

**DRAFT**

# MARY RIVER PROJECT RECLAMATION PILOT STUDY

## Revegetation Survey & Preliminary Reclamation Trial 2025 Project Update



### Prepared For

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**Down to Earth Biology**



## EXECUTIVE SUMMARY

**Background/Objectives**— EDI Environmental Dynamics Inc. (EDI) was retained to design and implement a reclamation pilot study at the Mary River Project. This investigation is intended to enhance reclamation success at the Mary River Project and guide future reclamation activities that support the environmental compliance and sustainability of the Project. The study objectives are to:

- 1) document the status of opportunistic post-disturbance revegetation at the Project;
- 2) initiate preliminary reclamation trials that examine methods and approaches that are appropriate and adaptable to the inherent challenges of the Arctic environment; and,
- 3) identify pathways and opportunities for future studies.

The first field component of this reclamation pilot study (Summer 2019) focused on surveying natural/unassisted revegetation at the Project and establishing a preliminary trial design. The second field component (Summer 2021) expanded the number of survey locations and reclamation trial sites. Periodic follow-up monitoring occurred in Summer 2020-25. This report — updated annually (or as required) — summarizes Project findings, including the most recent site monitoring findings.

**Study Sites/Baseline Conditions**— Study sites were established at four (4) locations along the Tote Road at KM16, KM18, KM52 and within an abandoned airstrip near KM58. These sites were selected to represent different revegetation timeframes, from 1-Year Post-Disturbance to >40 Years Post-Disturbance. Landscape and terrain were typified by a combination of xeric or subxeric conditions and either regosolic or brunisolic cryosols characterized by restrictive growth substrates (comprised of unconsolidated/loose sandy materials, coarse parent materials and/or permafrost) and poor fertility. Vegetation — including a combination of Arctic graminoids, forbs/perennial herbs, shrubs and ericaceous species, and bryophytes and lichen — was representative of the dry-to-moist graminoid/dwarf shrub land cover type that predominate of the broader Project area. Rates of natural revegetation in the Arctic are characteristically slow due to the region's climate, narrow growing season, and challenging site conditions and terrain. A key observation of the revegetation survey is that natural/unassisted revegetation does occur at the Project. Revegetation following disturbance appeared to be shaped by initial starting conditions, such as the level of landscape disturbance (i.e., status of landscape form and function), soil characteristics (i.e., nutrient availability and organic matter content), and integrity of nearby 'undisturbed' vegetation.

**Reclamation Trials**— Reclamation trials were established at three (3) locations (KM16, KM18, KM52) described above. The purpose of the reclamation trials was to apply and adapt different reclamation site/surface preparations and document natural/unassisted revegetation patterns. Reclamation earthworks at KM16 and KM52 were completed in Summer 2019; reclamation earthworks at KM18 were completed in Summer 2021. Two surface configurations were applied: 'rough-and-loose' and 'track-packing'. Ongoing seasonal monitoring of the trial sites has occurred from 2020 to 2025 which comprised a combination of qualitative and quantitative assessment. During early site monitoring (2020-21), no significant revegetation was recorded; all sites were deemed stable and had low erosion potential, but wind erosion and 'wind-swept' surface soil conditions were apparent. Over time (2022-23), an increasing number of small volunteer forbs and graminoids were found to have colonized all sites (KM16, KM18, KM52). The highest levels of



revegetation (i.e., based on visual assessment) were observed at KM18 and KM16 (both characterized as subxeric), whereas KM52 (characterized as xeric) had the lowest levels of revegetation. More recently (2024-25), cover vegetation continues to increase and the health and vigour of cover vegetation at all sites is improving.

**Conclusions/Recommendations—** In summary, the reclamation trial’s sample size (n=3) is small and represents a short-term timeframe with some design limitations. However, findings provide insight into some of the conditions, challenges and opportunities at the Project. Collectively, these investigations (and any/all subsequent initiatives) are intended to enhance reclamation success in the Arctic and guide future reclamation activities that support the environmental compliance and sustainability of the Project.

During appropriate phases of the Life-of-Mine cycle, it would be beneficial — i.e., as a long-term objective— to evaluate Project features that could be decommissioned and/or reclaimed to reduce the Project’s disturbance footprint. For example, discontinued laydown areas, access roads or other features associated with the Mine Site, the Milne Port and/or Tote Road should be evaluated as candidate sites for reclamation studies. Where appropriate, these features could provide a ready landscape for planning, designing and implementing medium- and even large-scale reclamation trials to examine the scalability of reclamation approaches and calibrate the time, effort and cost of reclamation onsite.





## AUTHORSHIP

Baffinland retained EDI to design and initiate a reclamation pilot study at the Mary River Mine Site. This report summarizes the study's rationale, methods and outcomes and recommendations to expand the study's scope. The following EDI Environmental Dynamics Inc. personnel contributed to this reclamation pilot study:

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## 1 INTRODUCTION

The Mary River Mine Project (the Project) is an open-pit iron ore mine located in the Qikiqtani Region of Nunavut. The Project — owned and operated by Baffinland Iron Mine Corporations (Baffinland) — has been under construction since 2013 and operational since 2014. Under the Project’s Terms and Conditions, Baffinland is committed to timely and effective reclamation during appropriate phases of the Life-of-Mine so that post-disturbance landscapes are safe, stable, non-polluting and align with a suitable aesthetic and self-sustaining land use(s). Baffinland recognizes that appropriate studies and field trials should be undertaken to inform and refine reclamation practices onsite that will benefit Final Reclamation and Closure objectives.

EDI Environmental Dynamics Inc. (EDI) was retained to review recent advances in Arctic mine reclamation and examine strategies (i.e., to the extent possible and practical) that are expected to promote natural revegetation at the Project (EDI Environmental Dynamics Inc. 2019). Building from this desktop investigation, a reclamation pilot study was designed with the objectives to:

- 1) document the status of opportunistic post-disturbance revegetation at the Project (i.e., natural and unassisted);
- 2) initiate preliminary reclamation trials that examine methods and approaches that are considered appropriate and adaptable to the inherent challenges of the Arctic environment; and,
- 3) identify pathways and opportunities for future studies.

The Summer 2019 field component of this reclamation pilot study focused on siting and establishing a preliminary trial design (EDI Environmental Dynamics Inc. 2020). The Summer 2021 field component then expanded the number of study sites. Periodic follow-up monitoring (Summer 2020-25) has documented site revegetation status and related observations. This report — which is updated annually — summarizes Project findings, including the most recent site monitoring findings. Collectively, these investigations (and any/all subsequent initiatives) are intended to enhance reclamation success in the Arctic and guide future reclamation activities that support the environmental compliance and sustainability of the Project.



## 2 POST-DISTURBANCE REVEGETATION SURVEY

### 2.1 SITE SELECTION AND SURVEY DESIGN

The first part of the reclamation pilot study focused on documenting the terrain, soil conditions, species composition, successional trajectories, and assumed revegetation rates within disturbed Project areas. In consultation with Baffinland's Sustainable Development and Site Environment teams, EDI conducted a desktop review of the Project footprint's available ortho/aerial imagery to establish a preliminary list of potential study sites representative of developed, disturbed or temporarily decommissioned areas. These areas were then field scouted by Baffinland and EDI personnel (accounting for future development plans, logistics and safety) to finalize the sites included in the revegetation survey.

After confirming site selection and delineating disturbed vs. control areas, site layout and boundary markers were established at each study site to facilitate the survey of cover transects (100 or 150 m long), vegetation plots (1x1 m vegetation quadrats), and soil plots (30x30x30 cm soil survey pits) — described in Section 2.2. As shown (Figure 1a), the site layout was comprised of three (3) paired vegetation and soil survey plots distributed at the start, middle and end of the vegetation cover transect. Applying the same experimental design, control areas (i.e., deemed representative of pre-development [undisturbed] site conditions) were sited on adjacent land approximately 30 m from the Project footprint.

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#### 2019 BASELINE SURVEY — KM52 & KM16

During the 2019 field/survey period, EDI established two study sites along the Tote Road at KM52 and KM16 (Map 1). Since 2013, the Tote Road has been subject to ongoing re-alignment and maintenance activities, including surface earthworks and regrading. Study site KM52 was selected because it represented approximately 1-year post-disturbance and KM16 represented approximately 5-years post-disturbance (i.e., referring to disturbance associated with the road works; timeframe relative to the time of field survey). The site disturbance history at each location was discussed with road maintenance personnel.

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#### 2021 BASELINE SURVEY — KM18 & KM58

During the 2021 field/survey period, EDI established one site along the Tote Road at KM18 (adjacent to a construction borrow pit). Another site was established within an abandoned airstrip near KM58, approximately 500 m outside the Project footprint (Map 2). Survey site KM18 was selected because it was disturbed during the construction of the nearby borrow pit and during ongoing road maintenance activities representing 1-3 years post disturbance (depending on location), and because it reflected a different ecotype than previous field surveys. Survey sites at the KM58 Abandoned Airstrip (i.e., comprising three survey areas, due to the size of the disturbance footprint; Figure 1b) were selected as they represented >40 years post-disturbance<sup>1</sup> and a unique location to investigate natural revegetation after disturbance (i.e., no seeding or planting and no reclamation earthworks and/or surficial preparations).

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<sup>1</sup> Erratum: This site was previously reported at representing >60 years post-disturbance (based on available information).

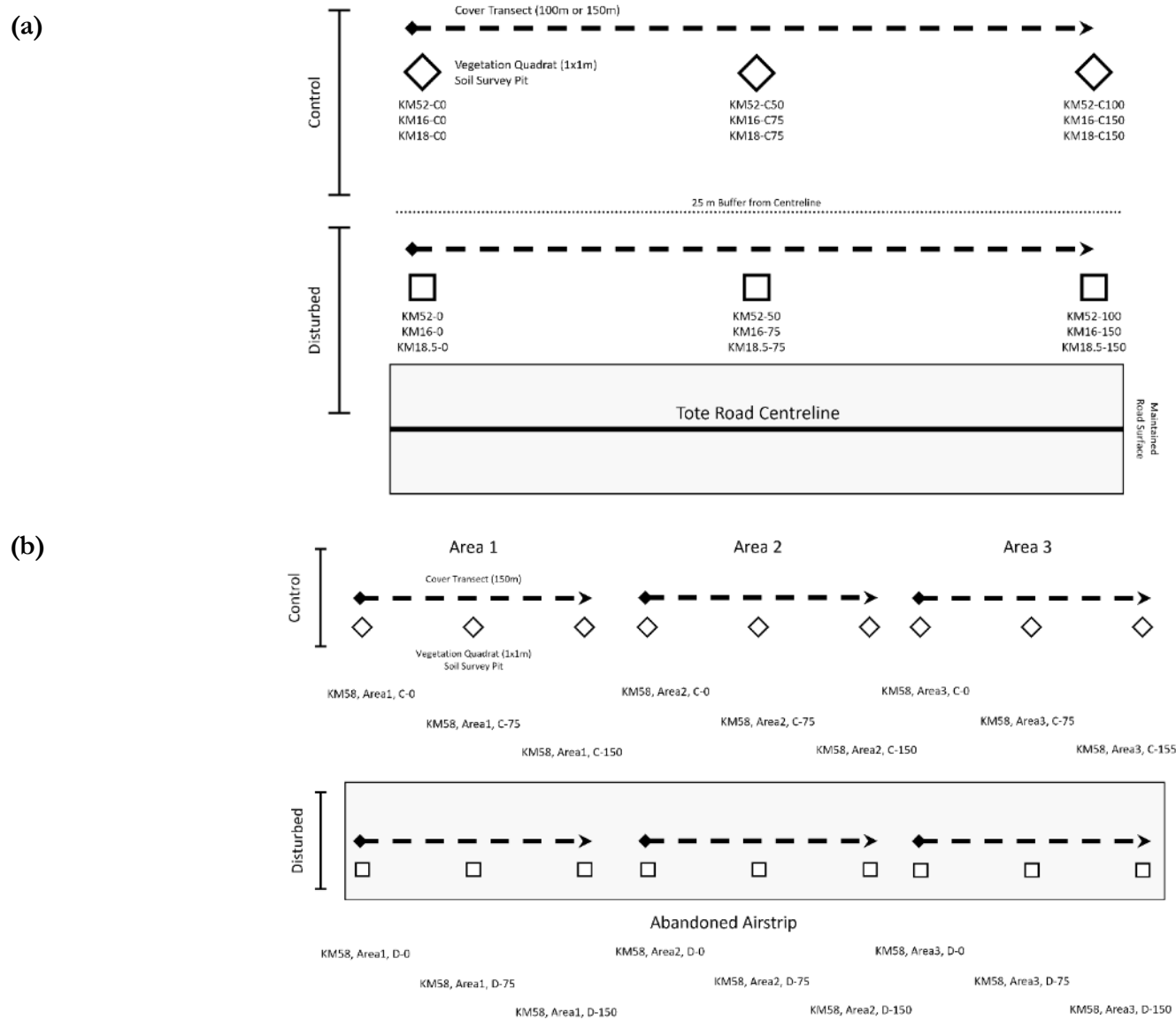


Figure 1. SCHEMA — Survey layout and sampling design (a) at KM52, KM18 and KM16, (b) near KM58.

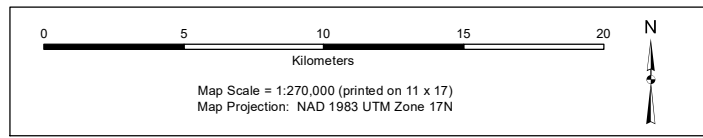


**2019 SURVEY  
KM52 and KM16 Survey Locations**



**Legend**

- KM 16
- KM 52
- Tote Road
- Port
- Mine



**Data Sources**

- Main map. Baffinland Iron Mines Corporation Imagery, 2019
- Inset map. National Geographic World Map.

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 EDI Environmental Dynamics Inc. has made every effort to ensure this map is free of errors. Data has been derived from a variety of digital sources and, as such, EDI does not warrant the accuracy, completeness, or reliability of this map or its data.

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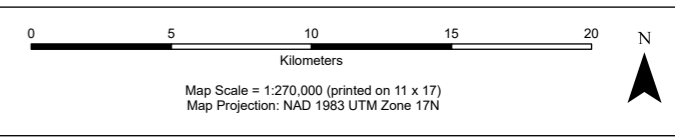
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**2021 SURVEY  
KM18 and KM58 Survey Locations**



**Legend**

- KM 18
- Km 58
- Tote Road
- Port
- Mine



**Data Sources**

- Main map: World Street Map, Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
- Inset map: National Geographic World Map, National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

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## 2.2 METHODS AND ANALYSES

**Landscape, Terrain and Soil**— Survey procedures for characterizing landscape, terrain and soil were based on methods described in the Field Manual for Describing Terrestrial Ecosystems — Land Management Handbook No. 25 (B.C. Ministry of Forests and Range and B.C. Ministry of Environment 2010) and The Canadian System of Soil Classification, 3<sup>rd</sup> Edition (Soil Classification Working Group 1998). Landscape features and terrain (e.g., slope grade, aspect, geomorphological process) were assessed at the transect scale. Soils were assessed at the plot scale. At each soil survey plot (Photo 1a), a shovel and hand trowel were used to expose a 30x30 cm area and dig up to a depth of 30 cm (being mindful not to disturb permafrost occurring below this depth) to access the subsoil layers (B or C horizons). Documented soil profile information included parent material, horizon depths, texture, colour, and structure. Soil samples were collected from the top 10–30 cm from each soil pit to analyze textural and nutritional attributes by ALS Environmental Laboratories.

**Vegetation Surface Cover and Composition**— Survey procedures for characterizing vegetation surface cover and composition were based on methods used in Baffinland’s existing vegetation monitoring program, and described in the Canadian Tundra and Taiga Experiment (CANTTEX) — Field Manual (Bean and Henry 2003, Bean et al. 2003). Vegetation species lists within and directly adjacent to the survey plots were recorded using various taxonomic reference guides (Bean and Henry 2003, Aiken et al. 2011, Mallory and Aiken 2012); bryophytes and lichen taxons were not characterized at the species level and only recorded in terms of presence or absence. Vegetation cover and structural composition were assessed at the transect and plot scale. The surface projective cover<sup>2</sup> was calculated based on measurements at 1 m intervals along the 100 m or 150 m transect (Photo 1b). Surface projective cover within the 1x1 m vegetation quadrats was recorded at two basal strata (i.e., due to overlapping structural cover components) and calculated based on 100–200 measurements within the point-frame grid (Photo 1c).

**Data Collection and Analysis**— Field data summaries are summarized as means or data ranges. Some survey sites had sparse cover vegetation; therefore, field data were commonly consolidated into coarse structural groupings. No statistical analyses were applied due to small sample sizes. An example field data collection sheet is in Appendix A.

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<sup>2</sup> Referring to the % presence or absence of exposed rock and bare soil, bryophytes, lichen, graminoids, forbs and shrubs.



(a) Soil Pit



(b) Cover Transect



(c) Vegetation Quadrat

Photo 1. SURVEY METHODS — Soil survey pit (a), cover transect (b), and vegetation quadrat (c).



## 2.3 2019 SURVEY | RESULTS

### KM52 — 1 YEAR POST-DISTURBANCE

Map 3 shows the sampling layout at KM52. Table 1 summarizes landscape, terrain and soil attributes. Table 2 lists observed vegetation species within and directly adjacent to the survey plots. Table 3 summarizes the mean surface projective cover within vegetation quadrats. Figure 2 shows the total projective cover along the survey transect. Supporting information (e.g., geo-referencing and lab analysis) is provided in Appendix B1.

**Landscape, Terrain and Soil**— Located near Katitkok Lake, the survey transects occur within a glaciofluvial and periglacial landform characterized by an undulating surface expression with nearly level to very gentle slopes with intermittent soils and frost-weathered bedrock (Photo 2a–b). Native (control) soils appeared to be Regosolic Turbic Cryosols as defined by an Om and Cy/Cgy/Cz sequence<sup>3</sup>. Control soil profiles (KM52-C0, -C50, -C100) were characterized by a discontinuous surface organic layer (Om, 0–2 cm in depth) and a sandy loam textured C horizon. If/where soils were present, the high incorporation of coarse parent materials (i.e., till and frost-weathered bedrock at the surface) resulted in a restrictive layer at 25–30 cm in depth. The soil moisture regime was xeric (dry); no mottling or gleying<sup>4</sup> was observed within any soil profile. Disturbed soil profiles (KM52-0, -50, -100) had no surface organic layer, a similarly textured sandy loam C horizon with high incorporation of coarse parent materials, but no discernible subsoil structure due to the site's disturbance history.

Laboratory analysis determined that both control and disturbed sites had poor fertility [as indicated by low available nutrients, low electrical conductivity (EC) and adsorption potential] and little incorporated organic matter for both control and disturbed soils.

**Vegetation Surface Cover and Composition**— Given the landform attributes and soil conditions described above, vegetation cover in control areas was sparse (29% along the transect; 66% within quadrats) and composed of graminoids, forbs/perennial herbs, shrubs, bryophytes and lichen (Photo 3a–c). Whereas disturbed areas exhibited scarce cover vegetation (4% along the transect; <2% within quadrats), primarily composed of small/juvenile graminoids and forbs (Photo 3d–f) if/where present.

Short-leaved sedge (*Carex fuliginosa* subsp. *misandra*), mountain avens (*Dryas integrifolia*), purple saxifrage (*Saxifraga oppositifolia*), yellow saxifrage (*S. aizoides*), Arctic bladderpod (*Physaria arctica*) and net-veined willow (*Salix reticulata*) were commonly observed within the study site — primarily in control areas. No exotic or non-native species were recorded. The presence and abundance of these species were generally consistent with known habitat descriptors for dry, rocky areas on plains and slopes that are characterized by imperfectly drained substrates composed of rocks, gravel, sand, silt, clay or till (Aiken et al. 2011).

<sup>3</sup> Om = Organic-mesic; Cy = C horizon with cryoturbation; Cgy = Cy with gleying; Cz = C horizon that is frozen due to permafrost.


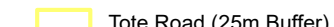




<sup>4</sup> Referring to secondary soil colours in the soil profile not associated with compositional properties.

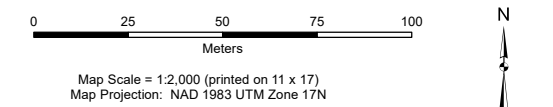


**KM52  
Vegetation and Soil Sampling Sites**



**Legend**

-  Tote Road
-  Tote Road (25m Buffer)
-  Soil
-  Vegetation
-  Survey Marker
-  Cover Transect



**Data Sources**

- Main map. Baffinland Iron Mines Corporation Imagery, 2019
- Inset map. National Geographic World Map.

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Photo 2. KM52 — Landscape overview southeast (a) and northwest (b).



Photo 3. KM52 — Cover vegetation at KM52-C0, -C50 and -C100 (a-c) and KM52-0, -50 and -100 (d-f).



**Table 1. KM52 — Summary of landscape, terrain and soil attributes.**

Survey Area	KM52 — Disturbed	KM52 — Control
Survey Marker ID	KM52-0, -50, -100	KM52-C0, -C50, -C100
<b>Landscape Attributes</b>		
Geomorphological Process	Glaciofluvial and Cryoturbation	
Parent Material	Glacial Till and Bedrock	
Surface Expression	Undulating	
Slope Class Description	Nearly Level (Class 2: 0.5–2%) to Very Gentle Slopes (Class 3: 2–5%)	
Aspect	South	
Drainage	Well Drained	
Soil Moisture Regime	Xeric (Dry)	
<b>Soil Attributes</b>		
* Organic Matter Content	1.3% ( $\pm 1.0$ SD)	1.8% ( $\pm 3.9$ SD)
* pH	8.7 ( $\pm 0.2$ SD)	7.7 ( $\pm 0.4$ SD)
* Texture/Particle Size	Sandy Loam	Sandy Loam
Surface Organic Depth	<None>	<Discontinuous>
Rooting Depth	<1 cm	8–15 cm
Restrictive Layer	20-25 cm (Till)	23–29 cm (Till)
<b>Nutritional Profile</b>		
* Available Nitrate -N	1.8 ppm ( $\pm 0.6$ SD)	1.5 ppm ( $\pm 0.9$ SD)
* Available Phosphate-P	<Below Detection Limit>	<Below Detection Limit>
* Available Potassium-K	33.3 ppm ( $\pm 3.5$ SD)	24.7 ppm ( $\pm 0.6$ SD)
* Available Sulfate-S	<Below Detection Limit>	<Below Detection Limit>
* Electrical Conductivity	0.5 dS/m ( $\pm 0.2$ SD)	0.6 dS/m ( $\pm 0.4$ SD)
* Sodium Adsorption Ratio	0.4 ( $\pm 0.1$ SD)	0.3 ( $\pm 0.0$ SD)
* Saline Classification	Non-Saline	Non-Saline

SD: Standard Deviation

dS/m: deciSiemens per metre

\*Mean values; Based on laboratory analyses of soil samples



Table 2. KM52 — Summary of observed vegetation.

Growth Form	Taxon	Common Name	Control	Disturbed	Environs*
Graminoid	<i>Carex fuliginosa</i> subsp. <i>misandra</i>	Short-Leaved Sedge	✓	✓	
Forb/ Perennial Herb	<i>Dryas integrifolia</i>	Mountain Avens	✓	✓	
	<i>Pedicularis lanata</i>	Woolly Lousewort			✓
	<i>Erysimum pallasii</i>	Arctic Wallflower		✓	
	<i>Saxifraga oppositifolia</i>	Purple Saxifrage	✓		
	<i>Saxifraga aizoides</i>	Yellow Saxifrage	✓		
	<i>Physaria arctica</i>	Arctic Bladderpod	✓	✓	
Shrub/Ericaceae	<i>Salix reticulata</i>	Net-Veined Willow	✓		
Exotic Weeds	—	—	<None Recorded>		

\*Recorded adjacent to study area // <Bold> Refers to high/predominant abundance.

Table 3. KM52 — Mean surface projective cover (%) within vegetation quadrats.

Survey Site (Survey Marker ID)	KM52 — Disturbed (KM52-0, -50, -100)	KM52 — Control (KM52-C0, -C50, -C100)
*Bare Soil/Rock	98.7% (±0.6 SD)	66.0% (±4.2 SD)
*Bryophytes/Lichen	<None>	16.3% (±2.2 SD)
*Litter	<None>	<None>
*Graminoids	<None>	6.2% (±0.4 SD)
*Forbs	1.3% (±0.6 SD)	9.6% (±3.7 SD)
*Shrubs/Ericaceae	<None>	1.9% (±3.3 SD)

\*Means values // SD: Standard Deviation

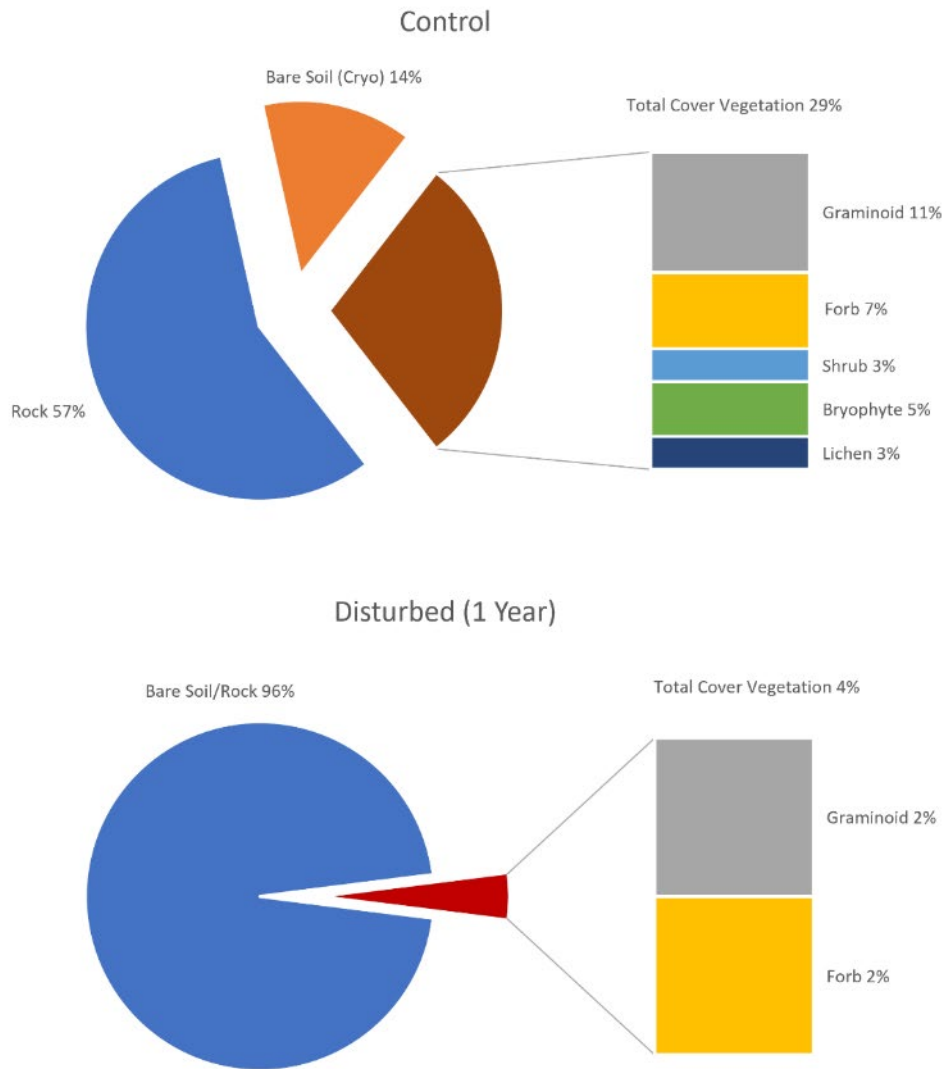


Figure 2. KM52 — Surface projective cover (%) along vegetation transect.



## KM16 — 5 YEARS POST-DISTURBANCE

Map 4 shows the sampling layout at KM16. Table 4 summarizes landscape, terrain and soil attributes. Table 5 lists observed vegetation species within and adjacent to the study area. Table 6 summarizes mean surface projective cover within the vegetation quadrats. Figure 3 shows total projective cover along the survey transect. Supporting information (e.g., geo-referencing and lab analysis) is provided in Appendix B2.

**Landscape, Terrain and Soil**— Located near Phillips Creek, the survey transects occur on an upland plateau with near-level slopes (Photo 4 a–b). The landscape is characterized by low-centred polygons (i.e., patterned ground caused by permafrost), resulting in an abundance of small hummocks and shallow depressions. Native (control) soils appeared to be Brunisolic Turbic Cryosols as defined by an Om and Bm/Bmy sequence<sup>5</sup>. Control soil profiles (KM16-C0, -C75, -C150) were characterized by a thin surface organic layer (Om, 4–6 cm in depth) followed by a sandy loam textured B horizon. The moderate incorporation of coarse parent materials (i.e., till) resulted in a restrictive layer at ~25 cm deep. The soil moisture regime was subxeric (dry); faint mottling<sup>6</sup> was observed in the soil profile. Disturbed soil profiles (KM16-0, -75, -150) were characterized by a discontinuous surface organic layer (Om, up to 2 cm deep, where present), a similar sandy loam B horizon with the incorporation of coarse parent materials and some discernible horizons or structure, but no mottling or gleying. Subsoils were intact, suggesting that the area had only been superficially disturbed.

Laboratory analysis determined that both control and disturbed soils had poor fertility [as indicated by low available nutrients, low EC and adsorption potential] and little incorporated organic matter.

**Vegetation Surface Cover and Composition**— Vegetation cover in control areas was abundant (83% along the transect; 92% within quadrats) with representation by graminoids, forbs/perennial herbs, shrubs, bryophytes and lichen (Photo 5a–c). Disturbed areas were characterized by discontinuous but still moderately abundant cover vegetation (51% along the transect; 40 within quadrats) primarily composed of graminoids and forbs/perennial herbs and few bryophytes or lichen species (Photo 5d–f).

Short-leaved sedge, membranous sedge (*C. membranacea*), mountain avens, dwarf fireweed (*Chamerion latifolium*), yellow oxytropis (*Oxytropis maydelliana* subsp. *melanocephala*), Arctic blueberry (*Vaccinium uliginosum* subsp. *microphyllum*), net-veined willow, and white mountain heather (*Cassiope tetragona*) were commonly observed both in control and disturbed areas. No exotic or non-native species were recorded. The presence and abundance of these species was generally consistent with known habitat descriptors for the dry-to-moist graminoid/dwarf shrub land cover type that is characterized by imperfectly drained to moderately well-drained dry-to-moist substrates characterized by rocks, gravel, sand, silt and clay (Aiken et al. 2011).

<sup>5</sup> Om = Organic-mesic; Bm = B horizon affected by chemical alteration and/or weathering; Bmy = Bm with cryoturbation.







<sup>6</sup> This characteristic results from oxidizing and reducing conditions associated with a fluctuating water table and/or presence of an impermeable subsoil layer.

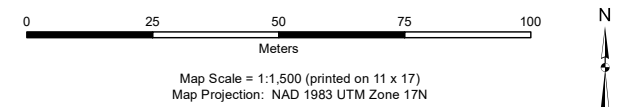


**KM16**  
Vegetation and Soil Sampling Sites



**Legend**

-  Tote Road
-  Tote Road (25m Buffer)
-  Soil
-  Vegetation
-  Survey Marker
-  Cover transect



**Data Sources**

- Main map. Baffinland Iron Mines Corporation Imagery, 2019
- Inset map. National Geographic World Map.

**Disclaimer**

EDI Environmental Dynamics Inc. has made every effort to ensure this map is free of errors. Data has been derived from a variety of digital sources and, as such, EDI does not warrant the accuracy, completeness, or reliability of this map or its data.

Drawn: Y. Navarro	Checked: P. Audet	Map 4	Date: 2019-08-28
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Photo 4. KM16 — Landscape overview southwest (a) and northeast (b).