APPENDIX L RECLAMATION AND REVEGETATION LITERATURE REVIEW

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MEMO

TO	B2Gold Nunavut
FROM	Jessica Lowey (MSc, Pag), Katherine Baird (MScF, RPBio)
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REFERENCE	0773592
SUBJECT	Goose Mine: Reclamation and Revegetation Literature Review

1. INTRODUCTION

1.1 OBJECTIVES

The objective of this memo is to support revegetation and progressive reclamation planning at the Goose Project (the Project) to meet Nunavut Impact Review Board (NIRB) Project Certificate No. 007 Amendment No. 001 (NIRB 2024) Term and Condition 36, by providing potential options for B2Gold Nunavut to consider and progress closure. In support of this, this memo includes:

- Summary of reclamation and revegetation term and conditions and commitments in the NIRB Project Certificate, FEIS, and associated comments (Section 2);
- Summary of the history of reclamation and current status at the Project (Section 3);
- Literature review of best practices and industry experiences for Arctic reclamation and revegetation (Section 4); and,
- Recommendations for progressive reclamation and revegetation strategies to meet Term and Condition 36, including practicality of topsoil/organic matter salvage, and progress revegetation planning for the eventual closure of the Project (Section 5).

2. REVEGETATION AND RECLAMATION CONDITIONS AND COMMITMENTS

NIRB Terms and Conditions (Project Certificate No. 007 Amendment No. 001 [NIRB 2024]) and FEIS (Sabina 2015) commitments on reclamation and revegetation are provided in Attachment A and Attachment B.

NIRB Term and Condition 36 outlines requirements for revegetation at the Project as it relates to the Mine Closure and Reclamation Plan, including considerations for progressive reclamation and maintenance of an up-to-date revegetation plan for the Project. NIRB Term and Condition 36 includes the following:

Category: Vegetation – Mine Closure and Reclamation Plan

> Project Phase: Pre-Construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure Monitoring
>
> Objective: To maintain an up-to-date revegetation plan for the Project.
>
> Term or Condition: The Proponent shall include revegetation strategies within its Mine Closure and Reclamation Plan that support progressive reclamation, and promote natural revegetation and recovery of disturbed areas compatible with the surrounding natural environment. These strategies should include exploration of the feasibility and practicality of topsoil/organic matter salvage through Project development. The Closure and Reclamation Plan should be updated on an on-going basis as more information becomes available from similar reclamation efforts at other northern projects, as applicable.
>
> Reporting Requirements: Within three (3) years from the commencement of construction of the Back River Gold Mine Project, information regarding the revegetation strategies developed and implemented by the Proponent in fulfillment of this Term and Condition shall be included in the Proponent's annual report to the Nunavut Impact Review Board and this information will include reclamation strategies for the Energy Centre Project. Subsequently, information regarding the Proponent's progress in fulfillment of this Term and Condition shall be provided annually in the Proponent's annual report to the Nunavut Impact Review Board. Whenever the Proponent makes subsequent revisions to the Monitoring Plan(s), the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan(s) and will ensure the updated Plan is posted on the Proponent's project website.

NIRB Term and Condition 36 should be addressed in consideration with other NIRB Terms and Conditions and FEIS commitments that outline reclamation and revegetation requirements. NIRB Terms and Conditions supporting No. 36 include No. 35, 34, 32, 15, and 7 (Attachment A). FEIS (Sabina 2015) commitments related to NIRB Term and Condition 36 are provided in Attachment B, in addition to the Interim Closure and Reclamation Plan (ICRP; Sabina 2021) describing plans for progressive reclamation and closure. Comments on the 2024 NIRB Annual Report from the Crown Indigenous Relations Northern Affairs Canada (CIRNAC) and Kitikmeot Inuit Association (KIA) addressing requirements related to NIRB Term and Condition 36 are included in Attachment C.

3. PROGRESSIVE RECLAMATION AT GOOSE PROJECT

The ICRP (Sabina 2021) outlines the activities and monitoring required for the temporary or permanent closure and reclamation of the Project, including the Project's plan for progressive reclamation (ICRP Section 6). Progressive reclamation is the opportunistic reclamation activities completed during the operational phase of a project before permanent closure (MVLWB/AANDC 2013). Opportunities for progressive reclamation are identified for open pits and tailings facility, underground mine, waste rock storage areas, tailings storage facility, contaminated materials and waste disposal, and buildings, equipment and infrastructure (ICRP Section 6.2; Sabina 2021). As construction of Goose Project finished in 2025 and areas remain active, progressive reclamation and revegetation has not been implemented to date at either the Goose Mine or Marine Laydown Area (ICRP Section 6.4; Sabina 2021).

Through development of the ICRP, natural revegetation was identified for most Project areas due to the cold climate and established practices for mine closure in Nunavut (ICRP Section 6.3; Sabina 2021). For most areas, strategies that support and encourage natural revegetation and recovery will be applied as appropriate (ICRP Section 6.3; Sabina 2021). Natural revegetation and recovery was selected based on results of the literature review of reclamation practices at northern mine sites as summarized in ICRP Appendix E, June 2018 (Sabina 2021), and included studies on active revegetation, seeding, and/or soil amendment trials. This initial review concluded that active revegetation offers limited benefits offset by logistical and cost challenges, as well as potential environmental impacts (Sabina 2021). Key constraints identified included harsh Arctic growing conditions, limited availability of native seed, lack of suitable growth media, lack of suitable soil amendments, and possible adverse effects on the physical stability of surficial soils (Sabina 2021).

In support of reclamation and revegetation, B2Gold Nunavut explored the feasibility of practicality of topsoil/organic matter salvage. B2Gold Nunavut stockpiled topsoil/organic layer and overburden material from the Echo and Umwelt open pits for reclamation at closure. Soil horizons were thin in these areas and so the organic and topsoil layers were not salvaged/stockpiled separately from the overburden material which primarily consists of unconsolidated material (silty clay loam). Assessment of the feasibility of topsoil/organic material salvage will be completed on a site-specific basis.

4. REVIEW OF ARCTIC RECLAMATION PRACTICES

A desktop literature review was completed for Arctic reclamation and revegetation strategies, consisting of scientific research, Inuit and government guidelines, and industry experience. The goal of this literature review was to summarize revegetation strategies to support progress towards meeting Term and Condition 36 and identify best practices and successful practices to inform progressive reclamation. Best practices for Arctic reclamation and closure to meet related conditions/commitments were also included. This review expands on the Project's existing summary of revegetation strategies implemented at Arctic mines (ICRP Appendix E, June 2018 [Sabina 2021]; Section 3), by including literature current to 2025, as well as incorporating mine case studies with guidelines and scientific research for a comprehensive assessment and to capture more recent advances in Arctic reclamation. By remaining up to date on emerging revegetation strategies this review demonstrates an ongoing effort to meet Indian and Northern Affairs Canada (INAC; 2002a) requirements for mine reclamation to "adapt to new and improved technologies and methodologies" and "current and comprehensive technical information".

A literature review table referencing and summarizing applicable scientific research, guidelines, and industry case studies is included in Attachment D. A synthesis of Arctic reclamation and revegetation practices and performance from reviewed literature to identify best practices is also provided in the following sections:

- Reclamation Policy and Guidelines (Section 4.1);
- Arctic Conditions and Limitations for Revegetation (Section 4.2);
- Site Preparation (Section 4.3);
- Revegetation (Section 4.4);
- Monitoring (Section 4.5);
- Other Considerations (Section 4.6); and,
- Inuit Traditional Knowledge (Section 4.7).

Northern mining projects relevant to Goose Mine (Nunavut, low Arctic) and incorporated in the review include Mary River Mine (Nunavut, high Arctic), Diavik Diamond Mine (Northwest Territories, Subarctic), Red Dog Mine (Alaska, low Arctic), Colomac Mine (Northwest Territories, Subarctic), Atlin Ruffner Mine (British Columbia, alpine tundra), Ekati Mine (Northwest Territories, Subarctic), Snap Lake Mine (Northwest Territories, Subarctic boreal-tundra transition), Hope Bay Mine (Nunavut, high Arctic), and Meliadine Mine (Nunavut, low Arctic).

4.1 RECLAMATION POLICY AND GUIDELINES

Policy and guidelines for mine reclamation and revegetation in Nunavut include the Mine Site Reclamation Policy for Nunavut (Indian and Northern Affairs Canada [INAC] 2002a), Mine Reclamation Guidelines for the Northwest Territories and Nunavut (INAC 2002b), and Northern Land Use Guidelines (e.g., INAC 2003; INAC 2009; INAC 2010). The Mine Site Reclamation Policy for Nunavut (INAC 2002a) states mine reclamation should be based on the 1994 Whitehorse Mining Initiative definition of mine site reclamation:

> returning mine sites and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

INAC (2002a) also includes the following related to progressive reclamation and revegetation:

> Best management practices, including progressive reclamation, should be applied to advance environmental protection and reduce environmental risks.
>
> The selection of key reclamation and closure alternatives should be based on current and comprehensive technical information generated by experts, such as competent, credible consultants.
>
> Mine closure and reclamation plans should be sufficiently flexible to allow adjustments as the life of the mine progresses, including the flexibility to adapt to new and improved technologies and methodologies, and allowing for progressive reclamation, while ensuring obligations under the plans are met.
>
> The reclamation of the surface to meet acceptable standards.

Additional guidelines and best practices for Arctic reclamation and revegetation are available from international, federal, territorial, and research bodies such as Northern Land Use Guidelines for

NWT Lands (GNWT 2015), Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories (MVLWB 2013), Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2007), Northern Landscaping: A Guide to Restoring the Plants and Soil in Northern Communities (CMHC 2002), Yukon Revegetation Manual: Practical Approaches and Methods (Matheus & Omtzigt 2013), Integrated Mine Closure Good Practice Guide, 3rd Edition (International Council on Mining and Metals 2025), among others assessed. Guidelines highlight that successful reclamation requires the re-establishment of soil processes such as nutrient cycling and native plant communities including a diversity of shrub, forb, graminoid, and bryophyte species.

4.2 ARCTIC CONDITIONS AND LIMITATIONS FOR REVEGETATION

Arctic environments have a variety of environmental constraints that make revegetation challenging (INAC 2009), including extreme climate, permafrost features, and tundra ecosystem succession. Arctic climates have a short growing season, short frost-free period, low temperatures, low precipitation, and high winds resulting in wind erosion and plant desiccation (Billings 1987; Chapin 1987; MVLWB 2013; Bliss & Matveyeva 1992; Nadelhoffer et al. 1992; Bell & Bliss 1980; Matheus & Omtzigt 2013; Lamarre et al. 2023). Tundra has permafrost-controlled soils (cryosols) that are cold, typically shallow soils with limited (< 5 cm) topsoil development, thin active layer (rooting zone layer that thaws each summer), slow rates of decomposition and nutrient turnover, and limited available moisture and nutrients (Bliss & Matveyeva 1992; Nadelhoffer et al. 1992; Matheus & Omtzigt 2013; MVLWB 2013). Disturbance to surface vegetation cover or the active layer in moist to wet permafrost areas can degrade permafrost and produce thermokarst (heat-pitting) resulting in ground subsidence and damage to permafrost-related landscape features, particularly in Subarctic areas (Matheus & Omtzigt 2013; MVLWB 2013; Webber & Ives 1978). Ecological succession and pedogenesis (soil development) are slow in cold stressed environments like tundra ecosystems (Cargill & Chapin III 1987; MVLWB 2013; Viereck 1966; Webber & Ives 1978). As a result, tundra ecosystems have a slow rate of secondary vegetational development and recovery (e.g., 20-25 years in most sites in northern Alaska; McKendrick 1997) and it may take several hundreds to thousands of years for tundra to reach its climax vegetation (Viereck 1966). These environmental constraints in combination with mine disturbed conditions (Section 4.3.1), have made Arctic revegetation projects difficult (e.g., wind erosion and substrate limitations at Mary River Project in the Canadian high Arctic [Audet & Setterington 2024]).

4.3 SITE PREPARATION

Site preparation involves the modification of substrate and surface conditions to facilitate revegetation through creating more favorable conditions for germination, establishment, and growth of native Arctic plant species. This is typically completed through substrate application, topsoil salvage and placement, soil amendment, and surface roughening and microsite creation.

Findings and best practices in site preparation for revegetation are included for:

- Mine Substrates (Section 4.3.1);

- Backfilling and Capping (Section 4.3.2);
- Topsoil and Organic Material Salvage (Section 4.3.3);
- Substrate Amendment (Section 4.3.4); and,
- Surface Preparation (Section 4.3.5).

4.3.1 MINE SUBSTRATES

Mine disturbances and substrates pose additional difficulty for vegetation recovery (Adams & Lamoureux 2005). The physical characteristics of mine substrates include steep slopes and instability, poor soil structure and texture (e.g., coarse soils with low water holding capacity), infertile soil media (low cation exchange capacity, low organic matter) with susceptibility to drought, high surface temperatures, surface evaporation, etc. (Adams & Lamoureux 2005; INAC 2009). Substrates are typically deficient of macronutrients (e.g., nitrogen, phosphorus), organic material, and fungal root associates (i.e., mycorrhiza), making revegetation challenging (Adams & Lamoureux 2005). Tailings and other mine waste also often have elevated metals, salts, or acidity which pose direct limitations to plant growth through heavy metal or ionic toxicity (Adams & Lamoureux 2005; Cater 2010).

Mine substrates requiring reclamation often include mine tailings, waste rock, crushed rock, gravel, or till. Different mine substrates have shown different success in revegetation trials and programs. Heterogeneous substrates (e.g., crushed rock/mixed gravel, glacial till, volcanic silt, lava) with mixed particle size and surface heterogeneity/microhabitats typically show better revegetation success than homogeneous substrates (e.g., processed kimberlite, lake sediment) with similar particle size with smoother surfaces, having higher live cover, density, and spontaneous colonization (Lamarre et al. 2023). Crushed rock and gravel have high reclamation substrate potential, as indicated by good establishment, growth and seed production for Arctic plants including vascular plants, moss, and lichen (Drozdowski et al. 2012; Lamarre et al. 2023; Miller et al. 2021). Tailings such as processed kimberlite are an unsuitable reclamation substrate unless amended due to its physical characteristics and potentially plant toxic concentrations of heavy metals (Miller et al. 2021; Naeth & Wilkinson 2014). Mixes of different substrate types can be used to produce heterogenous particle size, which has also been beneficial for revegetation (Drozdowski et al. 2012; Naeth & Wilkinson 2014).

4.3.2 BACKFILLING AND CAPPING

Backfilling and capping of contaminated areas is typically completed as part of the reclamation process prior to revegetation works. Sufficient covering depth is needed for revegetation success since overburden coverings (caps) which fail result in surface acidification from the buried layers, unsuitable for revegetation (Adams & Lamoureux 2005; Johnson 1987; Pionke & Regowski 1979).

Best practices for backfilling and capping for Arctic reclamation and revegetation include:

- In contaminated areas, install a geomembrane liner and gravel layer (capillary break) to prevent movement of water and contaminated materials upward to the rooting zone (Johnson

1987; MVLWB 2013; Stuckless et al. 2025). To support revegetation, the substrate and gravel covering should be sufficiently deep (e.g., ≥ 1 m) for plant roots to prevent root interference with contaminated materials (Stuckless et al. 2025).

- In non-contaminated areas, reclamation substrates are typically applied at depths of 30-50 cm over 50 cm gravel (e.g., Budzey et al. 2025; Drozdowski et al. 2012; Lamarre et al. 2023).

4.3.3 TOPSOIL AND ORGANIC MATERIAL SALVAGE

Soil reconstruction is considered the most important element of reclamation (Johnson 1987). Topsoil salvage and placement involves the removal of the topsoil layer prior to disturbance followed by reapplication to restore native soils for purposes of revegetation as recommended by Arctic reclamation guidelines (Alaska Department of Natural Resources 2025; GNWT 2015; INAC 2009; INAC 2010; MVLWB 2013). Topsoil includes mineral soils with organic material, nutrients, mycorrhizae, and soil biota along with native seed bank and propagules including buried seed, stems, roots, and rhizomes that expedite vegetation growth (Chapin III & Chapin 1980; Johnson 1987; INAC 2009; United States Geological Survey [USGS] 2000).

Topsoil salvage and placement have benefited reclamation and revegetation performance on northern disturbed sites in many cases, including mines (Bishop et al. 1999; Kidd and Max 2001; Bahroudi 2024; Diavik Diamond Mine [Drozdowski et al. 2012; Miller & Neath 2017]; Red Dog Mine [ABR Inc. 2007]; Mary River Project [EDI 2020]; Snap Lake Mine [Turcotte et al. 2025]). For example, salvaged topsoil provided the most consistent increase in plant density among all substrates (Diavik Diamond Mine [Drozdowski et al. 2012]) and also greater below ground (root) biomass (Miller & Neath 2017). Few studies found soil salvage with limited performance (e.g., Diavik Diamond Mine [Miller et al. 2021]), suggested possibly due to long stockpiling time, low application amounts, or incorporation rather than surface application. Johnson (1987) suggests that it is typically not practicable to stockpile or respread less than 10-15 cm topsoil, so thinner upland Arctic topsoil (often < 5 cm) may not be deep enough to stockpile at some sites. However, wetter tundra may have deeper topsoil or may still be suitable for salvage of the organic layer (tundra sod) for transplanting (Section 4.4.2.2).

Best practices for Arctic reclamation topsoil and organic layer salvage and placement include:

- Salvage topsoil and organic layer where feasible, typically suitable for sites with depths greater than 10-15 cm (Johnson 1987).
- Salvage the organic/sod layer (O horizon) separate from the mineral topsoil (A horizon) and maintain soil horizons where feasible (CMHC 2002; Miller et al. 2021). The organic mat in tussock tundra for example contains abundant buried seeds (Forbes & Jefferies 1999).
- Direct placement of material is preferred where possible, or if direct placement is not possible, it is essential to minimize the length stockpiling time to maintain higher viability of plant propagules like buried seed (Johnson 1987; Miller et al. 2021). Stockpiling time negatively

impacts soil characteristics reducing seed bank viability and germination (Abdul-Kareem and McRae 1984; Birnbaum et al. 2016; Golos et al. 2017; Mackenzie & Naeth 2019).

- When spreading material, prevent compaction by using low compaction tracked equipment, avoid soil handling when wet, and roughening surface after spreading to create microsites (INAC 2009).
- When spreading material, apply on the surface rather than incorporating material and apply with variable coverage, including higher application rates in select areas (Miller et al. 2021; e.g., 15 cm topsoil and 15 cm subsoil [Bahroudi 2024]). For seeding, mineral soil (e.g., topsoil) should be exposed, since Arctic plants typically require exposed mineral soils for germination and seeding onto mulches, erosion control mats, or organics often does not produce established seedlings (Adams & Lamoureux 2005).

4.3.4 SUBSTRATE AMENDMENT

Substrate amendments are materials applied to improve the physical and chemical characteristics of the reclamation substrate, such as use of organic matter (e.g., sewage, compost), fine materials, fertilizers, mycorrhizae, and other amendments. If topsoil salvage and placement are not possible to restore native soils, soil reconstruction can be completed using organic and fine-grained material amendments (Johnson 1987; Forbes & Jefferies 1999). Soil amendment has been shown to facilitate vegetation development in disturbed Arctic environments and mines (e.g., Diavik Mine [Drozdowski et al. 2012; Miller & Naeth 2021; Naeth 2004; Neath & Wilkinson 2014; Diavik Diamond Mines Inc. 2025], Red Dog Mine [ABR Inc. 2007]; Mary River Project [EDI 2020]; Jorgenson and Joyce 1994). Consideration of site-specific characteristics—substrate type, possible contaminants, hydrologic regime, and climate—and revegetation targets are needed to select appropriate soil amendments and application rates.

4.3.4.1 ORGANIC

Organic amendments are organic materials added to substrate to increase organic content and macronutrients, improve moisture retention, or reduce metal bioavailability (Adams & Lamoureux 2005; Jorgenson & Joyce 1994; Meidinger 1979) and generally is recommended by guidelines (e.g., MVLWB 2013). Organic material also provides an insulative cover to protect permafrost damage (Matheus & Omtzigt 2013), and in saline soils, limits evaporation and salt deposition/accumulation at the soil surface (Forbes & Jefferies 1999).

Although salvaged topsoil and organic materials are preferred for organic addition (Section 4.3.3), alternative organic amendments may include sewage sludge (biosolids), bio pellet, water treatment sludge, compost, manure, peat, leonardite, or biochar. Sewage sludge is the most commonly applied organic amendment found to be effective in many studies and mine sites (e.g., Drozdowski et al. 2012; Miller & Neath 2017; Neath 2004; Neath & Wilkinson 2014). Peat (sphagnum peat moss) also shows good performance (Miller & Neath 2017; Neath 2004) but is limited in availability and peat harvesting has negative environmental impacts. Compost shows variability in performance including positive results when incorporated (Ekati Mine [Dominion Diamond Mines Ltd. 2018]) and negative results when applied to the substrate surface as a mulch

(Bahroudi 2024). Organic amendments found to be a less effective amendments include water treatment sludge (Neath & Wilkinson 2014), leonardite (Bahroudi 2024), and biochar (e.g., Diavik Mine [Drozdowski et al. 2012; Miller & Naeth 2017; Naeth 2004; Neath & Wilkinson 2014; Rio Tinto 2017]). Performance of other bio pellets is unknown (Ekati Mine [Dominion Diamond Mines Ltd. 2018]).

Sewage sludge is an effective amendment for enhancing nutrients and plant cover (Bishop et al. 2000; Reid 2003). Neath & Wilkinson (2014) found that sewage increased available nitrogen/phosphorus, plant density/cover, and species richness with seeding. Miller et al. (2021) found best seed establishment in crushed rock with sewage sludge incorporation (upper 5–10 cm). Sewage sludge (biosolids) has been effective at initiating plant growth at northern mines; however, investigation of potential negative effects (e.g., pathogens, heavy metals, nitrates) is ongoing (e.g., Diavik Mine [Drozdowski et al. 2012; Miller & Neath 2017; Naeth 2004; Neath & Wilkinson 2014; Rio Tinto 2017], Red Dog Mine [ABR Inc. 2007], and Ekati Mine [Dominion Diamond Mines Ltd. 2018]). For example, Drozdowski et al. (2012) found sewage sludge had adverse high concentrations of high copper, molybdenum, phosphorus, selenium, sulphate and zinc. Sewage sludge also has fecal coliform (Streptococcus) and Salmonella (Naeth 2004) but may be reduced by 99.98% through winter application (Ekati Mine [Dominion Diamond Mines Ltd. 2018]). Sewage amendment is included in some reclamation plans, such as sewage mixed with till in progressive reclamation (e.g., Diavik Diamond Mine [Rio Tinto 2025]); however, is not widely applied during reclamation since implementation at a large scale can be impractical.

Best practices for organic amendments in Arctic reclamation and revegetation include:

- Incorporate organic amendments into substrate since mulches (topdressing) can block the rooting zone and inhibit plant establishment and growth (e.g., compost in Bahroudi 2024). Incorporation of organic material with surface sediments can be completed using a harrow to (e.g., to 5-10 cm [Miller et al. 2021] or to 10-30cm [Matheus & Omtzigt 2013]).
- Mulches are not recommended unless in special circumstances for erosion control (CMHC 2002).
- Match organic content and thickness to the surrounding site, wherein lowland areas tend to have thicker organic content and upland soils have lower organic content (Matheus & Omtzigt 2013).
- Apply sewage treatments in patches or islands (heterogeneity) and have mineral soil available for seed germination (Miller et al. 2021).
- Priority areas for organic amendment include erosion-prone areas, clay-rich areas, and slopes (Turcotte et al. 2025).

4.3.4.2 INORGANIC FERTILIZERS

Inorganic fertilizers add macronutrients nitrogen, phosphorus, and potassium (NPK) to increase availability in substrates for revegetation. Fertilizers in Arctic environments are shown to accelerate plant growth and cover (especially grasses) and overall biomass; however, may reduce vegetation diversity and inhibit natural revegetation in the long-term (Adams & Lamoureux 2005;

Bahroudi 2024; CMHC 2002; Forbes & Jefferies 1999). Fertilizers tend to favour non-native agronomic plant species rather than native plant species since Arctic native species are often adapted to the low nutrient conditions of the Arctic (e.g., Section 4.2; Chapin III & Chapin 1980; CMHC 2002). The dense flush of grasses in response to fertilization can inhibit natural colonization by shrubs and other species and potentially alter successional pathways (Chapin et al. 1995), relevant considering the shrub succession pattern seen under natural revegetation patterns in which shrubs establish prior to graminoid meadows (Viereck 1966). Shrubs have also been shown to perform better without fertilization (Turcotte et al. 2025). Some studies; however, have found low NPK effective at increasing total vegetation cover of bryophytes and other vascular plants (e.g., Neby et al. 2022). Fertilizers also favour above ground growth rather than root growth, which may be a better indication of long-term revegetation success in Arctic conditions where species have high root:shoot ratios (Adams & Lamoureux 2005). Due to the low holding capacity of coarse materials common in mining reclamation substrate, fertilizer runoff has the potential to impact downstream water bodies (Adams & Lamoureux 2005; MVLWB 2013) and nutrients may not be retained (depleted quickly), so benefits of accelerated growth may be shorter term (ABR Inc. 2007; Miller & Neath 2017).

Guidelines note the importance of minimal and judicious use of fertilizers for Arctic reclamation (e.g., CMHC 2002; MVLWB 2013; Matheus & Omtzigt 2013; USGS 2000), instead favouring topsoil/organic salvage, organic amendment, or nitrogen-fixing native plants to enhance nutrients. Mines have used inorganic fertilizers in some reclamation situations (e.g., Diavik Diamond Mine [Drozdowski et al. 2012; Naeth & Wilkinson 2014]; Ekati Mine [Dominion Diamond Mines Ltd. 2018]; Red Dog Mine [ABR Inc. 2007]; Snap Lake Mine [Turcotte et al. 2024]).

Best practices for the use of inorganic fertilizers for Arctic reclamation and revegetation include:

- Consider reclamation objectives – Objective of developing greater plant cover may conflict with the objective of greater species diversity, important when considering fertilization (Forbes & Jefferies 1999). Dry Arctic environments have naturally sparse vegetation cover (Forbes & Jefferies 1999).
- Match soil nutrients to the surrounding site – Native Arctic soils naturally have low nutrients, especially dry sites (Forbes & Jefferies 1999). Wetlands tend to have higher nutrient levels and may be more appropriate for fertilization (Forbes & Jefferies 1999).
- Fertilizer mix and application rate should be based on site conditions of soil chemistry and testing (Turcotte et al. 2025; Matheus & Omtzigt 2013). Typical rates include N 40-90 kg/ha; P_2O_5 30-70 kg/ha; K_2O 30-60 kg/ha; S 0-17 kg/ha (Matheus & Omtzigt 2013).
- Minimize fertilizer application – If fertilization is used, application should be at a low rate with seeding and transplanting (Adams & Lamoureux 2005; Matheus & Omtzigt 2013; USGS 2000). Matheus & Omtzigt (2013) suggest using less than half the recommended rates (e.g., <50kg N/ha). Turcotte et al. (2025) suggest using 200 kg/ha 10:30:25 NPK for overburden. USGS (2000) suggest rate of 560 kg/ha for slow release fertilizer. ABR Inc. (2007) suggest 448-504 kg/ha 20:20:10 NPK)

- Use slow-release fertilizers to avoid leaching (Adams & Lamoureux 2005; USGS 2000), such as MagAmp 7:52:6 NPK or Osmocote 14-14-14 NPK 2-year-release form (USGS 2000).
- Application should occur when plants are large enough to utilize fertilizers (i.e., after a few years growth) to prevent runoff (Adams & Lamoureux 2005).

4.3.4.3 FINE MATERIALS

Fine materials are used to amend coarse materials to improve soil structure for improved water retention ability, soil moisture, and nutrient retention for revegetation (Drozdowski et al. 2012; Forbes & Jefferies 1999; Neath & Wilkinson 2014), and is recommended by guidelines (e.g., MVLWB 2013). Fine materials may include glacial till, lakebed sediments, glaciolacustrine deposits, or zeolite, used to amend coarse materials such as waste rock. In mine reclamation applications, mixes of coarse waste rock with fine textured till have been shown to reduce adverse element concentrations and improve revegetation (e.g., 25:75 mix of processed kimberlite to till; Drozdowski et al. 2012; Neath & Wilkinson 2014). Zeolite amendment (fine textured) was also found to have the highest biomass and species richness (Bahroudi 2024). Lake bed sediments also have potential for reclamation and showed some vegetation recovery (e.g., Miller et al. 2021; Miller & Neath 2017). Fine materials; however, are prone to wind and water erosion (Johnson 1987), which can be reduced by surface roughening. Homogenous fine materials like some mine tailings materials instead should be amended by coarse materials.

4.3.4.4 MINERAL AMENDMENTS

Mineral amendments are used to counteract substrate conditions such as acidity (low pH), sodicity (high sodium), or low magnesium; however, are not referenced in mine reclamation guidelines. Lime (calcium carbonate) is used to amend acidic soils, dolomitic lime (calcium carbonate and magnesium carbonate) is used to amend acidic soils and low magnesium sites, and gypsum (calcium sulfate) is used to amend soil structure in high salinity or heavy clay (Adams & Lamoureux 2005; Cater et al. 2020; Meidinger 1979). Mineral amendments are expensive and not typically used in mine reclamation; however, pelletized dolomitic lime has been used to treat fugitive dust acid-contaminated sites, but results are not known (Red Dog Mine [ABR Inc. 2007]). Instead, capping contaminated areas or mixing with other substrates is preferred and more cost-effective than mineral amendments.

4.3.4.5 OTHER AMENDMENTS

Other less common amendments include mycorrhizae (Ekati Mine [Dominion Diamond Mines Ltd. 2018]) or nitrogen-fixing Rhizobium bacteria (USGS 2000). These amendments have limited research on their application for reclamation and revegetation at northern mines.

4.3.5 SURFACE PERPARATION

Surface preparation techniques recommended and widely applied in Arctic reclamation include contouring/slope stabilization, decompaction, surface roughening, addition of surface features, and other methods to decrease surface compaction and increase availability of microhabitats and seed contact with soil. Literature and best practices highlight the importance of surface preparation (microhabitats) for revegetation establishment, with some variability based on site-specific considerations (e.g., presence of permafrost, erosion potential). In general, surface preparations should aim to recreate similar site conditions as undisturbed/baseline conditions to which native plants are adapted.

4.3.5.1 SLOPE STABILIZATION AND EROSION CONTROL

Slope stabilization and erosion control are required prior to other surface preparation to prevent loss of fine materials (Johnson 1987). Techniques include contouring to match the surrounding landscape natural angle, constructing gentle (< 2:1) rounded slopes where possible, terracing/stepping steep slopes, rounding excavated slopes, and maintaining natural hydrology (INAC 2009; EDI 2020). Recontouring can be completed using stockpiled overburden with mineral topsoil placed on top at variable depths where possible (INAC 2009). Frozen material for reconstruction is not recommended since the ground ice may melt and cause subsidence (GNWT 2015; INAC 2009; INAC 2010). In cases where erosion is severe, other erosion and sediment controls such as cross ditches, berms or swales, and erosion control mats or tarps may be needed (GNWT 2015a, 2015b; INAC 2009; INAC 2010). Erosion control products such as anionic polymer Soil Lynx (soil binder) are also available but were found to not be effective on diamond mine wastes with high sand content (Miller et al. 2021). Surface decompaction and roughening through the rough-and-loose technique also slows water movement, increases water infiltration, and reduces erosion as shown in Arctic reclamation (Government of Northwest Territories 2017; Section 4.3.5.2).

4.3.5.2 SURFACE ROUGHENING AND DECOMPACTION

Surface decompaction and roughening are used to increase surface heterogeneity and microhabitats for plant propagules (Government of Northwest Territories 2017). Techniques commonly applied in mine reclamation include cultivation/tilling/ripping of severely compacted sites (e.g., roads) using a winged subsoiler, plow or t-plow, or disc trenching (e.g., Budzey et al. 2025; Forbes & Jefferies 1999; Turcotte et al. 2025; Rio Tinto 2025), surface scarification (e.g., CMHC 2002; GNWT 2015a, 2015b; INAC 2010; Turcotte et al. 2025; Rio Tinto 2025), rough-and-loose technique or mounding (e.g., CMHC 2002; Government of Northwest Territories 2017 [Colomac Mine]; Lamarre et al. 2023; Matheus & Omtzigt 2013; Polster 2013), berm and trough creation, and rock-placement (ABR Inc. 2007; CMHC 2002; Ekati Mine [Dominion Diamond Mines Ltd. 2018]). Even in coarse rocky substrates, scarification improves vegetation establishment (Turcotte et al. 2025).

Studies and guidelines recommend and demonstrate the benefits of surface roughening for revegetation in most circumstances, particularly progressive scarification and for promoting natural revegetation (e.g., Budzey et al. 2025; CMHC 2002; Forbes & Jefferies 1999; GNWT 2015a, 2015b; INAC 2010; Turcotte et al. 2025; Rio Tinto 2025). A study found surface preparation for texturing to have limited functional value after a year of their application due to wind erosion of fine materials, and recommend focusing on erosion control and microhabitat stability (e.g., Audet & Setterington 2024 [Mary River Project]), or even poorer performance on tilled TSF than untilled in terms of lower plant diversity than untilled sites (e.g., Bahroudi 2024).

Other uses may be a consideration, since the resulting rough surface from scarification of rock can impede wildlife and human movement, and so it may be desirable to maintain some smooth surfaces for travel in some circumstances (e.g., as identified by Inuit Traditional Knowledge Panel, Diavik Diamond Mine [Rio Tinto 2025]). Near surface permafrost sites also need special considerations for surface roughening such as reduced depth (Section 4.3.6). On slopes scarification/raking should be done perpendicular to the slope to aid in slowing water movement for erosion control.

4.3.6 PERMAFROST CONSIDERATIONS FOR SITE PREPARATION

Contouring, decompaction, and other surface preparation activities with heavy equipment should be managed to prevent permafrost melting. Nunavut RAC (2012) describes Good Environmental Practice Considerations in Canadian Permafrost Regions including use of tracked equipment.

Best practices to protect permafrost during Arctic reclamation include:

- On lowland permafrost sites with permafrost close to the soil surface, surface work should be minimized to light harrowing or raking (e.g., only the top few centimetres) rather than deep soil turning to avoid damage to permafrost (i.e., do not cultivate the frozen ground; Matheus & Omtzigt 2013). Arctic mines generally implement these best practices, such as limiting earthworks to <35 cm depth to protect permafrost (EDI 2020).
- Restore hydrological function and natural drainage patterns by aligning with surrounding landscape and terrain are also important to prevent water ponding/lakes which can result in permafrost degradation and ground subsidence (EDI 2020; INAC 2009).
- Maintaining 20-30 cm depth gravel fill can also prevent permafrost degradation (Jorgenson & Joyce 1994).
- In areas of human-caused thermokarsting, additional best practices include applying as much topsoil/organic material as possible (e.g., >20 cm), avoid tillage, establish quick cover (e.g., 10% cover crop), and avoid equipment use until the ground is frozen (Matheus & Omtzigt 2013).

4.3.7 BUFFERS AND SHELTERING

Abiotic and biotic vertical structures used as buffers in reclamation are installed perpendicular to the wind direction as wind breaks in an effort to trap snow, reduce wind speeds, wind-injury and wind erosion, and increase soil moisture at the microsite scale (Jorgenson & Joyce 1994; MVLWB 2013). Vertical structures include berms (i.e., artificial raised ridges of soil, embankments, or rock), artificial snow fences, wattle fences, and vegetation buffers such as shrub hedgerows (MVLWB 2013). Evidence for the effects of vertical structures on revegetation success are limited (Lemay et al. 2021); however, abiotic structures have been shown to increase soil moisture (Budzey at al. 2025; Jorgenson & Joyce 1994). Snow fencing may be more effective when taller (e.g., 1 m) and has been beneficial to revegetation in some studies (e.g., Lemay et al. 2021), while shorter show fencing (0.35 m, 0.65 m) did not have significant effects on revegetation (Budzey at al. 2025; Rausch and Kershaw 2007). Biotic shrub buffers were shown to possibly reduce plant-available water in summer due to transpiration (Budzey et al. 2025), while natural succession studies show snow accumulation as vegetation develops (Viereck 1966). Some industry reclamation and closure plans also reference the use of berms for snow capture and rock/boulder placement (ABR Inc. 2007).

4.4 REVEGETATION

Arctic revegetation includes both natural and active revegetation to restore plant communities and stabilize permafrost conditions (Nunavut RAC 2012; EC 2012). Active revegetation techniques include seeding, planting, transplanting vegetative mats or plugs, live staking, and cuttings/sprigs. Natural revegetation involves natural colonization and recruitment of plant species, which can be passive or facilitated through site preparation methods or maintenance of seed-sources. Kempenaar et al. (2013) provides information on site-specific considerations for passive versus active revegetation including erosion risk, proximity to seed sources, presence of seed bank, presence of invasive species, site productivity, cost, site diversity, site stressors, and disturbance size. Arctic native plants are well adapted to harsh Arctic environments including poor nutrient conditions and hardy to cold temperatures and frost (Antonovics et al. 1967; Densmore et al 1990; Wielgolaski 1975; Munshower 1994; Brown 1997). Revegetation in the Arctic is generally slow (Section 4.2), with recovered vegetation expected to not provide surface erosion control or visual quality for 1-10 years (Adams & Lamoureux 2005). Early patterns of Arctic plant colonization and growth have been shown to influence later successional community composition (Kearns et al. 2015; Viereck 1966), highlighting the importance of suitable revegetation methods.

Studies and guidelines generally recommend prioritizing passive or facilitated natural revegetation in stable areas and integrating this with active revegetation where needed. Findings and best practices in revegetation practices are included for:

- Natural Revegetation (Section 4.4.1);
- Active Revegetation (Section 4.4.2); and,
- Species Selection (Section 4.4.3).

4.4.1 NATURAL REVEGETATION

Natural revegetation involves allowing establishment and ingress of vegetation with no active revegetation intervention. Facilitated natural revegetation is recommended by Arctic reclamation guidelines in stable areas (e.g., Alaska Department of Natural Resources 2025; GNWT 2015a, 2015b; INAC 2009, 2010; Matheus & Omtzigt 2013; Nunavut RAC 2012; USGS 2000) since it reestablishes local native vegetation composition and structure, typically has greater species diversity, and avoids the risks of active revegetation such as invasive species introduction. However, suitability and effectiveness of natural revegetation depends on the presence of an active seed bank (e.g., topsoil salvage; Section 4.3.3) or proximity to seed sources from intact vegetation (Audet & Setterington 2024; Kempenaar et al. 2013; Matheus & Omtzigt 2013). Factors impeding passive natural revegetation include the presence of non-native or invasive species, site contamination, low productivity, or erosion risk, requiring more active intervention (Kempenaar et al. 2013; Matheus & Omtzigt 2013). Natural revegetation success can be increased through good site preparation methods (Section 4.3; e.g., topsoil placement, soil reconstruction, surface roughening), snow removal to lengthen growing season (Cater 2010), and through maintenance of nearby seed sources.

Experience across northern mines indicates natural regeneration is generally slower but has favourable effects in terms of greater species diversity and re-establishment of native plants (e.g., ABR Inc. 2007; EDI 2020; Meidinger 1979). Natural regeneration (unassisted) has been effective for mine disturbances (abandoned airstrip and roadsides), with early colonizers present within 1-3 yrs and 60–70% cover after 40 yrs post-disturbance (Audet & Setterington 2024). Arctic graminoids (grasses, sedges) and forbs are generally quicker to recover, while shrubs and mosses are slower to recover, and lichen are very slow to recover (Audet & Setterington 2024). In organic soils, native sedges can re-establish biomass equal to undisturbed tundra within 5-10 years (Chapin III & Chapin 1980) and for minor disturbances (e.g., vehicle tracks on tundra) natural revegetation is just as effective as active revegetation (Neby et al. 2022). Large natural disturbances (e.g., several kilometres [km] length and 1 km width) of gravel outwash (coarse mixed substrates) have also been shown to revegetate naturally without amendment (e.g., Viereck 1966). More expansive disturbances or sites contaminated with mining waste (e.g., tailings) are frequently shown to have very poor passive vegetation recovery (e.g., Naeth & Wilkinson 2014) and facilitated natural revegetation or active revegetation may be needed (Kempenaar et al. 2013; Matheus & Omtzigt 2013).

Similar to most literature recommendations and industry practice, Inuit engagement at other northern mines indicate preference for passive and facilitated natural revegetation (e.g., Diavik Diamond Mine [Rio Tinto 2025]; Snap Lake Mine [Turcotte et al. 2025]). Traditional knowledge may indicate that in areas of potential contamination, land should be allowed time to heal and to avoid attracting wildlife to these areas (e.g., as identified by Inuit Traditional Knowledge Panel, Diavik Diamond Mine [Rio Tinto 2025]). Natural revegetation was also historically allowed to occur in areas of Inuit disturbances and have shaped vegetation communities on the landscape (Oberndorfer et al. 2020; Section 4.7).

4.4.1.1 SEED SOURCE ISLANDS

Natural revegetation relies on seed or other plant propagule sources. Patches/islands of undisturbed vegetation should be maintained undisturbed to provide a seed source for natural revegetation (Forbes & Jefferies 1999; Neby et al. 2022). Incidental disturbances to the adjacent and nearby intact tundra should also be minimized (Neby et al. 2022). Within organic sites, particularly wet sites, undisturbed vegetation patches can expand into disturbed areas as the organic layer builds up, through lateral clonal growth or vegetation fragments that root in soft sediment, producing a complex mosaic where rhizomatous Arctic graminoids Carex and Eriophorum are common (Forbes & Jefferies 1999).

4.4.2 ACTIVE REVEGETATION

Active revegetation techniques like seeding or planting facilitate revegetation by accelerating vegetation cover at northern mines (e.g., Naeth 2004; EDI 2020). Guidelines and research recommend integrating natural revegetation with active revegetation methods. Generally, sites with expansive disturbances shown to have very poor natural revegetation recovery, may require intervention with active revegetation (Kempenaar et al. 2013; Matheus & Omtzigt 2013; Naeth & Wilkinson 2014). Guidelines, industry examples, and research findings for best practices are summarized below for active revegetation methods.

Findings and best practices in active revegetation are included for:

- Seeding (Section 4.4.2.1);
- Planting (Section 4.4.2.2);
- Transplanting (Section 4.4.2.3);
- Staking and Sprigs (Section 4.4.2.4); and,
- Bryophyte Propagation (Section 4.4.2.5).

4.4.2.1 SEEDING

Seeding is the most commonly applied and tested active revegetation method in Arctic environments, considered most effective when applied selectively, integrated with natural revegetation, and tailored to site conditions. Seeding can be utilized for large disturbances, erosion-prone slopes, or sites with poor natural recovery potential (Johnson 1987; Kempenaar et al. 2013; INAC 2009; GNWT 2015a; MVLWB 2013). Research and guidelines highlight the importance of using appropriate locally adapted native species to avoid the intentional or accidental introduction of invasive or unsuitable plants. Species selection for seeding include considerations in Section 4.4.3, including use of local native seed (Section 4.4.3.1) and diverse species composition. Seeded species typically include native graminoids and forbs, since direct seeding of shrubs has generally been unsuccessful (e.g., Forbes & Jefferies 1999; Turcotte et al. 2025), apart from willows or alder (Government of the Northwest Territories 2017). Although some northern cultivars of commercial grass seed exist (Matheus & Omtzigt 2013) and establish well and accelerate cover, use is not recommended since this often results in lower long-term species diversity and dominance by graminoids (ABR 2007; Naeth & Wilkinson 2014; Miller et al. 2021; Turcotte et al. 2025). It is recommended to avoid overutilization of grasses which can outcompete forbs and shrubs and inhibit succession and ecosystem recovery (Chapin et al. 1995). Some literature also discusses cautious use of temporary non-native nurse/cover crops where erosion risk is very high and urgent, but recommend alternative erosion control measures and highlight the importance of careful species selection (≤10% of seed mix; e.g., Hordeum vulgare) so that nurse crops do not persist and suppress native recovery (e.g., Forbes & Jefferies 1999; INAC 2009; Matheus & Omtzigt 2013).

Seeding best practices support a conservative seeding approach and discuss application methods, site conditions, timing, and species selection. Site considerations for seeding and seeding rates include substrate type, site preparation, slope and erosion risk, and ability for natural revegetation from neighbouring seed sources or salvaged topsoil material.

Best practices for Arctic reclamation seeding include:

- Seed on exposed mineral soils (e.g., topsoil) for better germination (Adams & Lamoureux 2005);
- Rake/furrow soil after seeding (e.g., to 1-2.5 cm) to improve seed-to-soil contact (USGS 2000);
- If mulches, erosion control mats, or organics are used, apply as topdressings since seedlings germinating on top of organics can quickly desiccate (Adams & Lamoureux 2005);
- Spring seeding after snowmelt is best, though fall frost seeding prior to snowfall can also be effective (Johnson 1987; Naeth 2004; Turcotte et al. 2025; Matheus & Omtzigt 2013);
- If commercial seed must be used, seed certification and pure live seed (PLS) quality are essential to prevent accidental introduction of non-native or weed seeds (Naeth 2004; Matheus & Omtzigt 2013);
- Methods of application typically recommended include dry broadcast seeding by hand or using ATV-mounted rotary spreaders, depending on site conditions (e.g., size and accessibility; USGS 2000); and,
- Tailor seeding rates to site-conditions and allow for natural revegetation (infiltration) to occur. Lower seeding rates should be used for flat, organic-rich areas (e.g., natural revegetation or 500-1,000 PLS/m²; Matheus & Omtzigt 2013) and higher rates for bare mineral soils or steep slopes (≥2,250–3,000 PLS/m²; Matheus & Omtzigt 2013) requiring faster establishment (Turcotte et al. 2025).

4.4.2.2 PLANTING

Planting uses nursery stock (e.g., plugs or potted stock) for active revegetation. Planting has been used successfully in reclamation trials (e.g., Minto Mine [Bodley et al. 2025]; Snap Lake Mine [Turcotte et al. 2025]; Colomac Mine [Government of Northwest Territories 2017]), and in mine reclamation (e.g., abandoned Atlin Ruffner Mine [Stuckless et al. 2024]; abandoned Faro Mine [CIRNAC 2025]; Ekati Mine [Dominion Diamond Mines 2018]). However, due to the time and expense of nursery propagation and planting (Hagen 2002), typically using locally collected Arctic native plant species (Section 4.4.2.5) since commercial plant stock of Arctic species is limited, it is selectively applied in northern mine reclamation. Survival of planted Arctic native species is generally good under variable conditions including disturbed gravel areas with low nutrients (Stuckless et al. 2024). Planting has been successful with graminoid and forb species (Budzey et al. 2025; Government of Northwest Territories 2017; Stuckless et al. 2024), as well as trees and shrubs including dwarf shrubs Dryas integrifolia, Empetrum nigrum, and Vaccinium vitis-idaea (Budzey et al. 2025; Matheus & Omtzigt 2013; Stuckless et al. 2024; Turcotte et al. 2025). Greenhouse propagation for planting is effective for most Arctic species; apart from some which may have low propagule viability (e.g., Cassiope tetragona, Dryas octopetala; Hagen 2002).

Best practices for Arctic reclamation planting include:

- June planting outperforms fall planting (Stuckless et al. 2024);
- Plant from top downwards on slopes (Stuckless et al. 2024);
- Verify planting densities using post-planting inspections (Stuckless et al. 2024);

- Shelter improves planting survival (Stuckless et al. 2024);
- Implement infill planting or multi-phased planting where required (Kuzyk et al. 2025; Stuckless et al. 2024);
- Water in dry conditions where feasible (May et al. 1982; Stuckless et al. 2024); and,
- Use experienced planters (Stuckless et al. 2024).

4.4.2.3 TRANSPLANTING

Transplanting of Arctic vegetation involves harvesting as tundra sod (i.e., tundra mats or carpets) or as plugs or root saucers from a donor site and placing at placement site (Adams & Lamoureux 2005). Tundra sodding is based on the traditional practice by the Iñupiaq peoples' of Alaska using the Nuna ulu technique (meaning "land/earth knife"), used to construct traditional sod houses and to insulate entryways to ice cellars (Cater 2015). Transplanted materials should be sourced from salvaged material since disturbance to intact tundra is not sustainable (Adams & Lamoureux 2005; Lynn 2025; Forbes & Jefferies 1999; MVLWB 2013; USGS 2020), with tundra sod donor sites including sites prior to disturbance, or possibly ocean bluffs being lost to erosion and climate change. This highlights the importance of salvaging and separating the tundra sod from lower overburden layers during mine construction.

Transplanting of tundra sod has had considerable success in the Arctic (Vital 1976). Wet tundra is more suitable for tundra sodding than drier sites due to their thicker organic layer and rhizomatous species (e.g., *Carex aquatilis*, *Dupontia fisheri*, *Eriophorum angustifolium*, *E. scheuchzeri*) which hold the sod well (Cater 2010; Cater 2015; Lynn 2025; Lynn et al., n.d). Dry or moist tundra typically does not hold together well and upland evergreen and deciduous shrubs typically do not survive transplanting as well (Lynn et al., n.d). For many mine reclamation applications, transplanting is considered impractical due to lack of donor sites (without destroying undisturbed tundra), time and cost constraints (e.g., Diavik Diamond Mine [Rio Tinto 2025; Diavik Diamond Mines Inc. 2025]), or due application difficulty for large areas (Webber & Ives 1978). Despite being labor intensive and costly compared to other revegetation techniques, tundra sodding offers advantages of rapid restoration of vegetation community and insulative cover where needed (Cater et al. 2015), such as is needed such as in areas of human-caused thermokarsting.

Tundra sod can be harvested and transplanted using heavy equipment and/or hand labor. Recent improvements in the tundra sod collection include use of a standard excavator fitted with a 4-ft wide frost bucket modified with plates welded to the bucket's sides, allowing extraction of thick (e.g., 30–40-cm thick), intact pieces of sod that could be loaded directly onto standard 4-ft × 4-ft pallets for loader transport (Lynn et al., n.d.). In situations where damage to tundra with heavy equipment is a concern, hand cutting has also been used (e.g., "Nuna ulu" cutting disc [Cater 2010]; serrated knife [Lynn 2025]; Pulaski [USGS 2020]).

Best practices for Arctic reclamation tundra sodding include:

- Harvest sod when the soil has thawed 6-12 inches (Cater et al. 2010);
- Scarify the surface prior to transplanting (USGS 2020);

- Direct placement is preferred, but sod can be stored for up to several months or years if kept moist (Webber & Ives 1978; USGS 2020);
- Match donor site to placement site conditions (CMHC 2002); and,
- Excavate placement site if needed so that after sod placement the tundra sod surface is even with the surrounding landscape.

Transplanting individual plants (plugs) or small clusters has been implemented less often in Arctic reclamation but has included the use of wetland sedge plugs (Hewitt et al. 2018; Government of Northwest Territories 2017). Species suitable as plug transplants include graminoids *Juncus stygius*, *Juncus drummondii*, *Equisetum arvense*, *Carex aquatilis* (Hewitt et al. 2018). In an alpine fellfield study (May et al. 1982), transplant plug success of Arctic species was variable, with fibrous-rooted species (e.g., *Deschampsia caespitosa*) more resilient than rhizomatous (e.g., *Carex rupestris*) or other rootstock species (May et al. 1982). Best practices for plug transplanting include careful excavation of roots, removal of soil from roots, and post-transplant watering for several weeks to minimize early mortality for dry sites (May et al. 1982).

4.4.2.4 STAKING AND SPRIGS

Live staking and sprigs are a revegetation and bioengineering technique using plant cuttings within moist and wet areas such as riparian areas or wetlands as recommended by guidelines (e.g., Cater et al. 2010; CMHC 2002; Government of the Northwest Territories 2015a, 2015b; Matheus & Omtzigt 2013; MVLWB 2013; USGS 2000). Live stakes (shrub cuttings) or sprigs (herbaceous cuttings) are collected locally from native species that readily form new roots from stems (adventitious roots) and are easily propagated in the field in moist soil without special treatment (Johnson 1987). Arctic shrubs suitable for live staking include certain willow species (e.g., *Salix alaxensis*, *S. arbusculoides*, *S. athabascensis*, *S. barclayi*, *S. planifolia*, *S. pulchr*a) (Adams & Lamoureux 2005; Alaska Department of Fish and Game [ADFG] 2005; Forbes & Jefferies 1999; Hagen 2002; Hewitt et al. 2018; Matheus & Omtzigt 2013; USGS 2000). Arctic herbaceous species suitable for sprigs/cuttings include many wetland graminoids such as *Arctophila fulva*, or even *Leymus* spp. for drier areas (Cater 2010; CMHC 2002; Forbes & Jefferies 1999). Application of staking and cuttings in mine reclamation is limited but has been shown effective in reclamation of riparian areas, wetlands, and tailing storage facility slopes (e.g., ABR Inc. 2007; Government of the Northwest Territories 2017). In some research trials, live stakes were not successful (Diavik Diamond Mine [Diavik Diamond Mines Inc. 2025]).

Best practices for Arctic reclamation staking include:

- Live stake cuttings should be collected during the dormant season, before bud break (i.e., early spring or fall) and stored frozen until install in spring (ADFG 2005; ABR Inc. 2007);
- Live stake cuttings between 2-5 cm in diameter into 2-3 ft (0.5-1 m) lengths are cut angled at the base (end to be inserted into the soil) and flat at the top, with side branches trimmed; and,
- Prior to install, live stake cuttings should be soaked in water out of direct sunlight for a few days (ADFG 2005; Government of Northwest Territories 2017).

4.4.2.5 BRYOPHYTE PROPAGATION

Bryophyte revegetation is an emerging method for reclamation using mosses and lichen. Mosses and lichen, in combination with bacteria, cyanobacteria/algae, are important components of biological soil crusts which provide bioactive microsites for plant establishment by stabilizing soils and improving water infiltration, particularly in sub-xeric to very xeric sites (Stewart & Siciliano 2015). Moss and lichen can be slow to recover in mine disturbances (e.g., EDI 2020); however, some mosses (e.g., *Polytrichum* and *Sphagnum*) show potential for mine reclamation due to their tolerance to heavy metals, low pH, and their ability to colonize bare sites to initiate soil formation, stabilize surfaces, and improve plant germination (Adams & Lamoureux 2005; Stanley et al. 2000). Although mosses show promise in mine reclamation in Arctic or alpine environments, research to date is limited (e.g., Diavik Diamond Mine [Lamarre et al. 2023]; Ekati Mine [Dominion Diamond Mines 2018]; Grasberg Copper Mine [Stanley et al. 2000]). Findings suggest bryophyte propagation with vegetation fragments is best using locally collected large to medium fragments (Lamarre et al. 2023), with additional methods described in Stanley et al. (2000). In terms of site conditions, surface variability of 1-5 cm (microtopography) was found beneficial (Lamarre et al. 2023). Many studies suggest bryophyte revegetation is best on unamended crushed rock or gravel (Diavik Diamond Mine [Diavik Diamond Mines Inc. 2025; Miller et al. 2021; Neath et al. 2014; Rio Tinto 2025]) while others suggest fertilization could improve moss revegetation of organic substrates (Svalbard tundra vehicle-tracks [Neby et al. 2022]).

4.4.3 SPECIES SELECTION

Native Arctic plant species are recommended for Arctic mine reclamation by guidelines and industry best practices (e.g., Webber & Ives 1978). Local native plants have a long history of genetic sorting and natural selection by the local environment and evolution with native insects and wildlife. Over the long-term, local Arctic native plants are often better able to survive, grow, and reproduce under the environmental extremes of the local area, having better reclamation success compared to introduced plants, as well as providing greater benefits to wildlife species (Brown 1997; Munshower 1994). Non-native, agronomic, and commercially available species (i.e., non-local seed sources or stock) should generally be avoided to reduce intentional and accidental introduction of non-native and potentially invasive species which can outcompete and exclude native species preventing native ecosystems from reestablishing (Adams & Lamoureux 2005; Forbes & Jefferies 1999), an issue of historical reclamation projects which often used agronomic species (Kearns et al. 2015). Recent mine reclamation programs emphasize the use of local native plant species (e.g., Diavik Diamond Mine [Diavik Diamond Mines Ltd. 2025; Rio Tinto 2025]). Species provenance is known to affect plant performance, pollinator networks, and herbivores, with effects extending up to higher trophic levels (Bucharova et al. 2021), so locally sourced species (see Section 4.4.3.1 for plant collection) perform better and are recommended (Kuzyk et al. 2025).

Literature describes a variety of considerations for local native plant species selection in Arctic mine reclamation:

- Diversity in plant species and life forms – graminoids, forbs, dwarf shrubs, shrubs, mosses and lichen. Incorporating several types of plant functional groups is more beneficial than just including a higher number of species (e.g., Diavik Mine [Drozdowski et al. 2012; Miller & Naeth 2017; Naeth 2004; Neath & Wilkinson 2014; Rio Tinto 2017]);
- Tolerance to site disturbance and contaminant conditions such as low nutrients, heavy metals (metallophytes), salts (halophytes, e.g., *Puccinellia* spp.), acid or low pH (calcifuges, e.g., legumes), drought, or flooding (Adams & Lamoureux 2005; Matheus & Omtzigt 2013);
- Nitrogen-fixing ability (e.g., legumes, alder) to improve soil macronutrient content and enhance revegetation, while preventing the negative effects of inorganic soil fertilizers like runoff (Adams & Lamoureux 2005; Forbs and Jeffries 1999; Johnson 1987; Jorgenson and Joyce 1994; Matheus & Omtzigt 2013);
- Early successional/pioneer species (USGS 2000) - Ecological succession patterns of natural revegetation (colonization) provide insight to suitable plant species (Viereck 1966);
- Tolerance of human disturbance (hemerophiles) and colonizing by natural revegetation effectively in similar disturbed sites with harsh conditions (e.g., gravel bars, roadsides, etc.; USGS 2000);
- Adaptability to various site conditions – Generalist species with wide ranges and greater tolerance to different site conditions (Webber & Ives 1978);
- Rapid cover ability – Viviparous species that produce an abundance of vegetative propagules (plantlets or bulbils) annually (e.g., *Bistorta vivipara*, *Poa arctica*), rhizomatous and stoloniferous species (clonal) which spread laterally quickly especially in wetlands (e.g., Arctophila fulva), and species with fast growth rate or prolific seeding such as Epilobium angustifolium or Puccinellia spp. (Adams & Lamoureux 2005; Forbes & Jefferies 1999);
- Rooting depth for site-specific concerns for capped areas overlying contaminated soils – e.g., shallow rooting native species (<0.5 m max vegetation height) to reduce the potential for uptake of contaminants from the underlying soil or disturbance to liners (Stuckless et al. 2024);
- Propagule viability and germination rate – Plants with high germination or rooting ability and survivability have greater applicability for active revegetation methods such as greenhouse propagation and outplanting (Hagen 2002);
- Minimal risk to wildlife – low potential for metal accumulation (avoid metallophytes that are hyperaccumulators) and neither attract or repel wildlife (MVLWB 2013); and,
- Cultural significance and traditional knowledge application, requiring Indigenous engagement.

Resources are available which include lists of native plants, tolerances and preferred growing conditions, site suitability, and propagation methods (e.g., CMHC 2002 [Appendix B, C, D]; Matheus & Omtzigt 2013 [Tables 5.19-5.22]; USGS 2020 [Table 9]), in addition to information which can be derived from baseline vegetation data where available (e.g., FEIS; Sabina 2015). Reclamation trials and studies also provide an abundance of information on plant revegetation performance in various conditions, including by natural revegetation or active revegetation. Plant species commonly cited as having high revegetation potential for disturbed mine sites include grasses (e.g., *Arctophila fulva, Agrostis* borealis, *Calamagrostis canadensis, Deschampsia* spp., Festuca *altaica*, *Luzula confusa*, *Poa arctica, Puccinellia* spp., *Trisetum spicatum*), sedges (*Eriophorum scheuchzeri, Carex aquatilis*, *Carex podocarpa*), legumes (e.g., *Astragalus* spp., *Hedysarum* spp., *Lathyrus* spp., *Lupinus* spp., *Oxytropis* spp., *Vicia* spp.) and other forbs (e.g., *Artemesia* spp., Asteraceae, Brassicaceae, *Cerastium beeringianum*, *Epilobium angustifolium*, *Senecio spp.*), and shrubs alder (*Alnus* spp.) and willow (*Salix* spp.), among other plant species (ABR Inc. 2007; Adams & Lamoureux 2005; Forbes & Jefferies 1999; Klebesadel 1973; Viereck 1966; Webber & Ives 1978).

4.4.3.1 LOCAL SEED AND PLANT PROPAGULE COLLECTION

Seed and propagule collection originates from the best practice to source native plants locally to conserve the gene pool/provenance and due to the inadequate commercial source of native Arctic plant species (Johnson 1987; Kuzyk et al. 2025; Webber & Ives 1978) as recommended by guidelines (e.g., CMHC 2002; Government of Northwest Territories 2017; INAC 2009; Matheus & Omtzigt 2013; MVLWB 2013; USGS 2000). Arctic species frequently use vegetation reproduction so propagules can include other plant parts such as stems, rhizomes, or bulbils in addition to seed (CMHC 2002; Hagen 2002). Northern mines have initiated local seed and plant collection programs for reclamation and trials (e.g., Atlin Ruffner Mine [Stuckless et al. 2024]; Diavik Diamond Mine [Lamarre et al. 2023; Miller et al. 2021]; Minto Mine [Budzey et al. 2025]; Snap Lake Mine [Turcotte et al. 2025]).

Best practices for collecting local vegetation materials (seeds, cuttings, transplanting) for Arctic reclamation and revegetation include:

- Collection site does not contain non-native or invasive species, is the same general vegetation type (capture species' ecotypes), and is nearby the revegetation site (e.g., suggested distances range from a 6 km radius [Adams & Lamoureux 2005] to a 200 km radius and 500 m elevation [CMHC 2002]);
- Minimize disturbance to the collection site and plant population (e.g., collect < 1/3 of seed, harvest from salvage sites; CMHC 2002);
- Collect materials according to timing of seed dispersal which is typically August-September for most Arctic species, apart from willows and alder in May-June (CMHC 2002; Adams & Lamoureux 2005);
- Maintain proper handling and storage (CMHC 2002);
- Local seed/propagule amount can be cyclical and low some years so collection may need to occur over several years and some species have low propagule viability so focus on species with expected high viability (Hagen 2002); and,
- Engage Indigenous communities in collection through to monitoring (Turcotte et al. 2025).

4.5 MONITORING

Monitoring reclamation is considered an important component of insuring revegetation success and to identify whether adaptive management is needed (Gann et al. 2019), and post-closure monitoring is a requirement for mine reclamation in Nunavut (INAC 2002a, 2002b). Circumpolar Arctic Vegetation Science Initiative (CAVSI; 2025) is currently developing Arctic research network and methods/best practices. Studies implemented a variety of methods to assess the performance of reclamation and revegetation practices including greenhouse experiments (e.g., Hagan 2002), landscape level reclamation trials (e.g., Ekati Mine [Dominion Diamond Mines Ltd. 2018]; Mary River Mine [EDI 2020];), randomized block experimental design (e.g., Budzey et al. 2025; Lamarre et al 2023; Miller et al. 2021; Naeth 2004), and time since disturbance chronosequence (e.g., Audet & Setterington 2024). Remote sensing technologies are also applied for revegetation assessment at mines (Gordon et al. 2023). Monitoring timelines for mines post-reclamation are variable but often reference plant cover or other criterion (e.g., Diavik Diamon Mine uses annually until mean 5% cover met, expected in 5-10 years [Diavik Diamond Mines Inc. 2025]).

Best practices for Arctic reclamation and revegetation monitoring include:

- Revegetation targets – develop revegetation targets that are specific and based on site conditions and target ecosystems. Different features will potentially require different reclamation strategies and surface configurations (EDI 2020);
- Consider Arctic species have high root:shoot ratios, so root development may be better indicator for long-term revegetation success (Adams & Lamoureux 2005). Assess below ground biomass and long-term survivability, not just initial rate of growth above ground (Adams & Lamoureux 2005);
- Higher vegetation cover is not always better – compare revegetation cover to the control, such as the surrounding environment or baseline which often has naturally sparse vegetation cover. Dry Arctic environments have naturally sparse vegetation cover (Forbes & Jefferies 1999);
- Vegetation assessment metrics include vegetation ground cover, below and above ground biomass, species richness, and general plant health (e.g., signs of chlorosis), while soil metrics include pH and soil nutrients (Turcotte et al. 2025);
- Monitoring program should have adaptive management triggers (Kuzyk et al. 2025); and
- Long-term monitoring – slow recovery of Arctic vegetation necessitates adequate monitoring timelines to assess revegetation success (Kuzyk et al. 2025). Many of the experimental studies identify short monitoring timelines as limitations and recommend long-term monitoring (e.g., Drozdowski et al. 2012; Lamarre et al. 2023). Long-term monitoring can be cost effective by reducing the monitoring interval (frequency) following initial annual monitoring (Kuzyk et al. 2025).

4.6 OTHER CONSIDERATIONS

Other considerations for Arctic revegetation and reclamation include:

- Damage to the surrounding tundra from contaminants such as saline drilling brine (salt) or oil (hydrocarbons) may also need restoration, with recommendations described in Cater (2010);

- Timing of activities to avoid disturbance to intact tundra – tundra soils are most vulnerable in spring and least vulnerable in winter (CMHC 2002);
- Invasive plant species – monitor and manage non-native and invasive plants in advance of reclamation works (INAC 2009; Kempenaar et al. 2013; Stuckless et al. 2024);
- Faunal fluctuations and overgrazing by caribou can inhibit revegetation success (Stuckless et al. 2024; Webber & Ives 1978);
- Snow removal effects to increase growing season (Forbes & Jefferies 1999);
- Long lead times are typically needed for native plant seed or plugs, due to source material constraints or time needed for local collection and propagation (Turcotte et al. 2025);
- Arctic has slow rates of vegetational change, so current plants in the baseline conditions and surrounding intact tundra may reflect past conditions (Forbes & Jefferies 1999); and,
- Climate change – Climate change is identified as a concern and consideration by Inuit Tapiriit Kanatami (2019). Long term permafrost monitoring by Natural Resources Canada shows continued warming (>0.5 °C per decade in cold Arctic permafrost) and increasing active layer thickness (Natural Resources Canada 2022). Climate-driven geomorphic transformation expected for the Canadian Arctic (Kokelji 2017; Kuzyk et al. 2025), which could influence vegetation community change and future revegetation. This can affect the stability and moisture regimes of reclamation substrates and the success of plant establishment. Revegetation considerations for climate change include considering a climate-shifted baseline in species selection (i.e., intermediate ecosystems), climate-resilient species, consideration of plant provenance (local), potential for multi-phased revegetation for adaptive management, importance of long-term monitoring, and using a diverse species mix to increase the probability that certain species will be suited to future climate conditions (BC MCM 2025; Kuzyk et al. 2025). ClimateNA climate modeling tool includes mean annual temperature, climate maps, mean annual precipitation, and climatic moisture deficit using the SSP2-4.5 climate scenario into the year 2100 (Kuzyk et al. 2025). BC MCM (2025) provides guidelines on climate change considerations for reclamation for BC which are also applicable to Nunavut, considering regional guidelines for mine reclamation in a changing climate are not currently available.

4.7 INUIT TRADITIONAL KNOWLEDGE

Reclamation is recognizing the importance of integrating Inuit Qaujimajatuqangit (i.e., Inuit Traditional Knowledge) and Inuit engagement is a requirement of new mining operations in the Canadian Arctic. Mine reclamation programs have had various success engaging Inuit in review of RCPs and considering Inuit Qaujimajatuqangit in mine reclamation and revegetation, with legacy mining sites often lacking proper engagement and having serious long-term issues like environmental contamination (CIRNAC 2025; Dance 2015; Sandlos & Keeling 2016). Resources to guide meaningful Inuit engagement for reclamation include government resources or requirements (e.g., NIRB; MVLWB 2013; Nunavut Regional Adaptation Collaborative [Nunavut RAC] 2012; Inuit Tapiriit Kanatami 2019), research initiatives (e.g., CAVSI 2025; Dance 2015), and industry-derived resources (e.g., Keeling and Potvin 2025 [Raglan Mine]; Kuzyk et al. 2025;

Sandlos & Keeling 2016 [Giant Mine]). Some Inuit associations have also developed policy and guidelines for reclamation, such as the Qikiqtani Inuit Association (2017) which developed goals for reclamation and obligations of the land user for Inuit Owned Lands in Qikiqtani Region (Baffinland); however, a similar guideline does not exist for Kitikmeot Region, Nunavut.

Best practices for Inuit engagement in mine reclamation emphasize early, sustained, and meaningful collaboration throughout the entire Life-of-Mine, from operations through closure and post-closure:

- Engagement can be facilitated through the establishment or continued use of stakeholder bodies. These ensure Inuit rightsholders are centrally involved in shaping the mine closure vision, aligning reclamation goals with intended future land uses and co-developing revegetation prescriptions that reflect Inuit priorities (Kuzyk et al. 2025; MVLWB 2013);
- Effective communications include hosting site-visits, public meetings, face-to-face discussions, and workshops, and developing a 3-D landscape models depicting pre-development, operational, and closure conditions;
- Engagement should address closure objectives, closure options, relevant reclamation research, and other key closure topics to produce a conceptual Closure and Reclamation Plan that reflects both ecological integrity and Inuit cultural values (MVLWB 2013);
- A record of engagement activities should be maintained, and reporting should be shared with Inuit governments (MVLWB 2013); and,
- Include Inuit participation in site monitoring and collaborative reclamation research, aligning Inuit Qaujimajatuqangit with western science (MVLWB 2013).

Inuit Qaujimajatuqangit provides valuable perspectives on reclamation and revegetation considerations, as referenced in this literature review. Considerations may include alternate land uses and land-based activities, traditional practices like wildlife harvesting, culturally important plant species, and concerns such as permafrost thaw (MVLWB 2013; Inuit Tapiriit Kanatami 2019). Insights from Inuit engagement provided in the context of Arctic mine reclamation at other sites have included the following: maintain strategic wildlife and human movement corridors by avoiding scarification in select areas, natural revegetation preferred but apply active revegetation in some instances, importance of all plant forms and species diversity (including important cultural plant species), avoid active revegetation of contaminated areas to avoid attracting wildlife to these areas until the land has had time to heal, cap contaminated areas with till and rock layers, consider traditional wildlife harvesting and other land-based activities, consider alternate uses for sites such as recreation (e.g., Diavik Diamond Mine [Rio Tinto 2025; Diavik Diamond Mines Inc. 2025]; Giant Mine [Sandlos & Keeling 2016]; Raglan Mine [Keeling & Potvin 2025]; Snap Lake Mine [Turcotte et al. 2025]). Some projects have involved Indigenous communities in seed collection, planting, and monitoring (e.g., Snap Lake Mine [Turcotte et al. 2025]).

It is also important to acknowledge the influence of Inuit cultural practices on shaping the landscape and vegetation communities (Oberndorfer et al. 2020). Inuit disturbed areas (e.g., built environments, fishing histories, tent rings) drive biodiversity and have unique species assemblages compared to undisturbed areas, with potential for at least an increase local-scale plant species diversity but have similar total species diversity (Oberndorfer et al. 2020). Examples include soil enrichment (nutrient inputs) resulting from Inuit fishing histories (favouring grasses) and calcium enrichment (favouring calciphiles) near middens and sod houses of Inuit (bones, shells), influencing plant species composition (Oberndorfer et al. 2020). Iñupiaq peoples of Alaska also traditionally practiced tundra sod collection using the Nuna ulu technique (meaning “land/earth knife”), used to construct traditional sod houses and to insulate entryways to ice cellars (Cater 2015).

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ATTACHMENT A NIRB TERMS AND CONDITIONS

TABLE A- 1 TABLE A-1 NIRB PROJECT CERTIFICATE NO. 007 AMENDMENT NO. 001 (AUGUST 7, 2024) TERMS AND CONDITIONS FOR RECLAMATION OR REVEGETATION

NIRB Condition No.	Category [a]	Project Phase [a]	Objective	Term or Condition [a]	Reporting Requirements [a]	IRCP Section (July 2021)
36	*Vegetation – Mine Closure and Reclamation Plan*	*Pre-Construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure Monitoring*	*To maintain an up-to-date revegetation plan for the Project.*	*The Proponent shall include revegetation strategies within its Mine Closure and Reclamation Plan that support* ***progressive reclamation****, and promote natural revegetation and recovery of disturbed areas compatible with the surrounding natural environment. These strategies should include exploration of the feasibility and practicality of topsoil/organic matter salvage through Project development. The Closure and Reclamation Plan should be updated on an on-going basis as more information becomes available from similar reclamation efforts at other northern projects, as applicable.*	*Within three (3) years from the commencement of construction of the Back River Gold Mine Project, information regarding the revegetation strategies developed and implemented by the Proponent in fulfillment of this Term and Condition shall be included in the Proponent's annual report to the Nunavut Impact Review Board and this information will include reclamation strategies for the Energy Centre Project. Subsequently, information regarding the Proponent's progress in fulfillment of this Term and Condition shall be provided annually in the Proponent's annual report to the Nunavut Impact Review Board.* *Whenever the Proponent makes subsequent revisions to the Monitoring Plan(s), the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan(s) and will ensure the updated Plan is posted on the Proponent's project website.*	6.3
35	*Vegetation – Revegetation and Reclamation*	*Pre-Construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure Monitoring*	*To maximize revegetation in reclaimed areas.*	*The Proponent shall develop a* ***progressive revegetation*** *program for disturbed areas that are no longer required for operations, such as a program to incorporate measures for the use of test plots, reseeding, and replanting of native plants as necessary. It is further recommended that this program be directly associated with the management plans for erosion control established for the Project.*	*The program and associated revegetation results should be provided within the Proponent's annual report submitted to the Nunavut Impact Review Board.* *Whenever the Proponent makes subsequent revisions to the Monitoring Plan(s), the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan(s) and will ensure the updated Plan is posted on the Proponent's project website.*	6.3
34	*Vegetation – Vegetation Monitoring Plan*	*Pre-Construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure Monitoring*	*To minimize potential impacts to vegetation along the winter road/trail routings and around all project sites, including project components added to the Back River Project under the Energy Centre Proposal.*	*The Proponent shall have in place a Vegetation Monitoring Plan that is designed to quantify the potential impacts on vegetation from the Project, including the annual construction/operation of the winter ice roads and trails. The plan should include all commitments discussed throughout the assessment of the Project (and subsequent modifications), including commitments to consult with the Kitikmeot Inuit Association, the Government of Nunavut, and other relevant parties, as well as:* *a. Establishment of pre-construction and post-operation vegetation conditions annually with supporting photographs to allow for long term comparisons of vegetation conditions along winter ice Nunavut Impact Review Board Page 37 of 74 road/trail routings and around project sites including the Energy Centre Project Infrastructure (wind turbines, solar panel array, Battery Energy Storage System, transmission lines, and service roads);* *b. Incorporation of measures to prevent or minimize potential destabilization and erosion along winter ice road/trail routings and around project sites, including the Energy Centre Project Infrastructure (wind turbines, solar panel array, Battery Energy Storage System, transmission lines, and service roads);* *c. Details on the triggers for implementing adaptive management options if effects to vegetation are observed, including potential impacts from dust deposition; and,*	*Within 60 days of the issuance of Project Certificate 007, Amendment No. 1 to reflect the addition of the Energy Centre Project, the Proponent shall submit an updated Vegetation Monitoring Plan to the Nunavut Impact Review Board (NIRB) to include the addition of the Energy Centre Project Infrastructure (wind turbines, solar panel array, Battery Energy Storage System, transmission lines, and service roads).* *Whenever the Proponent makes subsequent revisions to the Vegetation Monitoring Plan, the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan and will ensure the updated Plan is also posted on the Proponent's project website.*	Submission of the VMP 2020

NIRB Condition No.	Category [a]	Project Phase [a]	Objective	Term or Condition [a]	Reporting Requirements [a]	IRCP Section (July 2021)
				d. Discussion of how the findings from monitoring efforts would be used to inform reclamation planning.		
32	*Vegetation – Site Footprint*	*Pre-Construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure Monitoring*	*To minimize the impacts of the Project and approved Modifications on To minimize the impacts of the Project and approved Modifications on vegetation.*	*The Proponent shall ensure that Project activities are planned and conducted in such a way as to minimize the Project footprint.*	*In the Proponent's annual report to the Nunavut Impact Review Board, the Proponent shall provide information regarding the current Project footprint, taking into account construction and **progressive reclamation** activities, and including information regarding the loss or alteration of vegetation associated with Project activities (including identifying the type of any habitat losses resulting from these effects). Results shall be reported for all components of the Project including the Energy Centre infrastructure (wind turbines, solar panel array, Battery Energy Storage System, transmission lines, and service roads).*	Submission of NIRB Annual Reports
15	*Terrestrial Environment – Progressive Reclamation Plan*	*Pre-construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure*	*To ensure that project components, areas, and infrastructure are progressively reclaimed throughout the life of the Project including approved Modifications.*	*The Proponent shall have in place a plan for the **progressive reclamation** of project components, areas, and infrastructure throughout the life of the Project. The plan shall detail:* *a. projected timelines for the reclamation of project features, methodologies for undertaking such activities, and monitoring measures to ensure the effectiveness of reclamation methods employed;* *b. specific measures for adaptive management and triggers for their application, should monitoring results reveal trends that could affect the reclamation and closure objectives.; and,* *c. how Inuit Qaujimajatuqangit and Traditional Knowledge was collected, and used to inform closure plans and the design of project components.*	*The plan should be submitted to the Nunavut Impact Review Board (NIRB) at least 90 days prior to the start of construction, with results and details submitted annually thereafter or as may otherwise be required by NIRB. Whenever the Proponent makes subsequent revisions to the Monitoring Plan(s), the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan(s) and will ensure the updated Plan is posted on the Proponent's project website.*	6 1.3; 4.3; 5; 8 8 1.4; Appendix B Table 010, 011, 013, 015, 016, 017, 018, 020, 022 Inuit Qaujimajatuqangit and Traditional Knowledge collection and integration into Project assessment and design is detailed in Sabina's FEIS Submission of the IRCP 2021
7	*Climate and Meteorology – Mine Closure and Reclamation Plan*	*Pre-construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure*	*To ensure mitigation, monitoring, and adaptive management measures are in place for the long-term stability, containment, and integrity of project components, including the approved Modifications, and the protection of environmental features.*	*The Proponent shall maintain a Mine Closure and Reclamation Plan designed to: identify the processes that may act upon the mine components after closure and reclamation so that they can be factored within the design and operation of the mine; ensure physical and chemical stability of mine components that remain after closure; ensure mine components that remain after closure will not require long-term active care; and consider future use and aesthetics of the area with the surrounding lands. This plan should include:* *a. An adaptive management component that documents monitoring and mitigation measures to ensure long-term containment of the Tailings Storage Facility and Waste Rock Storage Areas;* *b. Details for monitoring the thermal condition and stability of storage facilities;* *c. Details on the triggers for implementing alternative mitigation options;* *d. Details pertaining to ongoing monitoring and research being conducted to supplement the adaptive management protocols; Details on the plans to maintain the integrity of the groundwater quality within and adjacent to the Project; and*	*The plan should be submitted to the Nunavut Impact Review Board (NIRB) at least 60 days prior to the start of construction of the Project and any approved Modifications with results submitted annually thereafter or as may otherwise be required by the NIRB.* *Whenever the Proponent makes subsequent revisions to the Mine Closure and Reclamation Plan, the Proponent shall submit the updated Plan to the NIRB within 60 days of revising the Plan and will ensure the updated Plan is also posted on the Proponent's project website.*	The IRCP as a whole 8 Monitoring details will be reported in annual reports and relevant information included in future ICRP updates if needed. 5.2.1.8 Appendix E 5.2.2 5.2.1 Submission of the IRCP 2021

NIRB Condition No.	Category [a]	Project Phase [a]	Objective	Term or Condition [a]	Reporting Requirements [a]	IRCP Section (July 2021)
				e. Details on how the Proponent will carry out continued analyses over time to confirm or update the approximate fill time for the mine pits.		

ATTACHMENT B FEIS COMMITMENTS

TABLE B-1 FINAL ENVIRONMENTAL IMPACT STATEMENT: BACK RIVER GOLD PROJECT (FEIS; SABINA 2015; NIRB PROJECT NO. 124149) COMMITMENTS FOR RECLAMATION OR REVEGETATION

Volume, Section	Page	Commitment [a]	ICRP Section (July 2021)
FEIS Volume 1, Section 9.3	9-3	*Achieving physical stability includes establishing the conditions Post-Closure that allow for natural revegetation so that the land returns to productive use by wildlife. As part of the MCRP, potential revegetation of disturbed sites was reviewed. At this time, active revegetation of the site as part of closure is not planned given the cold climate setting of the Project as well as the precedent established for mine closure in Nunavut.*	1.2
FEIS Volume 10, Chapter 29, Section 1.7	7	*Achieving physical stability includes establishing the conditions post-closure that allow for natural revegetation so that the land returns to productive use by wildlife. As part of this MCRP, potential revegetation of disturbed sites, including active revegetation, seeding, and soil amendment, were reviewed. At this time, active revegetation of the Property as part of closure is not planned given the cold climate setting of the Project as well as the precedent established for mine closure in Nunavut. Additional research in this field may be considered in future iterations of the MCRP.*	1.2
FEIS Addendum Volume 5, Section 5.4 (February 2017)	5-16	*Potential research studies to inform revegetation during progressive reclamation and Closure could include any numerous topics. The progress of these possible options would be dependent on the advancement of Project plans and closure plans and timing:* • *Substrate and plant species selection trials: trials to identify appropriate local native species mixes for revegetation on reclaimed soils. The goal of this research would be to select native species that are suitable for revegetation of various soil conditions expected on reclaimed areas.* • *Soil and plant processes research: identification of the soil processes, and biological, physical, and chemical conditions that are required to successfully regenerate native plants. This would be a comparative study of undisturbed sites and reclaimed soils to identify soil amendments to improve plant establishment.* • *Monitoring of progressive revegetation of large footprint areas to provide adaptive feedback to revegetation activities. The goal of this will be to improve revegetation success and long-term site stability and land capability.* *The NIRB has encouraged Sabina to consider revegetation and reclamation measures associated with the protection of vegetation. Sabina reiterates their commitment to research substrate and plant species selection trials, soil and plant processes, and progressive revegetation monitoring.*	None
FEIS Addendum Volume 5, Section 5.4 (February 2017)	5-14	*In consultation with the KIA, GN, and other relevant parties the Proponent shall develop and implement a vegetation monitoring plan for the winter road that is designed to quantify the potential impacts on vegetation. The plan shall be submitted to the NIRB prior to winter road construction. Findings from these studies will be used to inform reclamation planning as appropriate.*	VMP
FEIS Addendum Volume 5, Section 5.4 (February 2017)	5-16	*During the FEIS Final Hearing, Sabina repeated their commitment to ongoing revegetation and reclamation research which was provided in F-NSMA-TC-13. During the technical review phase, the topic of revegetation was raised by the NSMA; Sabina provided the following response, F-NSMA-TC-13, which outlines Sabina's previous commitment to revegetation research and progressive reclamation measures:* *In the Mine Closure and Reclamation Plan (MCRP; FEIS Volume 10, Chapter 29), Table 4.2-2 provides proposed progressive reclamation activities that will be evolved during the operational phase of the Project before permanent closure.*	1.2
FEIS Volume 10, Chapter 29, Section 4, Table 4.2-2 Back River Project MCRP	19	*As part of the Feasibility Study work, recommendations were made regarding future studies that will impact reclamation activities. Table 4.2-2 presents an update to the proposed reclamation studies going forward.* *Table 4.2-2. Updated Proposed Reclamation Studies* *Study No.* | *Description* | *Status and Schedule for Completion* *8* | *Revegetation research focused on large footprint areas which will significantly improve long-term stability and usability of the site follow Closure.* | *Ongoing.*	6.3 Appendix E
ICRP 2021, Section 1.2	1-2 to 1-3	*Achieving physical stability entails the removal of any culverts and restoration, as practicable, of the drainage to match the natural channel and implementation of erosion and sedimentation measures where required. Physical stability also includes establishing the conditions post-closure that allow for natural revegetation so that the land returns to productive use by wildlife. This includes the re-grading, if practicable, roads and airstrips to match natural contours to reduce erosion and contouring and stabilizing disturbed areas to the extent practical. Active revegetation of the Property as part of closure is not planned given the cold climate setting of the Project as well as the precedent established for mine closure in Nunavut. Additional research in this field may be considered in future.*	1.2
ICRP 2021, Section 5.2	6-3	*The isolated areas of WIR subbase upgrades as well as WIR service emergency camp pads will be scarified and reseeded on closure to promote revegetation to the extent reasonable.*	5.2

Notes:
FEIS = Final Environmental Impact Statement (Sabina 2015)
ICRP = Interim Closure and Reclamation Plan (Sabina 2021)
MCRP = Mine Closure and Reclamation Plan (FEIS Volume 10, Chapter 29; Sabina 2015)
VMP = Vegetation Monitoring Plan (Sabina 2020)
WIR = Winter Ice Road
[a] Direct quotation.

ATTACHMENT C COMMENTS

TABLE C-1 COMMENTS ON NIRB 2024 ANNUAL REPORT RELATED TO RECLAMATION OR REVEGETATION TERMS AND CONDITIONS AND COMMITMENTS IN NIRB PROJECT CERTIFICATE NO. 007 AMENDMENT NO. 001 (NIRB 2024) AND FEIS (SABINA 2015)

Comment No.	**Subject [a]**	**Reference [a]**	**Comment [a]**	**Recommendation [a]**	**B2Gold Nunavut Response [a]**	**Requirement**
CIRNAC-6	*Vegetation – Mine Closure and Reclamation Plan*	*NIRB Project Certificate No. 007 (Amendment No. 001), Term and Condition 36: Vegetation – Mine Closure and Reclamation Plan* *Back River Project 2024 Annual Report, Section 4.5.9 Pages 4-95 to 4-96, Appendix H* • *Back River Project FEIS Addendum, Volume 5, Page 5-20*	*Term and Condition 36 describes that B2Gold is required to develop revegetation strategies within its Mine Closure and Reclamation Plan that supports progressive reclamation, which should include exploration of the feasibility and practicality of topsoil/organic matter salvage through Project development. Revegetation strategies are to be provided within 3 years of the start of construction in the Annual Report and will include reclamation strategies for the Energy Centre Project.* *In the 2022 Annual Report, Sabina (now B2Gold) stated that an Interim Closure and Reclamation Plan (ICRP) was provided to the NIRB on December 13, 2021, containing a conceptual progressive revegetation program, but it did not include the program or any results with the 2022 Annual Report. This ICRP was also stated to have been further updated in 2022/23 as part of the amendment application process and submitted to the NIRB for review.* *In response to CIRNAC's comments on the 2022 Annual Report, B2Gold stated that research of revegetation strategies will be provided to the NIRB in 2023. This information was not provided with the 2023 Annual Report.* *Furthermore, the updated ICRP was not provided in the 2023 or 2024 Annual Reports, and the 2024 Annual Report provided no information regarding any revegetation strategies developed and implemented by B2Gold. It is unclear to CIRNAC if any revegetation strategies, including topsoil/organic matter salvage strategies, have been proposed as part of the revised ICRP, or if they are applicable to the Energy Centre components.* *In previous Annual Reports, Sabina/B2Gold stated that the progressive revegetation program in the ICRP was not fully developed as the project was in an early phase of construction, and that it will "…provide initial details in the 2025 Annual Report". CIRNAC is of the view that this is not an acceptable response, as the Project is no longer in an early phase of construction and B2Gold has had several years to advance the program. B2Gold has not fulfilled its commitment to CIRNAC or the reporting requirements of Term and Condition 36.*	*CIRNAC recommends that B2Gold:* *a. Provide revegetation strategies that have been developed and implemented in the 2025 Annual Report.* *b. Provide results on the feasibility and practicality of topsoil/organic matter salvage.* *c. Provide revegetation strategies for any progressive reclamation activities related to the Energy Centre components.*	*As the construction phase commenced in 2023, B2Gold Nunavut will submit revegetation strategies to meet Term and Condition 36 with the NIRB 2025 Annual Report.*	In NIRB 2025 Annual Report (March 2026), submit revegetation strategies to meet Term and Condition 36.
KIA-NIRB-13	*Incomplete Revegetation and Reclamation Plan*	*B2B Gold, Back River Project, 2024 Annual Report (April 4, 2025), Section 4.5.9* • *PC Condition No. 35* • *Mine Closure and Reclamation Plan November 2015)* • *Interim Closure and Reclamation Plan (July 2021)*	*The references provided are available online at the nirb.ca website and consist of the Interim Closure and Reclamation Plan dated July 2021. The original plan (2015) is not mentioned. The latest Plan indicates that "With the exception of WIR subbase upgrades and service emergency camp pads, active revegetation of the Property as part of Closure is not planned given the cold climate setting of the Project as well as the precedent established for mine closure in Nunavut."* *Furthermore, it is indicated that a revegetation research and review program was initiated at other northern mine sites and that undertaking revegetation and seeding would provide limited benefits and be outweighed by the logistics and cost constraints, as well as potential environmental impacts due to the northern climate (e.g., growing conditions, availability of native seed, lack of suitable growth medium). Additional studies are ongoing, and additional prescriptions will be provided in a subsequent version of the Plan. Also, it is unclear whether reclamation has been completed for areas used during construction, but that may not be needed anymore and were closed. Finally, it is unclear if the update to the Plan in 2021 was submitted to the NIRB within 60 days of revising the Plan.*	*The KIA requests the following:* • *The proponent should provide the 2015 version of the Plan in the reference list and detail the changes between the 2015 and 2021 Plan and expected changes for a subsequent version (i.e., in 3 years, as identified in the Annual Report).* • *Provide a statement on whether any areas were closed and revegetated in 2025 (e.g., related to construction).* • *Provide details on the Plan update and submission date to the NIRB.*	*B2Gold Nunavut is compliant as documentation is on the NIRB website. Submission of the updated Interim Closure and Reclamation Plan was part of the Terms and Conditions for the Energy Centre and is therefore filed under the Back River Project Energy Centre (Application No. 125740).*	None.
KIA-NIRB-40	*Missing information on interim closure*	*B2B Gold, Back River Project, 2024 Annual Report (April 4, 2025)*	*The Term or Condition for PC Condition No. 15 in the 2024 Annual Report states "The Proponent shall have in place a plan for the progressive reclamation of project components, areas, and infrastructure throughout the life of the Project. The plan shall detail:*	*The KIA requests the following:*	*Submission of the updated Interim Closure and*	In updated ICRP, include information on

Comment No.	Subject [a]	Reference [a]	Comment [a]	Recommendation [a]	B2Gold Nunavut Response [a]	Requirement
	and reclamation plan, PC Condition No. 15	• *PC Condition No. 15* *Back River Project Interim Closure and Reclamation Plan ICRP (July 2021)* *B2B Gold FEIS*	*1. projected timelines for the reclamation of project features, methodologies for undertaking such activities, and monitoring measures to ensure the effectiveness of reclamation methods employed;* *2. specific measures for adaptive management and triggers for their application, should monitoring results reveal trends that could affect the reclamation and closure objectives; and,* *3. how Inuit Qaujimajatuqangit and Traditional Knowledge was collected and used to inform closure plans and the design of project components."* *The Back River Project Interim Closure and Reclamation Plan ICRP (July 2021) does not contain explicit triggers for applying adaptive management, as stated in the second condition of PC Condition No. 15. Information regarding specific triggers should be added to this plan.* *The ICRP did not provide details on the collection of Qaujimajatuqangit or Traditional Knowledge to inform closure plans and the design of the project components. However, a line in the ICRP indicated that this is outlined in B2B Gold's FEIS; thus, it should be referenced in this condition.*	• *Please add specific triggers for the application of adaptive management to the ICRC [sic] (July 2021)* • *Please provide the reference for B2B Gold's FEIS in the reference section of PC Condition No. 15 in the 2024 Annual Report.*	*Reclamation Plan was part of the Terms and Conditions for the Energy Centre and is therefore filed under the Back River Project Energy Centre (Application No. 125740). The reference will be added in future annual reports.*	adaptive management triggers and details on the collection of Qaujimajatuqangit or Traditional Knowledge. Add reference to ICRP to future NIRB annual reports.
KIA-NIRB-14	*Missing information to assess compliance for the site footprint.*	*B2B Gold, Back River Project, 2024 Annual Report (April 4, 2025)* *Vegetation Monitoring Plan (January 2020)*	*The references provided consist of the Vegetation Monitoring Plan (January 2020) and Vegetation Monitoring Program (Golder 2019), available on the nirb.ca website. However, these documents only provide some details on how the footprint monitoring will be completed. The results of the footprint monitoring are provided in the table of the annual report. While this information is provided (e.g., loss or alteration of vegetation associated with Project activities, including identifying the type of habitat loss resulting from these effects), several details are missing. For example:* • *Efforts to minimize the Project footprint are not provided.* • *The annual report does not distinguish between construction and progressive reclamation activities.* • *The annual report does not provide a breakdown of footprint effects for the project's different components, including the Energy Centre infrastructure (wind turbines, solar panel array, Battery Energy Storage System, transmission lines, and service roads).*	*The KIA requests the following:* *The proponent should provide the vegetation monitoring program results while including efforts to minimize project footprints, a breakdown between construction and reclamation activities and a breakdown of footprint effects by Project components.*	*B2Gold Nunavut can provide this breakdown in future annual reports.*	In future NIRB Annual Reports, provide information on vegetation monitoring program results including efforts to minimize project footprints, a breakdown between construction and reclamation activities, and a breakdown of footprint effects by Project components.

Notes:

CIRNAC = Crown Indigenous Relations Northern Affairs Canada

FEIS = Final Environmental Impact Statement (Sabina 2015)

ICRP = Interim Closure and Reclamation Plan (Sabina 2021)

KIA = Kitikmeot Inuit Association

NIRB = Nunavut Impact Review Board

[a] Direct quotation.

ATTACHMENT D LITERATURE REVIEW TABLE

TABLE D-1 LITERATURE REVIEW OF ARCTIC RECLAMATION AND REVEGETATION RESEARCH AND GUIDELINES

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
1	Meidinger, D.V.	1979	*Natural Revegetation of Disturbances in the Peace River Coalfield*	Research (Primary)	Reclamation; Revegetation; Surface Preparation; Soil Amendment; Mining	British Columbia, Peace River Coalfield, Foothills, Rocky Mountains	Alpine Tundra/Subalpine	**Revegetation:** Natural revegetation recommended **Site Preparation:** Ripping compacted soils improves revegetation; Dolomitic lime for low magnesium sites; Finer materials preferred; Organic matter content improves revegetation and organic materials recommended **Other:** Environmental Conditions Impacting Revegetation: Moist sites revegetate faster than dry sites, compacted sites with less cover, coarse soils with less cover, organic material increases cover, magnesium sites with more cover	Environmental factors limiting alpine tundra revegetation also applicable to Arctic tundra
2	Hagen, D.	2002	*Propagation of native Arctic and alpine species with a restoration potential*	Research (Primary)	Revegetation; Propagation	Arctic, Svalbard & Dovre Mountain	High Arctic Tundra; Permafrost; Dry exposed ridges	**Revegetation:** Greenhouse propagation effective (but costly): *Luzula arcuata*, *Oxyria digyna*, *Papaver dahlianum* seed germination good (>50%); *Dryas octopetala* seed gemination low (<10%); Seed storage temp had no effect on germination; Cuttings of Arctostaphylos uva-ursi, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Salix herbacea*, *Salix polaris* root well (>70%); Cuttings of *Cassiope tetragona* and *Dryas octopetala* weak rooting ability; *Bistorta vivipara* bulbils had high germination (>50%) but high mortality; Genetic diversity must be considered in large-scale restoration	Arctic native plant propagation methods applicable for planting
3	Alaska Department of Natural Resources	2025	*2025 Reclamation Plan Form for Placer Exploration or Mining*	Guideline	Reclamation; Topsoil Salvage; Surface Preparation; Erosion Control	Alaska	Arctic/Subarctic	**Revegetation:** Natural revegetation recommended; Active revegetation not discussed **Site Preparation:** Reshape disturbed areas to blend with surrounding terrain; Stabilize slopes; Backfill trenches and shallow auger holes; Protect stockpiles from erosion and contamination; Stockpiled topsoil, overburden muck and vegetation must be redistributed promptly (or separated and stockpiled) - expected promote natural revegetation within five years; Organic material (brush, stumps) spread over reclaimed surfaces to inhibit erosion and support revegetation **Other:** Re-establish unstable stream channels in valley floodplain; Restore hydrology; Seal shafts at closure; Remove structures and debris	Recommendations applicable: Topsoil/organics salvage and application; Stabilize floodplain; Erosion control
4	Adams, P. W.; Lamoureux, S.	2005	*A Literature Review of the Use of Native Northern Plants for the Revegetation of Arctic Mine*	Research (Review)	Reclamation; Revegetation; Topsoil Salvage; Soil Amendment; Surface Preparation;	Arctic/Subarctic Canada	Arctic/Subarctic; Acidic and Metal-contaminated Tailings	**Revegetation:** Native tundra species (e.g., *Arctagrostis*, *Calamagrostis*, *Eriophorum*) outperform non-native commercial grasses under Arctic stress; Mosses (e.g., *Polytrichum*, *Sphagnum*) recommended for extreme substrates to initiate soil formation and stabilize surfaces; Phytostabilization with tolerant grasses plus soil amendments; Source seeds/cuttings locally to	Prioritize native seed mixes and bryophyte establishment on harsh substrates; salvage local topsoil/organics; pilot phytostabilization with tundra species; design monitoring to

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
			Tailings and Mine Waste		Mining; Best Practices			conserve gene pool (rules provided); Species exhibiting acid/heavy metal tolerances; Transplant root saucers or root mats **Site Preparation:** Topsoil salvage and reapplication critical; lime for acid tailings; organic amendments improve moisture retention and reduce metal bioavailability; use slow-release fertilizers to avoid leaching; Apply lime (acidity) and gypsum/calcium nitrate (sodicity); add organic matter; Create rough-and-loose microsites; Maintain some exposed mineral soil surface (seeding germination better on mineral) **Other:** Phytoremediation pathways (phytoextraction, phytostabilization) applicable in low–moderate contamination; conserve local gene pool by sourcing within ~6 km; avoid non-native species to prevent competition and gene introgression; Arctic seeds often dormant; slow seedling growth; high root:shoot ratios; shallow, spreading root systems; caution with topsoil covers over acidic tailings (capillary metal movement)	track succession and dust/metals in lichens; Prioritize native species propagation via local collections; pilot moss layer establishment on tailings/waste rock; lime acidic zones; use slow-release fertilizers; engage Indigenous/local partners for seed/cutting sourcing within ~6 km guideline
5	Budzey, B. F.; Landhäusser, S. M.; Stewart, K. J.	2025	*The influence of abiotic (snow fences) and biotic (hedgerows) vertical structures on soil moisture, temperature, and planted seedlings in subarctic mine site reclamation*	Research (Primary)	Reclamation; Revegetation; Substrate; Surface Preparation; Buffers; Mining	Yukon, Minto Mine	Subarctic Boreal; Semi-arid; Substrates: waste-rock overburden cover (50 cm), sandy loam to loam, low organic matter, elevated Cu/As; Discontinuous Permafrost	**Revegetation:** Planted fireweed and Canada bluejoint survival >85–93%; Biomass driven more by site-level moisture than structure proximity; Forb/grass aboveground biomass was clipped to ~ 2 cm before planting to reduce drought stress; Shrub hedgerows (planted) using *Alnus viridis* and *Dryas integrifolia* were planted using locally collected *Alnus viridis* and *Dryas integrifolia* seed collected in central and southern Yukon (grown at NATS Nursery in BC) **Site Preparation:** Site-specific factors like microtopography and substrate type had a greater effect on planted seedling performance by shaping soil moisture and temperature dynamics more strongly than shelter provided by larger physical structures; Substrate texture (sand content, rock fragments) reduced water retention/soil moisture for hedgerow and planted seedling survival and growth; Disc trenching (to 30cm) created microtopography that strongly shaped ponding and water redistribution (including control), outweighing vertical structure effects **Other:** Snow fences and hedgerows did not affect revegetation survival - snow fences may have been too short; Shrub Hedgerows (Alnus viridis, Dryas integrifolia) reduced plant-available water near PWP in summer likely due to transpiration; Snow fences (50% porosity; low 0.35 and 0.65 m) maintained higher soil volumetric water content (VWC) than biotic	Use rough-and-loose microtopography in uplands; Snow fencing to increase spring soil moisture for nurse crop establishment; Align structures to prevailing winds and verify with onsite climate logs.

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								hedgerows during summer/post-rainfall; Snow fence small height differences (0.35 vs 0.65 m) had limited impact; Vertical structures orientated perpendicular to window direction, 25-35 m long, spaced either 15 cm or 10 cm apart	
6	Turcotte, M. A. H.; Van Gulck, J.; Stavinga, D.; Peters, M.	2025	*An arctic case study of revegetation planning to implementation at Snap Lake Diamond Mine*	Research (Primary)	Reclamation; Revegetation; Surface Preparation; Topsoil Salvage; Soil Amendment; Mining; Indigenous	Northwest Territories, Snap Lake Mine	Subarctic Boreal–Tundra Transition; Dry Upland Pads/Laydown areas; Morainal Sands/Silts; Permafrost	**Revegetation:** Natural revegetation - recommended; Commercial seeding: Rocky mountain fescue, spiked trisetum, ticklegrass, alpine bluegrass performed best; Locally collected seed and propagation in nursery for planting: shrub seedlings (lingonberry, crowberry) had 46–96% survival (best in no fertilizer); Locally collected: direct shrub seeding failed (lingonberry, crowberry, bearberry); Seeding in spring generally favorable **Site Preparation:** Surface contouring to limit slopes; decompaction and microsite creation (scarification); Scarification and topsoil placement improved establishment; targeted fertilizer rates (200–250 kg/ha of NPK 13-16-10, mix depends on overburden presence); engineered covers left unvegetated on North Pile to deter wildlife; topsoil application (overburden) at 0.4 m thickness; Closure Recommended: 200 kg/ha of 10-30-25 (0) (nitrogen–phosphorous–potassium (sulfur)) fertilizer for areas with overburden (i.e., Active-OFS) and application of 250 kg/ha of 30-25-20 (7) (nitrogen–phosphorous–potassium (sulfur)) fertilizer in areas without overburden **Other:** Regulatory timelines span decades; closure criteria focused on vegetation cover and richness (e.g., min. species counts at 5 and 10 years); Indigenous engagement (Traditional Knowledge): Traditional Knowledge workshops, natural revegetation preferred, importance of all plant forms and diversity (species richness), input on plant species selection, community seed collection/planting/monitoring	Adopt a mixed approach: passive recovery + active seeding/planting in priority areas; set clear cover/richness criteria; integrate Inuit Qaujimajatuqangit and community monitoring; plan logistics (fertilizer/seed supply via winter road).
7	Bahroudi, B.	2024	*Influence of topsoil–till cover depth and amendments on ecosystem reclamation of a closed tailings storage facility*	Research (Thesis)	Reclamation; Topsoil Salvage; Soil Amendment; Mining	British Columbia, Kamloops	Semi-arid Grassland; Subzone: BGxw1; Coarse-textured Soils; Reclaimed Tailing Storage Facility; 10/20 vs 15/15 cm cover	**Site Preparation:** Soil amendments (zeolite, leonardite, compost) - Zeolite plots had highest biomass and species richness (including forbs), compost likely effective but was not incorporated so blocked rooting in soil; Topsoil/Subsoil cover (10 cm topsoil + 20 cm subsoil, 15 cm topsoil + 15 cm subsoil) - greater topsoil depth had higher biomass (15 cm topsoil + 15 cm subsoil best); Incorporate amendments into substrate/topsoil; Tilling reclaimed TSF did not improve outcomes vs bare tailings blocks (reduced C:N ratio and alpha diversity); Soil N increases	Results not directly applicable to Arctic but general recommendations are; Prioritize sufficient topsoil placement thickness; test zeolite/organic blends at small plots; Avoid thick mulches; Focus on native tundra grasses/forbs and microsite creation in cold, low-precipitation settings

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								grasses over forbs; Compost raised C, N, SOM and lowered pH; leonardite decreased C/N and SOM	
8	Webber, P. J.; Ives, J. D.	1978	*Damage and Recovery of Tundra Vegetation*	Research (Review)	Revegetation; Disturbance; Climate Change	Alaska, Canadian Arctic	High Arctic Tundra; Permafrost: Thermokarst	**Revegetation:** Native species preferred; Commercial native seed availability inadequate; Transplanting vegetation mats or plugs used in Arctic but may be impractical for large areas (sod/vegetation mats can be stored for several months if kept moist); Mixed planting recommended; Non-native species likely to only persist in the short-term but some non-native species have invaded Arctic climates; Arctic species with revegetation potential: Early successional native species and with weedy habit including Brassicaceae (e.g., *Braya purpurescens*) and Asteraceae (e.g. *Tephroseris* [Senecio] *palustris* ssp. *congesta*), *Agrostis borealis*, *Arctagrostis arundinacea*, *A. latifolia*, *Calamagrostis canadensis.*, *C. lapponica*, *Deschampsia caespitosa, D. sukatschewii*, *Eriophorum scheuchzeri*, *Luzula confusa*, *Poa arctica*, *P. glauca, P. rigens*) Site Preparation: N facilitates non-native plants **Other:** Vegetation recovery slow but possible (faster in low Arctic); Avoid disturbance near northern tree-line; Soil moisture and permafrost thickness influence vulnerability to disturbance - Moist tundra more sensitive than rocky and coarse material tundra which is resistant to disturbance; Disturbance of surface cover or active layer (freeze/thaw layer) can produce extensive thermokarst; Erosion as a result of thermokarsting in permafrost areas with high water content; Current vegetation may be adapted to past climate conditions and therefore be difficult to reestablish; Replacing organic mat to restore thermal regime	Use native sods and transplanting; prioritize mapping and site-specific planning; avoid non-native species
9	Forbes, B. C.; Jefferies, R. L.	1999	*Revegetation of disturbed arctic sites: constraints and applications*	Research (Review)	Revegetation; Surface Preparation; Soil Amendment; Substrate; Snow Removal	Canadian Arctic, Alaska, Russia, Iceland	Disturbed Tundra; Upland Gravel; Sandy and Saline Soils; Wetlands	Revegetation: Clonal propagation and seeding in wetlands aids recovery (patches of undisturbed vegetation recover smaller disturbance – rhizomatous Arctic graminoids, such as species of *Carex* and *Eriophorum*); Caution with exotic species which prevent re-establishment and recovery of native ecosystems (often dominated by grasses); Willow cuttings in wetlands; Organic mat in tussock tundra contains abundant buried seeds; Viviparous species can produce an abundance of propagules annually (vs. seminiferous); Transplanting can damage donor populations; Arctic species with revegetation potential: Pioneer N-fixing herbs like legumes (*Astragalus alpinus, Hedysarum alpinum, Hedysarum mackenzii, Oxytropis campestris, Oxytropis viscida*), *Salix spp., Phippsia algida, Puccinellia vaginata, Puccinellia langeana* (prolific seeder and seed in 2 years),	Reclamation methods all applicable and good review article: Focus on native species; avoid exotic introductions; improve soil moisture and nutrients; consider clonal planting in wetlands

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								Puccinellia arctica (prolific seeder and seed in 2 years); *Eriophorum vaginatum, Arctophila fulva* (clonal propagation), *Elymus arenarius* (clonal propagation), *Puccinellia phryganodes* (clonal propagation), *Artemisia* spp., *Epilobium latifolium*; Salt tolerant species: *Puccinellia langeana*, *Puccinellia arctica*, *Dupontia fisheri*, *Arctophila fulva*, *Festuca rubra*, *Potentilla egedii*, *Plantago maritima*, *Cochlearia officinalis*, *Elymus arenarius* **Site Preparation:** Substrates: gravel, sandy, saline soils slow to recover, wetlands faster to recover; Fertilization accelerates growth but may reduce diversity and changes community composition in upland (favouring non-natives) but promotes overall greater biomass - Objective of developing greater plant cover or greater species diversity may conflict (e.g., N fertilization); Fertilization in wetlands can support diverse wetland plant community; Tillage of compacted gravels or addition of soil amendments (e.g., finer textured soils) beneficial; Saline soils - reestablish an organic insulating layer to limit evaporation and salt deposition/accumulation at the soil surface; Salt treatment (calcium nitrate, natural flushing) **Other:** Natural recovery extremely slow; Arctic safe sites concept critical; Snow removal	
10	Hewitt, R.; Smith, J. A.; Doe, L. M.; Zhang, Q	2018	*Results of the Tundra Mine, NT Revegetation Trial Using Locally Harvested Pioneer Species Instead of Grass Seed and Fertilizer*	Research (Primary) - Presentation Abstract	Reclamation; Revegetation; Surface Preparation	Northwest Territories, Tundra Gold Mine	Subarctic Boreal–Tundra Transition; Permafrost	**Revegetation:** Locally harvested native pioneer species (Willow cuttings: *Salix athabascensis*); Transplant plugs: *Juncus stygius*, *Juncus drummondii*, *Equisetum arvense*, *Carex aquatilis*); 83-86% survival **Site Preparation**: Soils mechanically loosened and had slightly higher survival than control; No soil amendments applied	Reclamation methods all applicable
11	Kearns, N. B.; Jean, M.; Tissier, E. J.; Johnstone, J. F.	2015	*Recovery of Tundra Vegetation Three Decades after Hydrocarbon Drilling with and without Seeding of Non-Native Grasses*	Research (Primary)	Reclamation; Revegetation; Mining	Northwest Territories, Mackenzie Delta region, Kendall Island Bird Sanctuary, Parson's Lake	Low Arctic Tundra; Permafrost; Drilling Sump Pads; Saline Soils; Flood-influenced	**Revegetation:** Natural (passive) revegetation is recommended since also recovered and has lower negative risks; Active revegetation: Seeded non-native grasses (*Festuca rubra*; *Poa pratensis*) increased vegetation cover but introduced persistent non-native species after >30 years (did not invade undisturbed tundra but some risk for spread if disturbed), did not prevent thermokarst; Disturbed areas in seeded and unseeded areas significantly different than undisturbed tundra >30 years (dominated by pioneer species)	Reclamation methods all applicable

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								Site Preparation: Recovery inhibited since sumps are elevated and hydrological regime different than undisturbed tundra; Recommend tall shrub removal to prevent snow accumulation and warmer winter temperatures **Other:** Erosion generally minor relative to permafrost degradation	
12	Dance, A.	2015	*Northern Reclamation in Canada: Contemporary Policy and Practice for New and Legacy Mines*	Policy (Review)	Reclamation; Policy; Inuit; Mining	Canadian Arctic: Nunavut, Northwest Territories, Yukon, Northern Labrador, Nunavik	Arctic/Subarctic	**Other:** Reclamation reform needed; Federal programs (FCSAP, NCSP) and NOAMI improve legacy site management, but enforcement and capacity remain uneven; devolution shifts responsibilities to territories; examples include Giant, Faro, Colomac, Jericho; Table 1 summarizes the Reclamation Programs and Policies applicable to Nunavut; Reclamation rarely restores sites to pre-disturbance state; effectiveness depends on comprehensive planning, stable funding, and integration of traditional knowledge; progressive reclamation is critical; Robust securities and closure plans; clear regulatory frameworks; cumulative effects assessment and precautionary principle; cross-jurisdiction coordination; Indigenous Impact & Benefit Agreements; water/land licensing requirements; Progressive reclamation embedded in approvals; adequate, enforced financial securities; Indigenous engagement & TK integration; local employment and training (set-asides); transparent communication and monitoring; Weak enforcement; fragmented governance; inconsistent or insufficient securities; policy “streamlining” that reduces protective standards; inadequate planning for perpetual care.	Policy overview with some applications to Nunavut: Integrate Inuit TK through formal mechanisms (e.g., IIBA); coordinate with NIRB & Nunavut Water Board
13	Keeling, A.; Potvin, V.	2025	*Nunavik Inuit and Raglan Mine: New approaches to closure planning (isulinnisanganut parnasimautiit)*	Research (Primary)	Reclamation; Inuit; Mining	Québec, Nunavik, Raglan Mine (Katinniq) & Deception Bay	Arctic Tundra; Permafrost	**Other:** Inuit Engagement: Lessons include sustained collaboration, documentation, and benchmarking for industry, Closure Plan Subcommittee, integration of Inuit knowledge/values; new social chapter in closure plan; Inuktitut terminology, infrastructure repurposing, importance of traditional wildlife harvesting and other land-based activities	Based in Quebec, but Inuit engagement applicable to Nunavut: Establish a closure/reclamation subcommittee with Inuit partners (e.g., Kitikmeot communities), co-develop culturally relevant closure criteria, build shared terminology (Inuktut) for closure concepts; use training, site visits, and visual tools (e.g., 3-D models) to strengthen understanding, plan for infrastructure repurposing and

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
									community benefits, document and benchmark processes
14	Kempenaar, L.; McCarron, J.K.; Marques, L.R.; McClure, T.; Rennie, D.	2013	*Tools for Arctic Revegetation: What's in Your Toolbox?*	Industry (Conference)	Reclamation; Revegetation; Topsoil Salvage; Surface Preparation; Mining	Northwest Territories, Snap Lake Mine	Subarctic Boreal–Tundra Transition; Permafrost; Substrates: gravel pads, disturbed mine surfaces	**Revegetation:** Natural revegetation effective on small disturbances near seed/spore sources or with seed bank; Active revegetation (seeding/transplants) needed for large disturbances; Considerations for active vs. passive reclamation: invasives, erosion risk, proximity to natural area, seed bank, site productivity, cost, site diversity, site stressors, disturbance size; Species Selection: tailor to stressors and microsites; Erosion prone areas: non-native nurse crops have been used (some sites they persist and outcompete natives) **Site Preparation:** Site contouring; Topsoil placement or rehabilitation; Erosion control	Reclamation methods all applicable
15	Kuzyk, T.; Seahra, S.; Lowey, J.; Pedlar, R.; Bequet, A.-C.	2025	*Continued evolution of mine closure practices: integration of Indigenous perspectives and climate change in revegetation prescriptions*	Research (Review)	Reclamation; Climate Change; Inuit; Mining	British Columbia, Northern (Golden Triangle)	Arctic/Subarctic; Permafrost	**Revegetation:** Plant species selection: climate-resilient species, diverse species, local provenance, culturally important species; Multi-phase plantings (current-adapted followed by future-adapted species, early successional then later succession shade tolerant species) **Site Preparation**: Coarse woody debris placement to create microsites, improve moisture, and wildlife habitat **Other:** Climate-shifted baseline to set ecosystem targets; Engage Indigenous rightsholders in closure vision - align and collaborate with Nations on their intended future use of the land; Plan for connectivity to support wildlife & resilience; Tools: CCISS, ClimateBC, ClimateNA climate modeling tool (mean annual temperature, climate maps, mean annual precipitation, and climatic moisture deficit using the SSP2-4.5 climate scenario into the year 2100); Monitoring: validate climate projections and recovery, initial frequent monitoring then long-term monitoring at less frequent intervals	Recommendations relevant: Develop climate-shifted baseline targets; Plant source considerations; Monitoring program and adaptive management triggers; Co-develop revegetation with Inuit partners; *Integrated Mine Closure: Good Practice Guide* (ICMM 2025)
16	Matheus, P. E.; Omtzigt, C. M.	2013	*Yukon Revegetation Manual: Practical Approaches and Methods*	Guideline	Revegetation; Topsoil Salvage; Surface Preparation; Soil Amendment; Monitoring	Yukon	Arctic/Subarctic; Alpine/Subalpine; Permafrost; Substrates: saline/acid/alkaline soils, slopes, bare mineral soils; Highway ROW; Borrow Pits; Mine Sites	**Revegetation:** Natural revegetation - Facilitated; Broadcast seeding densities adjust by scenario/feature (hand seeding or ATV seeding): 500–1,000 PLS/m² for tundra, ≥2,250–3,000 PLS/m² for steep slopes; Frost seeding effective (Oct) when timed to dormancy; Seed quality (PLS) & certification critical; Species Selection: consider pH, moisture, salinity; Seed/Propagule collection: collecting/sowing seeds of local plants is preferred (however some northern cultivars of commercial seed exist); Native commercial seeds for tundra low nutrient: *Arctagrostis latifolia* (acidic), *Elymus alaskanus* (alkaline, saline),	Guideline for Yukon but applicable to Nunavut (specifically Scenario 6), although some recommendations are for more southern Subarctic conditions (other Scenarios)

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								Poa glauca (broad pH), *Deschampsia caespitosa* (acidic soils, wetter), *Poa alpina* (mild acidic), *Trisetum spicatum* (mild acidic, mild alkaline); Non-native nurse/cover crop for tundra (≤10% of mix): *Hordeum vulgare* (alkaline, saline); Local Native Seed for tundra low nutrient: *Festuca altaica* (low nutrient), *Poa arctica* (acidic, alkaline), *Poa alpigena* (low nutrient), *Hierochloë alpina* (low nutrient, dry), *Puccinellia nuttalliana* (alkaline, saline, dry, low nutrient), *Artemisia* spp. (mostly dry, low nutrient), *Lupinus arcticus* (low nutrient, N-fixing), *Dryas* spp. (alkaline, low nutrient); Woody Native Stakes (wet ditches or riparian): *Salix* spp. (wet); Woody Seedlings from Local Collected Seed: *Betula glandulosa* (acidic, organic), *Betula nana* (acidic, organic), *Alnus crispa* (mild acidic, wet); Non-native nurse crops (species that only persist few years to be replaced by native plants) **Site Preparation**: Stockpile & reapply organic materials; On non-permafrost sites, tillage/deep decompaction (25–40 cm) and roughened/scarification surface (rough and loose for decompaction and microtopography) - plough, disk harrow, ripping teeth on a tracked vehicle & track-walking on slopes to form catchments; calculate custom fertilizer mixes based on soil testing (typical N 40–90 kg/ha; P_2O_5 30–70 kg/ha; K_2O 30–60 kg/ha; S up to 17 kg/ha); Prioritize soil salvage & roughened microtopography; Fertilizer (N-P-K-S); Incorporation of organic material with surface sediments using harrow to 10-30cm; Organic material minimum thickness of 5 to 10 cm; Permafrost sites with shallow (2-5 cm) harrowing/raking rather than deep soil turning to prevent thermokarst; Match organic content/thickness to surrounding sites; Minimize fertilizer application (half recommended fertilizer amount, <50kg N/ha); If thermokarsting, apply as much soil/organic material as possible (>20 cm) in current/next spring, avoiding tillage, establish quick cover (i.e., 10% cover crop), equipment when ground frozen **Other:** Control Invasive Plants: manage invasive species via certified seed and equipment hygiene; Restore Thermal Regimes on Permafrost Sites; Use mulches/RECPs and willow staking for erosion control; monitor percent ground cover (targets: 50–60% first season on erosion-prone slopes; 20–30% on stable flats); Includes prescriptions for treatment methods and plant descriptions	

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
17	QIA (Qikiqtani Inuit Association)	2017	*Abandonment and Reclamation Policy for Inuit Owned Lands (Version 2.0)*	Policy	Reclamation; Policy; Inuit	Nunavut, Qikiqtani Region	High Arctic	**Other:** Abandonment and Reclamation Plan (A&R plan) for IOL; Defines goals for reclamation and obligations of land user: Progressive reclamation; Integration of Inuit Qaujimajatuqangit and community consultation; Physically, chemically, and biologically stable; Consistent with valued ecosystem components; Aesthetically and environmentally compatible with the surrounding undisturbed landscape; International best practices for Arctic conditions, as well as federal and territorial legislation, regulations and guidelines; Post-activity monitoring; "Nunavut Tunngavik Incorporated (NTI) and the Regional Inuit Associations require users of IOL to return the land to a safe and stable condition that maintains the ecosystem integrity and that is consistent with Inuit societal and cultural needs and aspirations."	The Goose Project is outside of Qikiqtani Region (Kitikmeot Region; therefore not directly affected by this Policy); Provides context for Inuit Values; Align A&R with IQ and CLARC expectations; prepare defensible security with line-item evidence; plan progressive works and monitoring; use concordance table.
18	Government of Northwest Territories; Presenter (Bioengineering team)	2017	*Revegetating Colomac Mine, NT: Bioengineering techniques for riparian areas (six-year update)*	Industry	Reclamation; Revegetation; Mining	Northwest Territories, Truck Lake, Colomac Mine	Subarctic; Riparian Channels and Shorelines; Substrate: Compacted, nutrient poor mineral soils; Hydrocarbon Contamination	**Revegetation:** Local native plant propagation; Planting: Trees, lupine; Riparian Areas: dormant willow cuttings (1.2 m) - soaked in water for 6 days, staked in clusters of 5 (95% cover achieved); Alder seed (~100 g/ha) - seed separated using lettuce spinner, hand-seeded, established in moist areas well; Native grass seed; Transplanting: Sedge plugs in wet areas - collected from multiple locations; Established cover in wetlands (e.g., Truck Lake wetland ~80% between 2010-2015; Steeves shoreline ~75%); Species selection: Locally collected pioneer species **Site Preparation:** Surface Preparation: "Rough-and-loose" microsite creation increased moisture capture, seed trapping, and reduced erosion excavator to ~1 m depth across slopes stopped sheet flow; Woody debris placement; Staged surface roughening improved success and erosion control. **Other:** Monitoring focused on % cover, survival of cuttings/plugs, biodiversity - annually first 5 years then less frequently (in August); Mycorrhizal Research; Lessons: plan early, train crews; Surface preparation in strips to allow access of machines for placement of materials (e.g., deadwood) prior to complete preparation	Recommendations mostly relevant to wetter conditions
19	Oberndorfer, E.; Broomfield, T.; Lundholm, J.; Ljubicic, G.	2020	*Inuit cultural practices increase local-scale biodiversity and create novel vegetation*	Research (Primary)	Inuit; Revegetation	Labrador, Nunatsiavut, Makkovik area	Subarctic Boreal–Tundra Transition; Coastal barrens, heath, sod houses, middens, wood houses; shallow	**Revegetation:** Natural revegetation: calciphiles and ruderal natives that occur in historically disturbed areas (e.g., *Montia fontana*, *Agrostis scabra*, *Elymus trachycaulus*, *Alnus viridis*, *Rubus idaeus*, *Rubus pubescens*, *Epilobium hornemannii*, *Epilobium lactiflorum*, *A. atropurpurea* [calciphile], *Draba incana*	Findings relevant to other Inuit landscapes: consult Inuit knowledge on species/propagules; account for legacy soils when selecting references and monitoring

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			communities in Nunatsiavut (Labrador, Canada)				substrates; nutrient inputs from country foods; Natural revegetation (historical Inuit disturbance): native, disturbance-tolerant calciphiles;	[calciphile], *Carex nigra* [calciphile], *Stellaria borealis*, *C. angustifolium*, *C. canadensis*) **Site Preparation:** Soil enrichment (nutrient inputs) resulting from Inuit fishing histories - Nutrient enrichment (Ca, P, Mg) from harvesting increases calciphiles and ruderal natives; Built environments (sod houses, middens, wood houses) have distinct plant assemblages and higher local species richness per area than undisturbed patches; Soil chemistry (Ca, P2O5, Mg, pH, Fe) explains vegetation differences; mechanical disturbance + nutrient inputs drive shifts from dwarf shrubs to grasses/herbs; reference areas may hide cultural legacies; Tent rings resemble adjacent heath; Calcium enrichment near middens and sod houses of Inuit (bones, shells) **Other:** Inuit cultural practices drive biodiversity (e.g., built environments, fishing histories, tent rings) and can increase local-scale plant species diversity (# species per unit area, but overall no difference); Management should support cultural practices; Monitor middens/sod houses for future non-native introductions as climate warms; Biodiversity islands; Calciphiles; Disturbance-tolerant species; Inuit historical disturbance results in transformation from heathland to grassland (nutrient enrichment favouring grasses)	targets, Design heterogeneity and organic enrichment islands
20	Chapin, F. S., III; Chapin, M. C.	1980	*Revegetation of an Arctic Disturbed Site by Native Tundra Species*	Research (Primary)	Revegetation; Topsoil Salvage; Soil Amendment	Alaska	Arctic Tundra; Permafrost: Thermokarst; Organic Soils	**Revegetation:** Natural revegetation: Native sedges re-established biomass equal to undisturbed tundra within 5–10 years; Native Species: *Eriophorum vaginatum*, *Carex* spp. like *C. bigelowii*, mosses; Exotic grasses established then declined (required repeated fertilization); Seed source for *E. vaginatum* from adjacent tundra and organic soil seed bank as seed source **Site Preparation:** Native plants in organic soils did not require fertilization, while exotics did; Topsoil source of seed bank **Other:** Succession from exotics to natives on tundra	Recommendations relevant: Prioritize native sedges and local seed sources for tundra disturbances; avoid exotics; consider modest fertilization to speed native recovery
21	Sandlos, J.; Keeling, A.	2016	*Aboriginal communities, traditional knowledge, and the environmental legacies of extractive development in Canada*	Research (Primary)	Reclamation; Inuit; Mining	Northwest Territories, Yellowknife, Giant Mine	Arctic/Subarctic; Arsenic	**Other:** Integrating TK beyond “flora/fauna data” to guide remediation goals and justice considerations; Highlights epistemic injustice and need for restorative approaches (compensation/apology) and long-term solutions beyond frozen block arsenic	Recommendations applicable: Inuit engagement

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22	Stuckless, B.; Brillinger, D.; Whitehead-Delong, L.; Tannas, S.	2024	*Revegetation with locally harvested native plant seeds at the abandoned Atlin Ruffner Mine*	Industry (Conference)	Reclamation; Revegetation; Erosion Control; Monitoring; Mining	British Columbia, Mount Vaughan, Atlin Ruffner Mine	Alpine Tundra; Substrate: Sand/gravel; Steep Slopes	**Revegetation:** Seed Collection: seed set different times of year and elevations but July most favourable, off-site stratification, and ex-situ greenhouse propagation; Planting densities from 1-3 plants per m2; Local native pioneer plant species suitable for revegetation of disturbed gravel areas with low nutrients (*Dryas integrifolia* [not N-fixing, though historically thought to be], *Lupinus nootkatensis* [N-fixing], *Saxifraga tricuspidata*, *Sedum lanceolatum*, *Oxytropis campestris* var. *spicata*) - slow growth rate prior to out planting, preferred gravels and coarse soils with frequent and heavy precipitation (well-drained but frequent watering), *Dryas integrifolia* low germination rate and susceptible to insect attacks, established variably from ~16.7-94% survival; Shelter improves survival; June planting outperforms fall; Target ~30% cover; Intervention and supplemental infill planting needed in some areas; Slopes plant from the top of the slope to the bottom; Experienced planters; Post-planting inspections to verify planting densities (Randomly selected plots 50 m2 and 20% of area surveyed); Long-term monitoring (10% of area surveyed); Natural colonization of species: *Festuca* spp., *Calamagrostis purpurascens*, *Chamaenerion latifolium*, *Chamaenerion angustifolium* **Site Preparation:** Minimal Soil Amendment: Small amount of organic treated manure to deter grazing; Bituminous geomembrane liner (installed 1 m depth); Remedial cap of contaminated areas **Other:** Plugs believed to have been pulled out by grazing but unclear (I suspect frost heave due to due to September planting [not enough time for roots to develop], and subsequent planting was in June); Remote piloted aircraft planned for steep slope monitoring; Invasive species: *Crepis tectorum*	Recommendations applicable: Prioritize locally adapted natives; plan for seed logistics/propagation; align root depths with cover systems; plant spring/early summer; create shelter and monitor via RPA where access is risky
23	May, D. E.; Webber, P. J.; May, T. A.	1982	*Success of Transplanted Alpine Tundra Plants on Niwot Ridge, Colorado*	Research (Primary)	Revegetation; Transplanting; Alpine	Colorado, Niwot Ridge	Alpine Tundra; Microenvironments: fellfield, snow bed, dry & moist meadows, shrub tundra	**Revegetation:** Transplant success to intact communities ranged 98% (*Deschampsia caespitosa*) to 17% (*Carex rupestris*); Species: *Deschampsia caespitosa* (98%), *Kobresia myosuroides* (83%), *Acmastylis rossii* (79%), *Carex pyrenaica* (70%), *Sibbaldia procumpens* (44%), *Carex rupestris* (17%); Fibrous-rooted species most resilient than rhizomatous or other rootstock species; Transplant success not guaranteed even in native microenvironment; Fellfield microenvironment inhibited transplant success; Ecological tolerance less of a determinant than root form; Transplanting methods: Careful excavation of	Not directly applicable since study in alpine environment, but some overlapping species indicate effectiveness of transplant: Plug/sod transplants most effective for fibrous-rooted native graminoids on priority microsites; Avoid transplanting highly exposed dry sites unless amended; Post-transplant

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								roots, removal of soil from roots, post-transplant watering for several weeks minimized early mortality	watering/irrigation where feasible
24	EDI Environmental Dynamics Inc.	2020	*2 Documents: (1) Reclamation Pilot Study: Mary River Mine Project - Revegetation Survey & Preliminary Reclamation Trial; (2) Research Review Advances in Arctic Reclamation: Implications for Reclamation Practices & Trials at the Mary River Mine Project*	Industry (Primary, Review)	Reclamation; Revegetation; Surface Preparation; Monitoring; Mining	Nunavut, North Baffin Island, Mary River Mine; Tote Road KM52 (near Katitkok Lake) & KM16 (near Phillips Creek)	High Arctic Tundra; Xeric/Subxeric; Glaciofluvial & Morainal Parent Materials; Sandy Loam, Coarse Fragments; Restrictive till layer (~20–29 cm); Polygonal Ground; Turbic Cryosols; Permafrost near-surface; High wind	**Revegetation:** Natural revegetation of native grasses, sedges, forbs, shrubs occurs (1, 5 year disturbance chronosequence); shrubs/bryophytes/lichen in control areas but limited in disturbed areas; no exotic species recorded; disturbed KM52 (~1 yr post-disturbance) ~4% cover vs. controls ~29% cover; disturbed KM16 (~5 yrs post-disturbance) ~51% cover vs. controls ~83% cover; early-succession graminoids/forbs dominate passive restoration (Year 1: *Carex fuliginosa* ssp. *misandra*, *Dryas integrifolia*, *Erysimum pallasii*, *Physaria arctica*; Year 5: *Carex membranacea*, *Bistorta vivipara*, *Oxytropis maydelliana* subsp. *melanocephala*, *Saxifraga oppositifolia*, *Saxifraga aizoides*, *Potentilla hyparctica*, *Vaccinium uliginosum* subsp. *microphyllum*) **Site Preparation:** Established two configurations: (1) Rough-and-Loose decompaction, surface heterogeneity, microsites and (2) Track-packing (compaction and surface imprinting to reduce erosion, surface roughness); earthworks limited to <35 cm depth to protect permafrost; CAT 345D Excavator with standard 122 cm wide 4 tooth bucket; tie-in to natural drainage patterns; trial strips georeferenced for monitoring **Other:** Soils in both sites non-saline, low nutrients, little organic matter; recommend expanding sites, identifying indicator species, increasing replication/chronosequence; annual/biannual monitoring; different landscapes and landscape features will require potentially different and perhaps even a combination of reclamation strategies and surface configurations; Section 3 provides good condensed summary of reclamation/revegetation at Mines and in research; Section 4 provides good recommendations for how lit review informs recommendations	Adopt rough-and-loose for microsites on coarse, xeric substrates; limit excavation depth to avoid permafrost impacts; target early-succession natives (graminoids/forbs) for initial cover; replicate trials across endpoints (roads, laydowns, waste rock); monitor annually/biannually
25	Cater, T. C.	2010	*Tundra Treatment Guidelines: A Manual for Treating Oil and Hazardous Substance Spills to Tundra (3rd ed.)*	Guideline	Reclamation; Revegetation; Spills; Guideline	Alaska, North Slope, Arctic Coastal Plain & Foothills	Arctic Tundra (aquatic, wet, moist, dry); Permafrost	**Revegetation:** Enhance natural revegetation; Transplanting native vegetation (willow live stake cuttings, sprigs of *Arctophila fulva* in wet areas, springs of *Leymus* in dry areas); Tundra sodding (transplant intact tundra soil and live plant materials prior to their loss/development, best time to harvest sod is when the soil has thawed 6–12 inches, Cutting disc ["Nuna ulu"] and excavator); Seeding (local native plants preferred, native cultivars for erosion control); Plant Species: example native plants and site conditions	Spill-response context rather than reclamation, but some recommendations or best practices applicable

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								Site Preparation: Soil amendments: Targeted fertilization where appropriate (e.g., to increase seed production), saline with gypsum or calcium nitrate (plus water), acidic with lime **Other:** Extending growing season: Early spring snow removal, snow fencing (4-8 ft high perpendicular to wind) for snow accumulation or to prevent snow on site for early growing season; Irrigation: improve growing conditions during dry season; Brine, hydrocarbon, synthetic fluid spill reclamation (e.g., sorbents, manual removal, snow management, drainage protection, land barriers, recovery with skimmers and pumps, flooding, flushing, trenching, burning/removing contaminated vegetation, mechanical removal [scraping, trimming, brushing], excavation and off-site disposal, draining and dewatering, backfilling to stabilize thermal balance); Recommendations to minimize impacts to tundra (e.g., use plywood/rig mats/boardwalks, avoid repeated passes, respect tundra travel thresholds); Recommendations for tundra travel (e.g., winter travel, vehicle types); Snow fencing to trap snow; Remove snow for earlier growing season; Monitoring (soil/water, vegetation cover/composition, active-layer depth) essential; Tactics vary by tundra type; Caution that cleanup operations can cause more damage than contaminants	
26	Canadian Mortgage and Housing Corporation (CMHC); Avens Associates Ltd.	2002	*Northern Landscaping: A Guide to Restoring the Plants and Soil in Northern Communities*	Guideline	Revegetation; Surface Preparation; Topsoil Salvage; Soil Amendment	Canadian Arctic/Subarctic: Nunavut, Northwest Territories, Yukon, Northern Labrador, Nunavik	Arctic/Subarctic; Tundra/Taiga; Substrate: Thin, coarse-textured soils; Permafrost; Erosion-prone Slopes (>5%)	**Revegetation:** Revegetation techniques: natural colonization, seeding, cuttings/sprigging (aboveground stem nodes, such as *Arctophila fulva*), live stake cuttings (willow/poplar), rootings, transplanting of native sods/vegetation mats, mass planting; Species Selection: Local native species, pioneer species for initial cover with trajectory to climax species, hemerophiles, provides list of native plants and site conditions (e.g., Appendix B, C, D); Storage and timing guidance for seeds; Seeding: fall or spring, local collection, direct or indirect, storage considerations; Transplant: active layer above permafrost, collection/placement in late fall after the surface of the ground is frozen, match placement site **Site Preparation:** Site Preparations include: correcting soil problems, re-contouring, conserving topsoil/organic material, erosion control, protecting adjacent area, scarifying surface, trapping snow with snow fences to accumulate organic matter and moisture; Handle soils carefully (salvage native soils; match host soils); Protect permafrost; Recontour & control erosion; Plan barriers to prevent traffic damage; Fertilizer not recommended (favours non-natives, and grasses) or should be	Guideline for smaller-scale planting projects, not reclamation

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								minimal (N) and judicious; Mulches not recommended unless in special circumstances (e.g., erosion control) **Other:** Snow Fences	
27	Indian and Northern Affairs Canada (INAC)	2002	*Mine Site Reclamation Policy for the Northwest Territories*	Policy	Reclamation; Policy; Mining	Northwest Territories	Arctic/Subarctic; Policy-level (Mine Sites; Land and Water Liabilities; Crown Lands; Mackenzie Valley regime)	**Revegetation:** Policy sets standards and expectations rather than specific revegetation prescriptions; aims for viable, self-sustaining ecosystems compatible with healthy environment & human use **Site Preparation:** Requires closure & reclamation plans for all mines; progressive reclamation; design for closure; tailings/waste rock stability **Other:** Mandates full financial security equal to outstanding liability; credits progressive reclamation; recognizes RECLAIM cost model; outlines procedures for insolvency and Crown protection; water quality standards; post-closure monitoring	Use as analog for NWT portions and for federal expectations; ensure full-cost security, progressive reclamation credits, RECLAIM inputs, and robust monitoring/updates
28	Indian and Northern Affairs Canada (INAC)	2002	*Mine Site Reclamation Policy for Nunavut*	Policy	Reclamation; Policy; Mining	Nunavut	Arctic	**Other:** Policy requirements for Mine Site Reclamation in Nunavut; Principles; Implementation Considerations	Policy requirements for Mine Site Reclamation in Nunavut
29	Indian Affairs and Northern Development (INAC); Chouinard, R.	2002	*Mine Reclamation Guidelines for the Northwest Territories and Nunavut*	Guideline	Reclamation; Policy; Guideline; Mining	Nunavut; Northwest Territories	Arctic/Subarctic	**Other:** Land Use and Aesthetics; Physical Stability; Chemical Stability; aim for walk-away outcomes (passive care acceptable; active care to be avoided for modern mines); "The selection of reclamation objectives at a project site should consider: naturally occurring bio-physical conditions, characteristics of the surrounding landscape, local community values and culturally significant or unique attributes of the land, level and scale of environmental impact, land use prior to mine development, and expected post operational land use activity."	Government Guidelines for Mine Site Reclamation in Nunavut
30	Indian and Northern Affairs Canada (INAC)	2003	*Northern Land Use Guidelines: Overview*	Guideline	Reclamation; Guideline; Government; Mining	Nunavut; Northwest Territories	Arctic/Subarctic	**Site Preparation:** Consult regulators; plan/design before construction; mitigate environmental impacts across project life; reclamation to original or suitable condition	Government Guidelines for Crown Land Use in Nunavut
31	Indian and Northern Affairs Canada (INAC)	2009	*Northern Land Use Guidelines: Pits and Quarries (Vol. 07)*	Guideline	Reclamation; Revegetation; Surface Preparation; Topsoil Salvage; Guideline; Government; Quarries	Nunavut; Northwest Territories	Arctic/Subarctic	**Revegetation:** Recommendations: Natural revegetation preferred; Seeding poses risk of invasive non-native species introduction or unsuitable species; Salvage/replace topsoil (contains native seeds and organic material to expedite vegetation growth); Where erosion is a concern - seed native grass or legume species or plant native stock like shrubs or trees (requires local seed/propagule collection) or use of a cover crop that will die back	Government Guidelines for Reclamation Practices in Nunavut (Quarries/Pits, and relevant to Mining)

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								Site Preparation: Recommendations: Landscape reconstruction - round excavated slopes (except permafrost areas), slopes < 2:1 or natural angle, steppe steep slopes, gentle slopes and rounded shapes preferable to straight lines; Recontour using stockpiled overburden with mineral soil on top (provides insulating layer for permafrost); Apply stockpiled topsoil above recontoured areas (differ depths, avoid use on steep slopes [erosion], consider undulating or irregular terrain); Prevent compaction - Use low compaction equipment (tracks), avoid soil handling when wet, roughen surface after spreading (microsites), if severe compaction use soil ripping techniques or soil amendments; Separate stockpiles; Consideration for areas of continuous permafrost **Other:** Recommendations: Drainage and Erosion Control - maintain surrounding natural hydrology, slope grading/roughening/horizontal grooves/revegetation, if erosion severe - may need berm or swale, brush, ditches; Avoid creation of ponds/lakes in permafrost terrain - this creates warming and leads to permafrost degradation and subsidence of ground; Multi-year monitoring	
32	Government of the Northwest Territories (GNWT), Department of Lands	2015a	*Northern Land Use Guidelines: Access—Roads and Trails*	Guideline	Reclamation; Revegetation; Surface Preparation; Topsoil Salvage; Erosion Control; Guideline; Government; Roads	Northwest Territories	Arctic/Subarctic; Permafrost; Eskers; Patterned ground; Fine-textured soils; Riparian	**Revegetation:** Recommendations: Natural revegetation preferred in stable areas; Active revegetation on erosion-prone slopes using native seed mixes and shrub cuttings (e.g., willows); Maintain vegetation in ditches to control erosion; Native seeding on slopes; Willow cuttings; Erosion-control mats **Site Preparation:** Recommendations: Topsoil salvage and placement; Surface scarification; Restore drainage (cross ditches, drains, berms); Erosion Prone Areas: Recontouring, terracing, erosion control mats, soil binders, rock or gravel blankets **Other:** Recommendations: Removal of culverts with streambed restoration	Government Guidelines for Reclamation Practices in NWT (Roads, and relevant to Mining), but limited detail
33	Indian and Northern Affairs Canada (INAC)	2010	*Northern Land Use Guidelines: Access—Roads and Trails (Vol. 05)*	Guideline	Reclamation; Revegetation; Surface Preparation; Topsoil Salvage; Erosion Control; Guideline;	Nunavut; Northwest Territories	Arctic/Subarctic; Permafrost; Eskers; Patterned ground; Fine-textured soils; Riparian	**Revegetation:** Recommendations: Natural revegetation preferred in stable areas; Progressive reclamation; active revegetation with native seed mixes, willows, mats on erosion-prone slopes; remove culverts & restore streambed at closure; Where erosion is a concern - active seeding or planting (e.g., live willow stakes) of native plants recommended **Site Preparation:** Recommendations: Topsoil salvage and placement; Surface scarification; Drainage controls (ditches,	Government Guidelines for Reclamation Practices in Nunavut and NWT (Roads, and relevant to Mining), but limited detail

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					Government; Roads			cross drains, berms); Erosion Controls - mulching and spreading, erosion control mats, soil binders, rock or gravel blankets, terracing **Other:** Recommendations: Drainage and Erosion Control; Multi-year monitoring	
34	Government of the Northwest Territories (GNWT), Department of Lands; AANDC; Environment Canada; Fisheries and Oceans Canada	2015b	*Northern Land Use Guidelines: Northwest Territories Seismic Operations*	Guideline	Reclamation; Revegetation; Erosion Control; Guideline; Government; Seismic	Northwest Territories	Arctic/Subarctic; Permafrost; Tundra; Riparian; Slopes	**Revegetation:** Natural revegetation preferred in stable areas; Active revegetation in erosion-prone sections using native seed mixes and shrub cuttings (e.g., willows); Avoid non-native plant introduction **Site Preparation:** Erosion control: erosion blankets or tarps, cross ditches or berms; Mulching can aid recovery	Government Guideline for seismic reclamation in NWT (minimal detail)
35	Johnson, L. A.	1987	*Management of Northern Gravel Sites for Successful Reclamation: A Review*	Research (Review)	Reclamation; Topsoil Salvage; Erosion Control; Revegetation; Gravel Pits	Alaska	Arctic/Subarctic; Substrates: Gravel (low moisture/nutrients); Permafrost; Riparian vs Upland communities	**Revegetation:** Passive revegetation viable for sites with adequate soils and nearby early-successional plant sources; Active revegetation for other sites using seeding, planting, transplanting, cuttings; Use adapted native species that can aid in reconstructing soil (may be in short supply) **Site Preparation:** Soil reconstruction most important element - Stockpile and respread topsoil (≥10–15 cm practical minimum), or if topsoil salvage and placement not possible, recreate with organics/fines; Erosion control during mining; Minimize disturbance and stockpiling time (for higher viability of plant propagules); Overburden to bury toxic materials below depth of root penetration **Other:** Off-site impacts can extend 15–25 ha per ha mined; gravel pits may alter hydrology; Visual screening and wildlife habitat enhancement; Select sites to maximize natural reinvasion (near seed sources)	Review recommendations all applicable; Commit to ≥10–15 cm salvage/respread where feasible; design borrow pits near propagule sources; Integrate microtopography and erosion controls
36	MVLWB	2013	*Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories*	Guideline	Reclamation; Revegetation; Topsoil Salvage; Soil Amendment; Surface Preparation; Mining; Inuit	Northwest Territories, Mackenzie Valley	Arctic/Subarctic; Permafrost	**Revegetation:** Natural revegetation; Active enhanced revegetation (seeding, planting, cuttings); Recommend native plant collection and propagation methods, successional processes, and final plant communities that provide biodiversity and sustainability; Organic topsoil stockpiles as a seed bank; Transplant vegetation from areas at present risk of loss; Species selection: locally adapted native plants, low potential for metal	Government Guidelines for Reclamation Practices in NWT (also applicable to Nunavut)

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								accumulation, plants that neither attract or repel wildlife, avoid non-native except in emergency erosion control **Site Preparation**: Re-grading and slope stabilization; Contour and scarify; Organic supplements should be used (e.g., peat, biosolids); Strip, stockpile, and properly cover organic and fine-grained soils (record volumes); Amend coarse materials (e.g., waste rock) with finer grade materials; gravel layer (capillary break) to prevent movement of contaminated materials upward to rooting zone in contaminated areas; Soil Amendments: organic materials, mulches, fertilizers, or other temporary soil amendments; Fertilizers in northern environments has the potential to impact downstream water bodies (nutrient runoff) **Other:** Bioengineering - stabilize soils, control erosion, enhance natural revegetation: Wattle fences, live gravel bar staking, and rough and loose staking to stabilize embankments; monitor metals uptake; Wind breaks for erosion control; Local Studies: characterize the local climate, temperature, precipitation, wind; manage effects on ground thermal regime; Permafrost aggradation into soil stockpiles; Consider effect of vegetation on near-surface permafrost (e.g., tall shrubs); Post-Closure Monitoring - consider passive monitoring approaches including aerial surveillance and remote sensing; Stakeholder engagement; Robust geotechnical designs for 1000-year horizon; Inuit Engagement: Establish closure and reclamation stakeholder working group; maintain engagement record; engage Inuit in site monitoring and have regular site visits; share reporting with Inuit governments; integrate Inuit input and western science; develop 3-D model to scale of the pre-development landscape, the mine during operations, and the final closure landscape; Engagement should focus on addressing specific issues and providing input into the development of closure objectives, closure options, relevant reclamation research, and other key closure issues to produce an acceptable conceptual CRP; public meetings/face-to-face meetings/workshops	
37	Nunavut RAC (Nunavut Regional Adaptation Collaborative)	2012	*Good Environmental Practices for Northern Mining and Necessary*	Guideline	Climate Change; Mining; Inuit	Nunavut, Steensby Port & Meadowbank TMF	Arctic Tundra; Permafrost; Coastal	**Revegetation:** Recommendations: Revegetation of downstream slopes TMFs (e.g., through encouraging natural revegetation); Revegetation of TMF caps (to establish permafrost and stability) **Site Preparation:** TMFs with thaw-stable foundations; Summary of "Good Environmental Practice Considerations in Canadian Permafrost Regions"; Permafrost degradation is a	Embed climate risk assessment in EA/CRP; design TMFs for thaw-stability; instrument dams (thermistors, piezometers); plan port logistics for short/long open-water seasons; set design

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			Infrastructure (Task 2 Report)					concern (soil temperature, increasing active layer depths, increasing surface runoff, changing drainage patterns as a result of subsidence and thermokarst formations, and increasing sediment loadings and mass wasting on slopes) **Other:** Incorporate climate adaptation; Recommended Best Management Practices for Climate Change Adaptation; Call for NIRB guidance formalizing climate risk frameworks; Continuous data collection (water levels, waves, ice, currents)	elevations for flood/erosion per 1:200 events
38	Neby, M.; Semenchuk, P.; Neby, E.; Cooper, E.J.	2022	*Comparison of methods for revegetation of vehicle tracks in High Arctic tundra on Svalbard*	Research (Primary)	Revegetation; Surface Preparation; Soil Amendment; Vehicle-tracks	Norway, Svalbard, Adventdalen	High Arctic Tundra; Cassiope/Dryas dwarf-shrub heath; Vehicle-track Disturbance; Substrate: Intact soil and seed bank	**Revegetation:** Passive revegetation effective: intact (but reduced) seed bank and small disturbance; Active revegetation: Local seed/cutting addition had limited benefit over natural revegetation; By year 8, vegetation cover still less than reference and bryophyte-dominated (composition different); No treatments successful in advocating the growth of the dwarf shrubs *Dryas* and *Cassiope* **Site Preparation**: Treatments: C control, F fertilizer, FG fertilizer × garden cloth; G garden cloth, P plant cutting addition, S seed/bulbil addition, T tilling; Fertiliser (low NPK) most effective at increasing total vegetation cover (71% vegetation cover, of which 62% were bryophytes and 38% were vascular plant species); Garden cloth created modest microclimate benefit (~+0.3°C); Tilling had minimal effect **Other:** Highlights importance to minimize disturbance and avoid vehicles on unfrozen tundra; Strong time effect; Risk of non-native ingress; Highlights very slow recovery of *Cassiope*/*Dryas* shrubs	Not directly applicable since revegetation of ~~I~~intact soil and seed bank much different than mine reclamation
39	Audet, P.; Setterington, M.A. (EDI Environmental Dynamics Inc.)	2024	*Challenges of Reclamation in the Canadian High Arctic: Pilot Study at an Active Mine Site on North Baffin Island, Nunavut*	Research (Primary)	Revegetation; Surface Preparation; Mining	Nunavut, North Baffin Island, Mary River Project	High Arctic Tundra; Xeric/Subxeric; Glaciofluvial & Morainal Parent Materials; Sandy Loam, Coarse Fragments; Restrictive till layer (~20–29 cm); Polygonal Ground; Turbic Cryosols; Permafrost near-surface; High wind; Disturbed Sites: Roadside/Abandoned airstrip	**Revegetation:** Natural revegetation of native grasses, sedges, forbs, shrubs occurs (1, 1-3, 5, >40 year disturbance chronosequence); 60–70% cover after >40 yrs (exploration activities); early colonizers present by 1–3 yrs (species list provided); lichen absent on disturbed plots across all timeframes; proximity of intact vegetative mats supports passive recovery by natural revegetation **Site Preparation:** Surface preparations ("rough & loose", track packing) had limited functional value (degraded within ~1 year on sandy sites); shallow earthworks (<35 cm) to avoid permafrost impacts; stability maintained	Expect slow recovery; prioritize protecting adjacent vegetation, erosion control; use shallow earthworks; consider turf transplants/bryophytes; set timelines in decades and track early colonizers (sedges/forbs)

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								Other: No exotics observed; Constraints include wind erosion and substrate type; Importance of minimizing incidental disturbance	
40	CAVSI (Circumpolar Arctic Vegetation Science Initiative) Organizing Group (Walker et al.)	2025	*Circumpolar Arctic Vegetation Science Initiative (CAVSI): A Framework to Guide the Next Decade of Arctic Vegetation Research*	Guideline	Revegetation; Climate Change; Monitoring; Inuit	Circumpolar Arctic	Arctic; Polygonal Ground; Shrub Tundra; Wetlands; Permafrost	**Other:** Research Priorities include: Climate change and disturbance regimes, community engagement and indigenous; Recommendations/Guidelines: Standardized monitoring/survey methods, archives, and classification to detect Arctic vegetation change; Plot-based tracking of stratification/greening and biodiversity shifts; Indigenous Priorities – "Prioritize the inclusion of indigenous communities in research efforts, ensuring that conservation strategies align with local knowledge and values. Develop frameworks for collaboration that enhance the benefits of research for indigenous communities"	Research tools which may be applicable to northern mines (e.g., vegetation lists, vegetation monitoring methods, etc.); Indigenous Priorities
41	Kokelj, S.V.; Lantz, T.C.; Tunnicliffe, J.; Segal, R.; Lacelle, D.	2017	*Climate-driven thaw of permafrost preserved glacial landscapes, northwestern Canada (G38626.1)*	Research (Primary)	Climate Change	Northwestern Canada; Circumpolar Arctic	Arctic; Permafrost; Thermokarst	**Other:** Climate-driven geomorphic transformation expected (vegetation community change as well); Highlights sensitivity of ice-rich terrain; Avoid deep cuts that expose ground ice; Avoid actions that trigger thermokarst; Account for sediment mobilization risks;	Climate change impacts in Arctic and permafrost environments
42	ITK (Inuit Tapiriit Kanatami)	2019	*National Inuit Climate Change Strategy*	Guideline	Climate Change; Inuit	Nunavut	Arctic	**Other:** Climate change priorities include: 2) health, well-being, and the environment; 3) food systems; Permafrost thaw a concern	Climate change identified as a concern and consideration; Minimal other detail
43	Rio Tinto (Diavik Diamond Mines Inc.)	2025	*Diavik Final Closure & Reclamation Plan*	Industry (Closure Plan)	Reclamation; Revegetation; Surface Preparation; Topsoil Salavage; Substrate; Mining; Inuit	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Low Arctic Tundra; Waste Rock; Coarse Waste Rock; Till; Lake; Contaminated: Coarse Processed Kimberlite (CPK), Processed Kimberlite Containment Facility (PKCF), open pits, dikes, water management ponds; Non-contaminated: infrastructure areas, airstrip, roads, and laydown areas	**Revegetation:** Natural revegetation (passive colonization) in contaminated areas (e.g., PKCF, Rock Piles, WTA, fuel tank farms, etc.); Active (assisted) revegetation using native plant seeding (25 kg/ha seed, UTV-mounted seed spreader and hand seeding, rake or UTV harrow afterwards, early pioneer native species [some not local to Diavik area], 3:1 grass to forb mix from commercial seed supplier) in priority non-contaminated areas (e.g., roads, airstrip, laydowns, plant sites); Native seed effective on crushed rock, sediment, and mixes with PK; Use native plants; Shrub cuttings or seeding were not successful in trials; Seeding grasses and forbs accelerated reclamation success; Transplanting: Transplanting was not considered practical or reasonable as it would be destructive of the undisturbed ground and be a significant effort (time and cost) **Site Preparation:** Non-contaminated areas: Scarification including recontouring and deep ripping (medium dozer [e.g.,	Reclamation methods all applicable (but location low Arctic); Seed mix species; Revegetation trial performance applicable; TK Panel; Infographic of Mine Reclamation timeline; Appendix X-9 "Revegetation Strategy Report"; Reclamation research final report (literature review, TK) in Appendix X-16 of CRP V4.1 (Naeth et al. 2018)

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								CAT D10] with plow or t-plow to a depth of 10-25 cm); Contaminated areas covered with coarse waste rock and no other treatment (natural revegetation by lichen and moss); Soil amendments: Sewage sludge mixed with till in progressive reclamation; Material: waste rock and till, CPK (Coarse Processed Kimberlite); Materials on site identified as suitable for reclamation: organic, organic over glaciolacustrine, and glaciolacustrine materials; Seeding performance was effective on crushed rock as other reclamation substrates (but best on organic amendments like salvaged soil, sewage, peat); Microtopography: improve plant establishment through scarification/deep ripping, variable rock size; Amendments: Amendments (specifically topsoil salvage and organics), while beneficial, deemed to be impractical for implementation at large scale and other amendments such as biochar not recommended based on research results; Bryophyte recovery best on crushed rock (expected recovery 5+ years) **Other:** TK Panel: Passive revegetation preferred (but active needed in some instances), Avoid active revegetation in areas with chemical or waste storage (e.g., PKCF) and instead allow vegetation to return naturally when conditions safe (avoid attracting wildlife to contaminated area and time to heal), cap NCRP with till and rock layers and focus revegetation efforts around the water collection ponds at the base of the pile, Scarification of rock can impede wildlife and human movement (Leave wildlife movement routes when scarifying roads and laydowns); Monitoring: annually until mean 5% cover met, expected in 5-10 years, TK monitoring focus; Erosion Control: crushes rock in erosion prone areas inherently resistant, erosion blankets and jutes in high risk areas	
44	Diavik Diamond Mines Inc. (Prepared by WSP)	2025	*Revegetation Strategy Report*	Industry (Closure Plan)	Reclamation; Revegetation; Surface Preparation; Topsoil Salavage; Substrate; Mining; Inuit	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Low Arctic Tundra; Waste Rock; Coarse Waste Rock; Till; Lake; Contaminated: Coarse Processed Kimberlite (CPK), Processed Kimberlite Containment Facility (PKCF), open pits, dikes, water management ponds; Non-contaminated:	**Revegetation:** Natural revegetation (passive colonization) in contaminated areas (e.g., PKCF, Rock Piles, WTA, fuel tank farms, etc.); Active (assisted) revegetation using native plant seeding (25 kg/ha seed, UTV-mounted seed spreader and hand seeding, rake or UTV harrow afterwards, early pioneer native species [some not local to Diavik area], 3:1 grass to forb mix from commercial seed supplier) in priority non-contaminated areas (e.g., roads, airstrip, laydowns, plant sites); Native seed effective on crushed rock, sediment, and mixes with PK; Use native plants; Shrub cuttings or seeding were not successful in trials; Seeding grasses and forbs accelerated reclamation success; Transplanting: Transplanting was not considered	Reclamation methods all applicable (but location low Arctic); Seed mix species; Revegetation trial performance applicable; TK Panel; Infographic of Mine Reclamation timeline; Appendix X-9 "Revegetation Strategy Report"; Reclamation research final report (literature review, TK) in Appendix X-16 of CRP V4.1 (Naeth et al. 2018)

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
							infrastructure areas, airstrip, roads, and laydown areas	practical or reasonable as it would be destructive of the undisturbed ground and be a significant effort (time and cost) **Site Preparation:** Non-contaminated areas: Scarification including recontouring and deep ripping (medium dozer [e.g., CAT D10] with plow or t-plow to a depth of 10-25 cm); Contaminated areas covered with coarse waste rock and no other treatment (natural revegetation by lichen and moss); Soil amendments: Sewage sludge mixed with till in progressive reclamation; Material: waste rock and till, CPK (Coarse Processed Kimberlite); Materials on site identified as suitable for reclamation: organic, organic over glaciolacustrine, and glaciolacustrine materials; Seeding performance was effective on crushed rock as other reclamation substrates (but best on organic amendments like salvaged soil, sewage, peat); Microtopography: improve plant establishment through scarification/deep ripping, variable rock size; Amendments: Amendments (specifically topsoil salvage and organics), while beneficial, deemed to be impractical for implementation at large scale and other amendments such as biochar not recommended based on research results; Bryophyte recovery best on crushed rock (expected recovery 5+ years) **Other:** TK Panel: Passive revegetation preferred (but active needed in some instances), Avoid active revegetation in areas with chemical or waste storage (e.g., PKCF) and instead allow vegetation to return naturally when conditions safe (avoid attracting wildlife to contaminated area and time to heal), cap NCRP with till and rock layers and focus revegetation efforts around the water collection ponds at the base of the pile, Scarification of rock can impede wildlife and human movement (Leave wildlife movement routes when scarifying roads and laydowns); Monitoring: annually until mean 5% cover met, expected in 5-10 years, TK monitoring focus; Erosion Control: crushes rock in erosion prone areas inherently resistent, erosion blankets and jutes in high risk areas	
45	Miller, V.S.; Naeth, M.A.; Wilkinson, S.R.	2021	*Microtopography and organic amendments for reclamation of waste materials at an arctic diamond mine*	Research (Primary)	Reclamation; Surface Preparation; Substrate; Revegetation; Mining	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Low Arctic Tundra; Permafrost; Substrates: crushed rock, processed kimberlite (PK), lakebed sediment	**Revegetation:** Active seeding grass/forb mix applied to all substrate treatment (wild collected in NWT but not site, rate of 1g or 1,600 seeds/m2) - *Elymus trachycaulus*, *Poa glauca*, *Poa alpina*, *Oxytropis deflexa* best establishment (*Eriophorum angustifolium* natural colonization); Seeding best performance on crushed rock with incorporated sewage sludge (5–10 cm); Passive revegetation of moss/lichen (increased by year 4, best	Reclamation methods all applicable (but location low Arctic): Prioritize gravel/rock substrates for covers; incorporate biosolids where permitted; create Depressions/furrows on smooth pads; plan for bryophyte/lichen

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
								on crushed rock without amendments); Plant diversity low after 4 years **Site Preparation:** Substrates: crushed rock best substrate for seeded plants (plant density 8x more than PK and 2x lake sediment) and moss/lichen; Soil Amendments: sewage sludge even at small amounts improved growth and seed head frequency of seeded species, salvaged soil incorporated at small amounts had minimal effect (capping, direct placement may have been better), moss and lichen best on crushed rock without additional amendments; Microtopography (depressions, furrows) enhance revegetation on PK (large depressions best for PK and more resistant to erosion); Soil Lynx (Anionic polymer erosion control product) ineffective on mine wastes (sandy); Erosion Control **Other:** Apply heterogeneity and patch application (e.g., sewage); Salvaged soil less effective at low rate; PK was substrate with the poorest plant establishment and not suitable without amendment; Grazing observed	trajectory; consider geotextiles/mulches for erosion
46	Naeth, M.A.	2004	*Revegetation of Disturbed Sites at Diavik Diamond Mine, N.W.T. – Research Proposal (Appendix L)*	Research (Review)	Reclamation; Surface Preparation; Substrate; Topsoil Salvage; Soil Amendment; Revegetation; Mining	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Low Arctic Tundra; Permafrost	**Revegetation:** Synthesis of prior research: Plant species with demonstrated revegetation potential by substrate type; Native cultivars often outperform wild seed; Wild seed set can be low and cyclic in nature; Fall broadcast seeding (prior to snowfall) to leverage spring moisture; Shrub and bryophyte establishment methods still needed **Site Preparation:** Synthesis of prior research: organic amendments (sewage, peat, topsoil) improve establishment; Research Proposal: 6 Substrate (50 cm): glacial till, processed kimberlite, glacial till and topsoil, processed kimberlite and topsoil, glacial till and processed kimberlite, and no substrate addition; 3 Amendments (10–20 cm incorporation): Sewage sludge, inorganic fertilizer; Reduced Nitrogen application rates for natives **Other:** Kimberlite constraints; Topsoil scarcity - minimize topsoil use while maximizing benefits; Soil chemical parameters: available macro and micronutrients, total organic carbon, pH, electrical conductivity; Soil physical parameters: bulk density, penetration resistance, percent organic matter, soil moisture, temperature, temperature, moisture; Sewage Sludge Contaminants: fecal coliforms, Salmonella, heavy metals	Reclamation methods all applicable (but location low Arctic): Design factorial field trials on available substrates; use fall seeding; prioritize organic amendments; tailor N rates; include bryophyte/shrub techniques

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47	Naeth, M.A.; Wilkinson, S.R.	2014	*Establishment of restoration trajectories for upland tundra communities on diamond mine wastes in the Canadian Arctic*	Research (Primary)	Reclamation; Revegetation; Substrate; Soil Amendment; Topsoil Salvage; Mining	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Low Arctic Tundra; Permafrost; Substrates (5): processed kimberlite, glacial till, gravel, mixes; Amendments (4): inorganic fertilizer, salvaged soil, sewage sludge, water treatment sludge	**Revegetation:** Native species seed mixes (5 - Forbs, Diverse, Non-Aggressive, Drought tolerant, Adaptable) and natural regeneration investigated; Seeding essential to establish vascular vegetation cover; Seed mix composition/diversity had no effect on plant community development after 5 years; Natural revegetation on gravel had greatest moss regeneration (but limited vascular cover); Fertilizer may favour graminoids and may prevent natural revegetation but increased cover **Site Preparation:** Substrates (5): processed kimberlite, glacial till, gravel, mixes; Amendments (4): inorganic fertilizer, salvaged soil, sewage sludge, water treatment sludge; Processed kimberlite had high and potentially plant toxic concentrations of heavy metals chromium, cobalt, and nickel; Addition of fine textured materials (e.g., glacial till) to coarse mine wastes improved nutrient and water retention and enhanced revegetation; Sewage and inorganic fertilizer increased available nitrogen/phosphorus, plant density/cover; Soil amendment increased species richness; Topsoil in their study had limited source of propagules likely because it was stockpiled for more than 6 months and soil horizons were admixed	Reclamation methods all applicable (but location low Arctic)
48	Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)	2025	*Northern Abandoned Mine Reclamation Program*	Government Program	Reclamation; Mining	Yukon, Northwest Territories (8 sites: Faro Mine, Giant Mine, Cantung Mine, Clinton Creek Mine, United Keno Hill Mine, Mount Nansen Mine, Ketza River Mine, Great Bear Lake)	Arctic/Subarctic	**Revegetation:** Faro Mine: Community-led revegetation using locally sourced tree seedlings (planting), erosion control seeding **Site Preparation:** Faro Mine: Re-shaping, covering, establishing surface drainage on waste rock and tailings **Other:** Collaboration with Indigenous and Territorial governments; Employment and business opportunities for impacted communities	Projects are mostly sub-arctic rather than tundra; Recommendations and findings still applicable (e.g., Indigenous community engagement, progressive reclamation, integrate cultural values and local plant species in revegetation plans)
49	Lamarre, J. J. M.; Dhar, A.; Naeth, M. A.	2023	*Arctic ecosystem restoration with native tundra bryophytes*	Research (Primary)	Reclamation; Bryophyte Propagation; Substrate; Surface Preparation; Mining	Northwest Territories, Lac de Gras, Diavik Diamond Mine & Iceland, Heiðmörk	Arctic; Substrates: crushed rock, lake sediment, processed kimberlite, acidic volcanic silt loam, acidic crushed lava	**Revegetation:** Bryophyte propagation (small, medium, large fragments) in slurry with water apply to substrate or on top of erosion control cheese cloth; Large (2.1–40 mm) fragments and erosion control yielded highest live cover; Medium (1.1-2.0 mm) fragments without erosion control had highest density; Small (<1 mm) less effective; Bryophyte collection local (within 1 km), Species occurring naturally in disturbed areas included *Dicranum* and *Polytricum* spp.; Species which had higher cover in propagation experiments was *Ceratodon purpureus* (small and large fragments) and *Racomitrium lanuginosum* (medium	Bryophyte propagation and revegetation methods applicable; Surface preparation and substrate recommendations

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								fragments) [acid tolerant]; Additional bryophytes colonized trial sites naturally **Site Preparation:** Erosion Control: Cheesecloth increased significantly increased bryophyte live cover, total cover, species occurrence, and density, and moderated soil temps; Substrates (50 cm depth over gravel pads): Heterogeneous (crushed rock/volcanic silt/lava) outperformed homogeneous (processed kimberlite/lake sediment) for bryophyte revegetation - higher live cover, density, and spontaneous colonization bryophytes with substrates with 1 to 5 cm surface variability; Homogeneous substrates have less microhabitats or areas to trap propagules and more susceptible to erosion; Retain or create microtopographic heterogeneity; Avoid overly smooth surfaces; Tailor fragment size to erosion control availability **Other:** Gravel pads built to protect permafrost: layer of boulders over tundra, followed by a layer of small to mid-sized rocks, topped with 50 cm of gravel (Dhar et al. 2022)	
50	Drozdowski, B. L.; Naeth, M. A.; Wilkinson, S. R.	2012	*Evaluation of substrate and amendment materials for soil reclamation at a diamond mine in the Northwest Territories, Canada*	Research (Primary)	Reclamation; Substrate; Soil Amendment; Topsoil Salvage; Revegetation; Mining	Northwest Territories, Lac de Gras, Diavik Diamond Mine	Arctic; Substrates (30-40 cm over 50 cm gravel): glacial till (clay to boulders >1 m in diameter), gravel, processed kimberlite (silicon, magnesium, iron [95% sand]), 50:50 processed kimberlite and till, 25:75 processed kimberlite and till (till 68% sand and 27% silt)	**Revegetation:** Native seed mixes; Season of seeding had not effect; *Poa glauca* dominated most treatments; *Elymus violaceus* (*Agropyron violaceum*) dominated processed kimberlite; *Festuca saximontana* dominated gravel **Site Preparation:** Substrates (30 to 40 cm over 50 cm gravel): glacial till (clay to boulders >1 m in diameter), gravel, processed kimberlite (silicon, magnesium, iron [95% sand]), 50:50 processed kimberlite and till, 25:75 processed kimberlite and till (till 68% sand and 27% silt); Amendments: salvaged topsoil, sewage sludge, inorganic fertilizer, water treatment facility sludge, none; Mixes of processed kimberlite and till enhanced soil structure and reduced adverse element concentrations; Vegetation grew on all treatments (no clear best treatment in all conditions), but plant response was most favourable in 25:75 processed kimberlite and till with sewage sludge; Amendment salvaged topsoil provided the most consistent increase in plant density among substrates (soil should be salvaged); Sewage had adverse high concentrations of high copper, molybdenum, phosphorus, selenium, sulphate and zinc; Unamended gravel performed well and among best for plant growth; Lowest plant densities occurred in unamended processed kimberlite	Reclamation methods all applicable (but location low Arctic)
51	Jorgenson, M. T.; Joyce, M. R.	1994	*Six Strategies for Rehabilitating*	Research (Review)	Reclamation; Revegetation;	Alaska	Arctic Tundra; Permafrost;	**Revegetation:** Plant Species selection: locally adapted native species, pioneer species found in disturbed areas, N-fixing	Reclamation methods all applicable (but older publication

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			Land Disturbed by Oil Development in Arctic Alaska		Topsoil Salvage; Soil Amendment; Oil		Disturbances: gravel mine sites and overburden stockpiles, gravel roads and pads, gravel spray/road dust, contaminants	legumes; Seeding: native grass cultivars with fertilization on gravel pads with some success (lower diversity but facilitate soil development and increase soil moisture, but may inhibit natural colonization); Thick gravel xeric forbs: *Draba* spp., *Cochlearia officinalis*, *Braya purpurascens*, *Epilobium latifolium*) and grasses (mainly *Festuca baffinensis*); Natural colonization in wetlands facilitated by fertilization (preferred over non-local seeding); Natural colonization in areas of minor tundra disturbance suggested (e.g., off-road vehicles) **Site Preparation:** Techniques for modifying the hydrologic balance include the creation of small berms to capture drifting snow, various soil amendments to increase water retention, mulch (e.g., straw) to reduce evaporation; Techniques for increasing nutrient availability include application of organic topsoil and sewage sludge; Gravel fill reduces plant germination (thinner fill had better plant establishment); Leaving 20-30 cm depth gravel fill to prevent permafrost degradation (removal would cause permafrost degradation and wetter conditions) **Other:** Berms (50 cm, 1m) capture snow and increase soil moisture early summer; Pond creation: Inoculation of created pond with natural pond water and sediments to provide a medium for introducing aquatic bacteria, algae, and invertebrates; Wetlands/wet tundra easier to restore than moist or dry tundra (wetlands have early successional species, while moist and dry tundra have slower to develop vegetation structures and later successional species with slower growth rates); Remediation of contaminated soils	in 1994 and improvements since then)
52	Lemay, E.; Côté, S. D.; Tremblay, J. P.	2021	*How will Snow Retention and Shading from Arctic Shrub Expansion Affect Caribou Food Resources?*	Research (Primary)	Revegetation; Snow fencing	Québec, Nunavik, Deception Bay	High Arctic Tundra; Permafrost; Dominant plants: herbaceous tundra with dwarf shrubs and grasses	**Other:** Snow fences (9 m long and 1 m high) installed perpendicular to the prevailing south-easterly winter winds for snow accumulation - Increased snow cover combined with ambient light increased foliar biomass of Betula glandulosa (better caribou forage), increased snow depth did not alter the nitrogen content in the leaves of plants but decreased phenolic concentrations	Snow fences have some potential for application to increase soil moisture and vegetation cover
53	USGS	2000	*Native Plant Revegetation Manual for Denali National Park and Preserve*	Guideline	Revegetation; Soil Amendment; Topsoil Salvage	Alaska, Denali National Park	Subarctic; Boreal Forest; Alpine Tundra	**Revegetation:** Natural revegetation recommended where possible; Species Selection: early colonizers, species with high density/cover/visual appeal, naturally colonize disturbed sites with harsh conditions (e.g., roadsides similar to gravel bars), density limited by propagule presence or seedling establishment, easy to ID for seed collection, Table 9 summarizes success; Seeding legume and wheatgrass native mix on well-drained,	Revegetation methods applicable (but location sub-arctic)

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								nutrient-poor soils with high gravel and sand content, direct seeding, raking to 1-2.5 cm depth following seeding, cover increases in year 3-4 (e.g., *Hedysarum*, *Oxytropis*, and (occasionally) *Astragalus*, *Agropyron* spp. [*Elymus* spp.]); Erosion control using non-native annual cover crop like *Lolium multiflorum* or installing erosion control mats or bioengineering structures (live staking, brush bars, hedge layering); Collecting native seed - late July and lasts until late August, processing; Transplanting: source tundra vegetation mats from construction area prior to disturbance, cut using Pulaski tool, store for up to several years, scarify substrate prior to transplanting; Container-grown plants; Seed collection; Willow live stake cuttings (riparian willows like *Salix alaxensis*, *S. arbusculoides*, *S. barclayi*, *S. planifolia*, *S. pulchra*) **Site Preparation:** Topsoil salvage (active layer above permafrost, careful storage, 10-20 cm depth); Rip compacted sites to a depth of 20-50 cm; Stabilize soils (e.g., terracing, scarification); Slow release fertilizer (e.g., MagAmp 7-52-6 NPK or Osmocote 14-14-14 NPK 2-year-release form at a rate of 560 kg/ha); Nitrogen-fixing Rhizobium bacteria	
54	Viereck, L. A.	1966	*Plant succession and soil development on gravel outwash of the Muldrow Glacier, Alaska*	Research (Primary)	Revegetation; Chronosequence; Plant Succession; Soil Development	Alaska, Muldrow Glacier	Subarctic Alpine Tundra; Shrub Birch Tundra; Gravel Outwash (Stands are: (1) 4 km x 1 km Pioneer; (2) 3 km x 1 km Meadow; (3) 3 km x 1 km Early Shrub; (4) Late Shrub; (5) 16 km Climax)	**Revegetation:** Natural revegetation - long time series, list of plant species included according to successional stage (early successional species in slightly altered coarse river gravel with some mine materials, pH 8: Dryas *drummondii*, *Dryas integrifolia*, *Astragalust ananaic*, *Astragalust nutzotinensis*, *Hedysarum madcenzii*, *Oxytropis gracilis*, *Ditrichum flexicaule*, *Stereocaulon paschale*, *Populus balsamifera*, *Salix alaxensis* [many N-fixing]; Meadow stage: *Elymus innovatus*, shrubs expand but less new establishment [i.e., shrubs establish before grasses dominate]; Shrub stages: *Vaccinium* and *Betula* replace willows and moss layer develops further; Climax: shrub birches decrease in height/grow prostrate and moss layer develops, and possible establishment of *Eriophorum vaginatum* tussocks) **Other:** Chronosequence: 25-30 years Pioneer, 100 years Meadow, 150-200 years Early Shrub, 200-300 years Late Shrub, 5,000-9,000 years Climax Tundra; Diagram of vegetation changes through succession provided; Permafrost development leads to greater soil moisture in summer (reduces drainage); Snow accumulation as vegetation develops	Successional trajectory provides information on possible natural revegetation and implications of active revegetation (e.g., species which can grow in gravel and low nutrient, early successional shrubs should seed before grasses dominate since they are inhibited by dense grass)

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
55	ABR Inc.	2007	*Red Dog Mine Closure and Reclamation Plan - SD F3: Revegetation Plan for the Red Dog Mine*	Industry	Reclamation; Revegetation; Soil Amendment; Topsoil Salvage	Alaska, DeLong Mountains, Red Dog Mine	Low Arctic Tundra	**Revegetation:** Natural revegetation much less cover but with more species diversity; Seeding with fertilization higher cover but less species diversity (dominated by grasses) and reduced (inhibited) natural selection - suggest seeding native grasses/forbs at low rate (20 lb/acre, generally in fall [Sept] or early spring); Species selection: locally collected native species, commercial native cultivars (Arctared fescue and Bering hairgrass not recommended), agronomic non-native species (not recommended), native legumes (N-fixing); Natural colonizers (e.g., *Cerastium beeringianum*, *Epilobium latifolium*, *Calamagrostis canadensis*, *Polemonium boreale*, *Carex podocarpa*, *Senecio lugens*, *Draba hirta*, *Stellaria longpipes*, *Artemisia campestris*, *Lesquerella* sp, *Astragalus* spp, *Poa arctica*, *Festuca altaica*, *Artemisia arctica*,*Trisetum spicatum*, shrub birch, *Oxytropis borealis* wet with *Juncus*/*Eriophorum angustifolium*/*Equisetum arvense*); Areas with minor disturbance allow natural revegetation with light fertilizer (100–200 lb/acre of 20-20-10 NPK); Areas with poor revegetation potential recommended to allow natural succession and monitor what plants able to colonize poor soils; Live staking of shrub (willow) cuttings in wet areas (collected spring, stored frozen till June); Native legumes: *Astragalus alpinus*, *Hedysarum mackenzii*, *Oxytropis deflexa*, *O. borealis*, *O. campestris*, *O. maydelliana*; *Artemisia tilesii*; Seed collection: forbs in July/August, grasses/sedges in Sept; Stockpile seeding species selection: Nortran hairgrass, Tundra bluegrass, Alpine bluegrass, Spike trisetum, Thickspike wheatgrass, Polargrass Bluejoint (20 lbs/acre), Tilesy sage, Alpine milkvetch, Alpine sweetvetch, Boreal sweetvetch, Field Oxytrope, Boreal yarrow, Tall fireweed, Siberian aster, Arctic bladderpod (40 seeds/yard2) **Site Preparation:** Recontour and scarify for decompaction; Re-establish natural drainages; Removal of contaminated soils; Acid-contaminated sites (fugitive dust) treated with pelletized dolomitic lime but results not known; Fertilizer application (e.g., 400-450 lb/acre of 20:20:10 NPK); Sewage sludge had better long-term performance of seeded native cultivars (vs. fertilizers which deplete nutrients quickly) **Other:** Reclamation registry to record activities; Berms for snow capture; Rock or boulder placement	Revegetation methods applicable

#	Author(s)	Year	Title	Source Type	Topic(s)	Geographic Location	Site Condition	Key Findings	Applicability to the Goose Project
56	Dominion Diamond Mines Ltd.	2018	*Ekati Diamond Mine Interim Closure and Reclamation Plan (Version 3.0)*	Industry	Reclamation; Revegetation; Topsoil Salvage; Soil Amendment; Surface Preparation; Mining	Nunavut, Lac de Gras, Ekati Mine	Subarctic; Substrate: Diamond mine waste materials such as processed kimberlite	**Revegetation:** Plant Species Trials (PK): planting of native grasses, forbs, shrubs, and sedges; Revegetation Methods (Kimberlite Waste Rock and Coarse Processed Kimberlite): Native seed mixes of grasses, forbs, and shrubs, transplanting locally harvested grasses and mosses, and planting seedlings; maintain islands of undisturbed vegetation to provide a seed source for revegetation; Successful candidates for revegetation: Hulten Bering's tufted hairgrass (*Deschampsia beringensis*; 53%), creeping red fescue (*Festuca rubra*; 33%), tufted hairgrass (*Deschampsia caespitosa*; 16%), and alpine bluegrass (*Poa alpina*; 11%) **Site Preparation:** Stabilization of Lowland Areas Trials (PK): mounding and ripping techniques; Rock and Cover Combination Trials (PK): boulder field creation; Surface Roughening (PK): mounding, ripping, application of coarse till material; Mycorrhizae Trials (PK): native mycorrhizae collection; Organic Matter Incorporation Trials (PK): bio pellet and compost trials; Amendments (Kimberlite Waste Rock and Coarse Processed Kimberlite): lakebed sediment, bio pellets, compost, topsoil, fertilizers; Other Amendments: sewage sludge, rock phosphate, calcium carbonate, gypsum; Sewage Sludge - evaluations for potential adverse impacts (e.g., pathogens, heavy metals, and nitrates), Winter application of sewage sludge significantly reduced the health risk associated with using a biosolid waste material as a soil amendment to 0.02% of the original fecal coliform (Streptococcus) and Salmonella levels	Reclamation methods all applicable

Notes;
cm = centimetres; C/N =carbon/nitrogen; CRP = Closure and Reclamation Plan; EA = Environmental Assessment; FCSAP = Federal Contaminated Sites Action Plan; ha = hectares; kg = kilograms; lbs = pounds; m = metres; m2 = square metres; N-fixing = nitrogen-fixing; NCSP = Northern Contaminated Sites Program; NPK = nitrogen, potassium, phosphorus; NWT = Northwest Territories; PK = Processed Kimberlite; PKCF = Processed Kimberlite Containment Facility; TK = traditional knowledge; TMF = Tailings Management Facility; SOM = soil organic matter