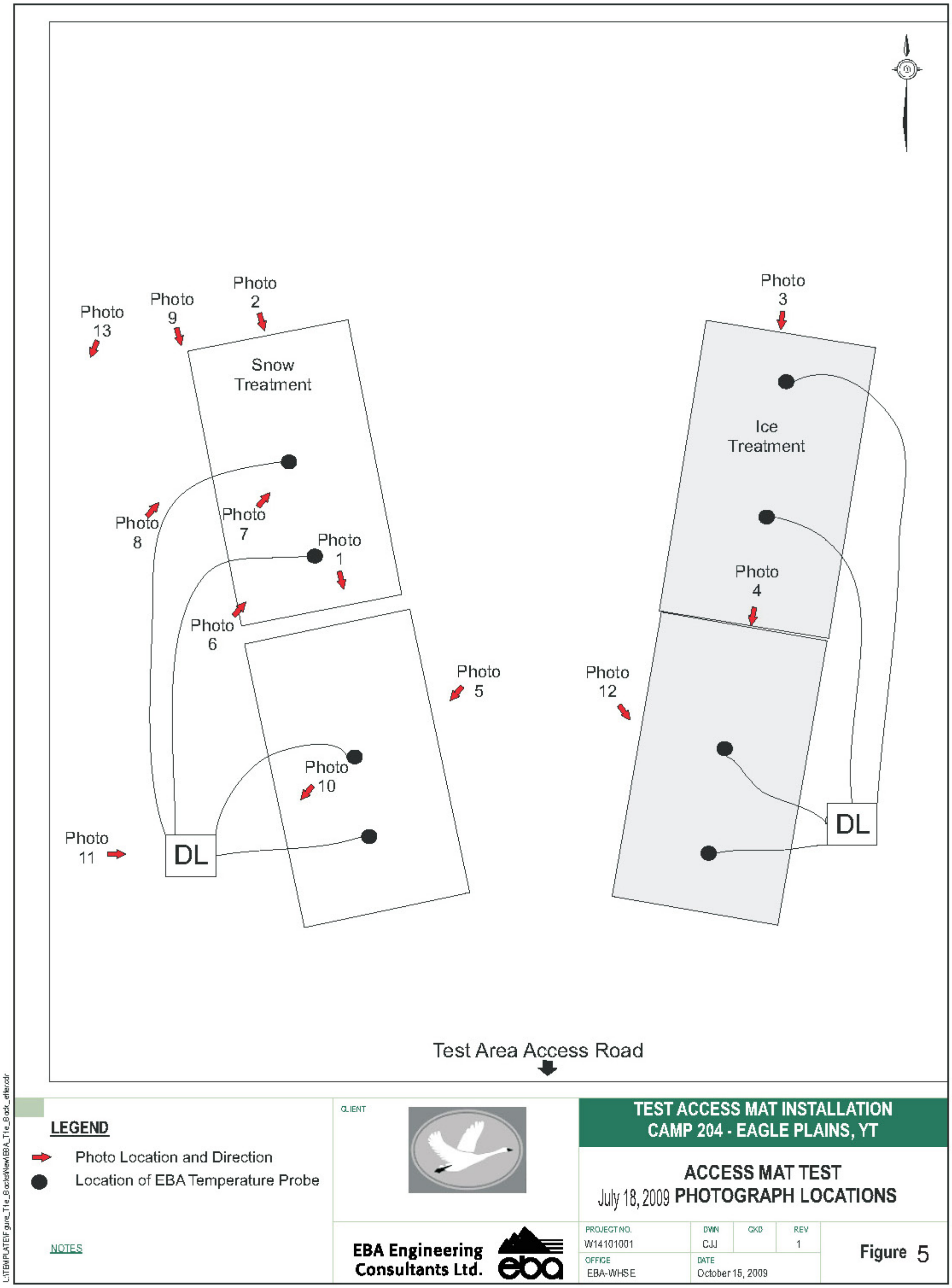
Photo 6
April 9, 2009. Camp 204 weather station.

Photo 7
September 5, 2009. Camp 204 access mat test site - mat removal.

Photo 8
September 5, 2009. Camp 204 access mat test site - mat removal.

Photo 9
September 5, 2009. Camp 204 access mat application showing ground cover following mat removal

Photo 10
September 5, 2009. Camp 204 access mat application showing insect webs and vole paths that developed under the access mats.



After mat removal, photographs were taken on July 18, 2009 to illustrate the condition of the areas which had been covered by mats. This photo index diagram shows direction of for the next 17 photographs below.

Photo 1
Under Snow – General Overview – Facing South (July 18, 2009)

Photo 2
Under Snow – General Overview – Facing South (July 18, 2009)

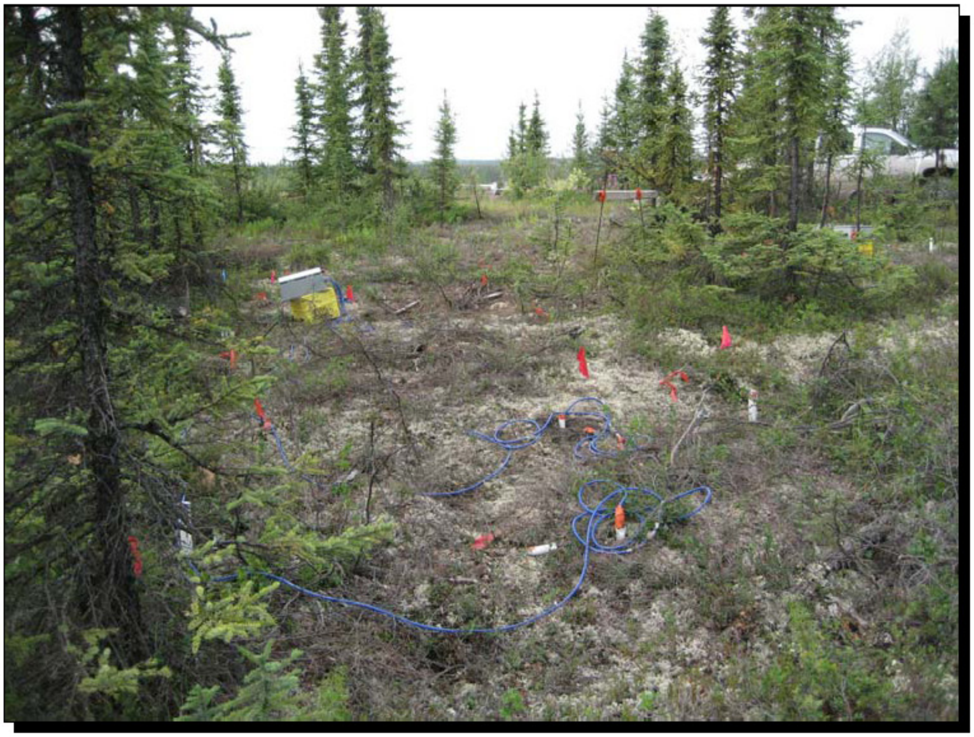


Photo 3
Iced under mats – General Overview – Facing South (July 18, 2009)

Photo 4
Iced under mats – General Overview – Facing South (July 18, 2009)

Photo 5
Drill Cuttings on Snow under mats – Facing South (July 18, 2009)

Photo 6
Drill Cuttings on Snow under mats – Facing North (July 18, 2009)

Photo 7
Drill Cuttings on Snow under mats – Facing North (July 18, 2009)

Photo 8
Matting damage to vegetation– Facing North (July 18, 2009)

Photo 9
Close up of matting damage to vegetation– Facing South (July 18, 2009)

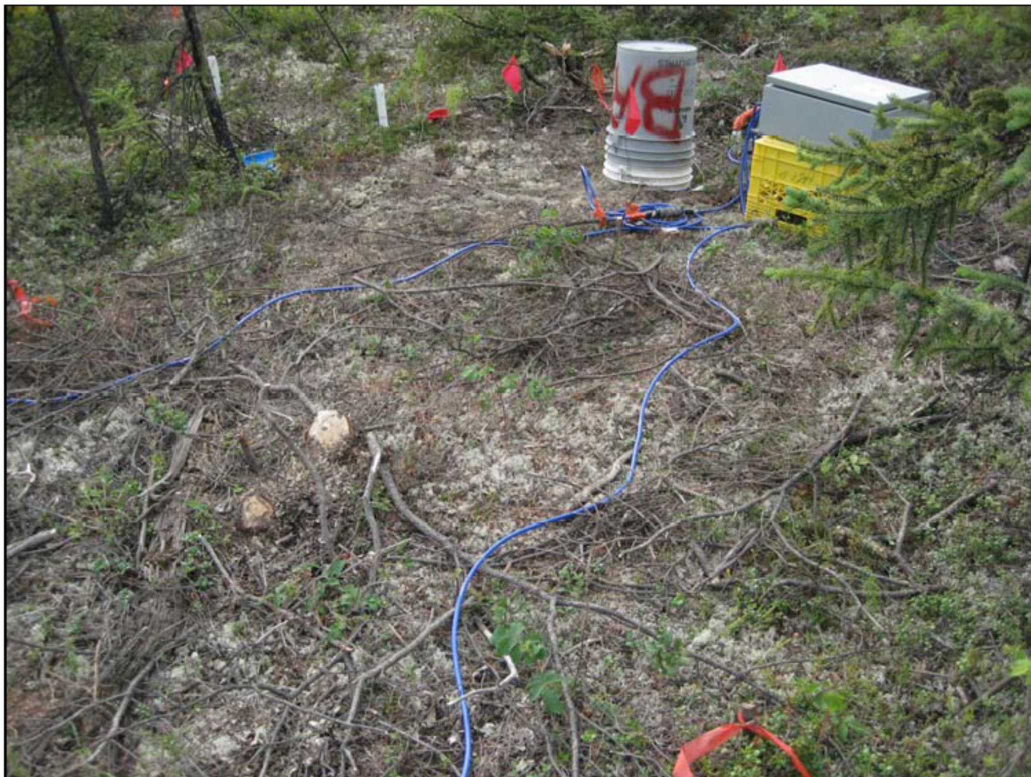


Photo 10
Showing mechanical tree removal – Facing South (July 18, 2009)

Photo 11
Logging box installation for the snow treatment mats (July 18, 2009)

Photo 12
Thermistor cable and iButton installation with logging box – Facing South (July 18, 2009)

Photo 13
Damage to iButton Thermistor location TC15 – facing South (July 18, 2009)

Photo 14
Photo demonstrating physical damage to spruce trees in the treatment areas. Damage was incurred by tree cutting and physical removal, and branches were left at the location. Photo taken September 5, 2008 in the ice treatment area.

Photo 15
Photo demonstrating the original density of spruce trees at the test plot location (background), and the test plot areas with spruce trees removed (foreground). Photo taken September 5, 2008.

Photo 16
Photo showing typical damage and recovery to dwarf birch, during the first growing season post-treatment. Unaffected dwarf birch are shown in the foreground, while a damaged shrub is in the background (Ice treatment). Dead stems are shown with a red arrow, while limited regrowth is shown with a blue arrow. Photo taken July 18 ,2009.

Photo 17
Photo showing willow regrowth during the first season post-test (2009). In the right foreground is are several damaged willow stems (mixed with birch), with moderate new growth from root shown (new shoots). Photo taken July 18, 2009.

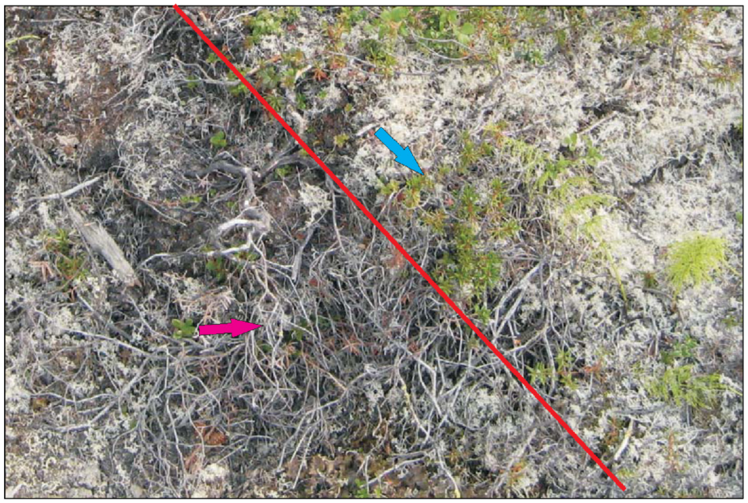


Photo18
Photo demonstrating damage to labrador tea plants in the snow treatment area. Unaffected growth outside of the plot is indicated by a green arrow, while affected dead stems with minor regrowth are shown by the red arrow. The Red line indicates the limit of the test mat. Photo taken July 18, 2009..

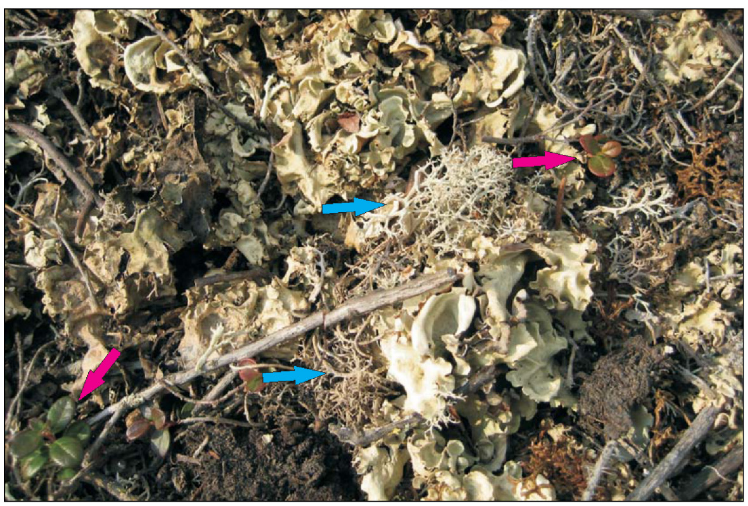


Photo19
Photo demonstrating remaining damage and regrowth in the snow plot during the summer of 2009. Blueberry (*Vaccinium*) regrowth is shown by red arrows. Reindeer lichen (with no apparent damage) is noted by blue arrows.

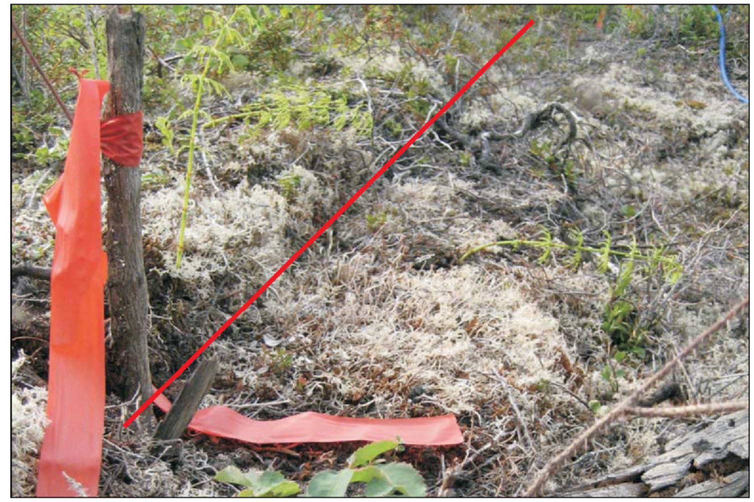


Photo 20
Photo showing physical damage to reindeer lichen resulting from mat placement. The red line in the photo represents the approximate edge of mat (which extended to the right). Note the crushed lichen from beneath the mat, with limited regrowth noticeable. Photo taken July 18 ,2009.

SCHEDULE 1
to Northern Cross (Yukon) Limited
Eagle Plain Matting Test Report
Vegetation, Soil and Permafrost Monitoring Results

March 4, 2008 Desktop review by EBA describing general discussion of matting test considerations

CD ENCLOSURE

Digital Thermistor and Weather Station Data: MS Excel files on CD

March 4, 2008 EBA File: W14101001

Northern Cross (Yukon) Limited
#840, 700 - 4 Avenue SW
Calgary, AB T2P 3J4

Attention: Mr. Peter S. Moignard
Geological Consultant

Between March 1 and March 4, 2008, EBA Engineering Consultants Ltd. (EBA) (Edmonton) completed a desktop review of Northern Cross (Yukon) Limited's (Northern Cross) plans to create mat access roads and drilling platforms for the purpose of completing summer drilling in the Eagle Plains Area of the Yukon Territory. The desktop assessment of this proposed program considered the following potential impacts associated with the proposed 2008 test program involving four test areas adjacent to the Dempster Highway. The following is a summary of the specific environmental considerations made by EBA during the above described review and the opinion provided to Northern Cross, based on the available information.

The Seasonal Timing of Mat Placement and Removal

- It is EBA's opinion that the mats placed during unfrozen summer conditions should not be removed under frozen conditions. The potential damage to surface vegetation by removal of mats under the above-described situation would be greater than any potential damage associated with leaving mats in place for a longer period of time to allow for unfrozen conditions to return.

Placement and Removal Method

- EBA reviewed video footage of mat placement and removal and based on this information determined that in order to minimize disturbance to vegetation, efforts should be made to ensure that mats are not slid along the soil surface and that scuffing of the ground is avoided.

Potential Impact of Access Mat Use on the Chemical and Physical Properties of Soils

- The following are potentially relevant soil parameters which EBA considered in this desktop review: organic carbon, organic matter, cation exchange capacity, nutrient holding capacity, water holding capacity, available and total nutrients (N, P, K and S), soil density and soil compaction.
- EBA's review of these parameters is based on professional opinion only as no information regarding actual field application of mats was made available for review. EBA's consideration of these parameters was also based on information provided by Northern Cross regarding the ground pressure of placed mats under maximum load. It was explained that the maximum ground pressure would be equivalent to a human footprint (5 PSI). Bearing capacity and loading is addressed in more detail in a report entitled "Use of Access Mats for Ground Protection

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During Summer Operations at Well Pads and Access Routes, Oil and Gas Exploration, Eagle Plains, Yukon" (EBA, February 2008).

- Based on the above information, EBA determined that the most critical potential impacts to the soil would be alteration of physical characteristics mainly due to compaction. Chemical alteration of soil conditions would not likely occur during the short-term, one-time disturbances that are being proposed in Northern Cross's access mat placement program. It was also determined that if ground pressures were 5 PSI or lower as described compaction would be unlikely.
- All other soil parameters considered would depend on physical alteration of soil conditions not likely to occur under the conditions proposed by Northern Cross matting program.

Potential Impacts of Matting on Vegetation

- Potential impacts on surface vegetation could result from physical damage incurred during placement and removal of the mats or during operation if mats were to shift or slide across the ground surface. Based on the outlined assumptions above, including low ground pressure, it is unlikely that significant damage to vegetation would occur as a result of crushing.
- Assuming that soil conditions are not impacted, i.e., the physical and/or chemical properties of the soil are not altered by mat placement and use, any disturbance to vegetation would represent short-term damage and would likely recover once mats were removed.
- If mat use causes soil to be exposed through scraping or scuffing of the ground surface, additional vegetation issues could arise including, but not exclusive to, invasion by weedy species or alteration of the successional state of the existing vegetation community.
- In order to reduce potential structural damage to vegetation with the use of access mats, seasonal changes in vegetation should be considered. In late fall sap content in limbs is reduced and moisture content of foliage is typically low. This condition can result in increased fragility and greater susceptibility to vegetation damage. Avoiding mat placement in late fall will reduce the potential structural damage to vegetation.

Reclamation of Areas Impacted by Access Mat Placement

- Based on the above summary of opinions it is not expected that reclamation will be necessary after mat removal. It is also likely that reclamation efforts would cause more damage than benefit and overall would defeat the purpose of access mat use in the first place.

It is important to note that the above summary letter is based on EBA's professional opinion and was determined with limited information regarding actual field application of mat roads in the Eagle Plains Area of the Yukon Territory. EBA supports Northern Cross's proposed approach to gathering actual field information through a staged operation field trial evaluating four test sites over the early spring and summer of 2008.

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