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June 5, 2020

Filed Electronically

Canada Energy Regulator
Suite 210, 517 Tenth Avenue SW
Calgary, Alberta T2R 0A8

Attention: Mr. Jean-Denis Charlebois, Secretary of the Commission

Dear Mr. Charlebois:

Re: NOVA Gas Transmission Ltd. (NGTL)
2018 Meter Stations and Laterals Abandonment Program (2018 Abandonment Program)
MHW-003-2019 and Order ZO-008-2019 (Order)
Condition 6: Egg-Pony Caribou Range Habitat Restoration Plan
File No.: OF-Fac-Gas-N081-2018-16 01

On December 20, 2019, the Canada Energy Regulator (CER or Commission), issued the Order approving the 2018 Abandonment Program.[1] The CER, pursuant to Condition 6 of the Order, directed NGTL to file the following with regards to the 2018 NGTL Abandonment Program:

> **At least 60 days prior to commencing physical abandonment activities,** NGTL must file with the Commission for approval an Egg Pony Caribou Range Habitat Restoration Plan (Plan) for the abandonment of the Meadow Creek Receipt Meter Station and Lateral, created in consultation with the appropriate Provincial land manager. The restoration to be implemented should substantially advance the relative succession of vegetation growth and enhance functional caribou habitat attributes (e.g., access control). The Plan must include the following:
>
> a) site locations for restoration activities (GPS coordinates and approximate size in square metres);
>
> b) for each site where physical abandonment activities are to occur, a description of any site location constraints that limit what restoration measures may be implemented;
>
> c) specifications for implementation of tree planting restoration measures for each site, including selection of tree species appropriate for each ecosite, minimum heights of tree plantings, and density and pattern of tree planting, for enhancing caribou habitat functionality;

[1] CER Filing ID: C03865.

d) specifications for implementation of further access control restoration measures for each site including identification of potential measures (e.g., mounding, rollback), appropriate site specific locations, and their densities and size specifications;
e) a description of criteria that will be used during monitoring to evaluate the effectiveness of site restoration measures described in c) and d);
f) a schedule for implementation of restoration measures within the first year following physical abandonment activities; and,
g) a description of proposed actions to be taken by NGTL if the criteria described in e) are not met during the reclamation monitoring schedule outlined in Condition 8.[2]

NGTL encloses for approval by the Commission, the Egg-Pony Caribou Range Habitat Restoration Plan for the 2018 Abandonment Program. NGTL currently anticipates commencing Abandonment Activities for the Meadow Creek Receipt Meter Station and Lateral in Q3 2021.[3]

If the CER requires additional information with respect to this filing, please contact me by phone at (403) 920-2940 or by email at nicole_prince@tcenergy.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Nicole Prince
Regulatory Project Manager
Regulatory Facilities, Canadian Natural Gas Pipelines

Enclosure

cc. Andria Logan, Canada Energy Regulator

2 Upon review of the Order, NGTL notes that Condition 6(g) erroneously refers to Condition 8; Condition 6(g) should refer to Condition 7.
3 Schedule is subject to change.

CANADA ENERGY REGULATOR

NOVA GAS TRANSMISSION LTD.

2018 METER STATIONS AND LATERALS ABANDONMENT PROGRAM

EGG-PONY CARIBOU HABITAT RESTORATION PLAN

June 2020

To: Secretary of the Commission
Canada Energy Regulator
Suite 210, 517 Tenth Avenue SW
Calgary, Alberta T2R 0A8

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1.0 INTRODUCTION AND ORGANIZATION

This section introduces the Caribou Habitat Restoration Plan (CHRP) for the Meadow Creek Receipt Meter Station and Lateral abandonment (Project) component of the 2018 Meter Stations and Laterals Abandonment Program (2018 Abandonment Program), and outlines how this document is organized.[1]

1.1 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada PipeLines Limited, an affiliate of TC Energy Corporation, received approval from the Canada Energy Regulator (CER), formally the National Energy Board (NEB), to abandon the Project (Order ZO-008-2019) subject to conditions of approval.[2] This CHRP has been prepared in accordance with Condition 6 of the Order, which addresses the Project's interaction with a boreal caribou population, specifically the Egg-Pony caribou range (see Figure 1-1).

Condition 6 of the Order defines the scope of the CHRP as follows:

6. Egg Pony Caribou Range Habitat Restoration Plan

   At least 60 days prior to commencing physical abandonment activities, NGTL must file with the Commission for approval an Egg Pony Caribou Range Habitat Restoration Plan (Plan) for the abandonment of the Meadow Creek Receipt Meter Station and Lateral, created in consultation with the appropriate Provincial land manager. The restoration to be implemented should substantially advance the relative succession of vegetation growth and enhance functional caribou habitat attributes (e.g., access control). The Plan must include the following:

   a. site locations for restoration activities (GPS coordinates and approximate size in square metres);

   b. for each site where physical abandonment activities are to occur, a description of any site location constraints that limit what restoration measures may be implemented;

   c. specifications for implementation of tree planting restoration measures for each site, including selection of tree species appropriate for each ecosite, minimum heights of tree plantings, and density and pattern of tree planting, for enhancing caribou habitat functionality;

[1] The term Caribou Habitat Restoration Plan is used to remain consistent with other filed NGTL caribou plans; it is the same plan as the Caribou Range Habitat Restoration Plan referred to in Condition 6.

[2] CER Filing ID: C03865-3.

d. specifications for implementation of further access control restoration measures for each site including identification of potential measures (e.g., mounding, rollback), appropriate site specific locations, and their densities and size specifications;

e. a description of criteria that will be used during monitoring to evaluate the effectiveness of site restoration measures described in c) and d);

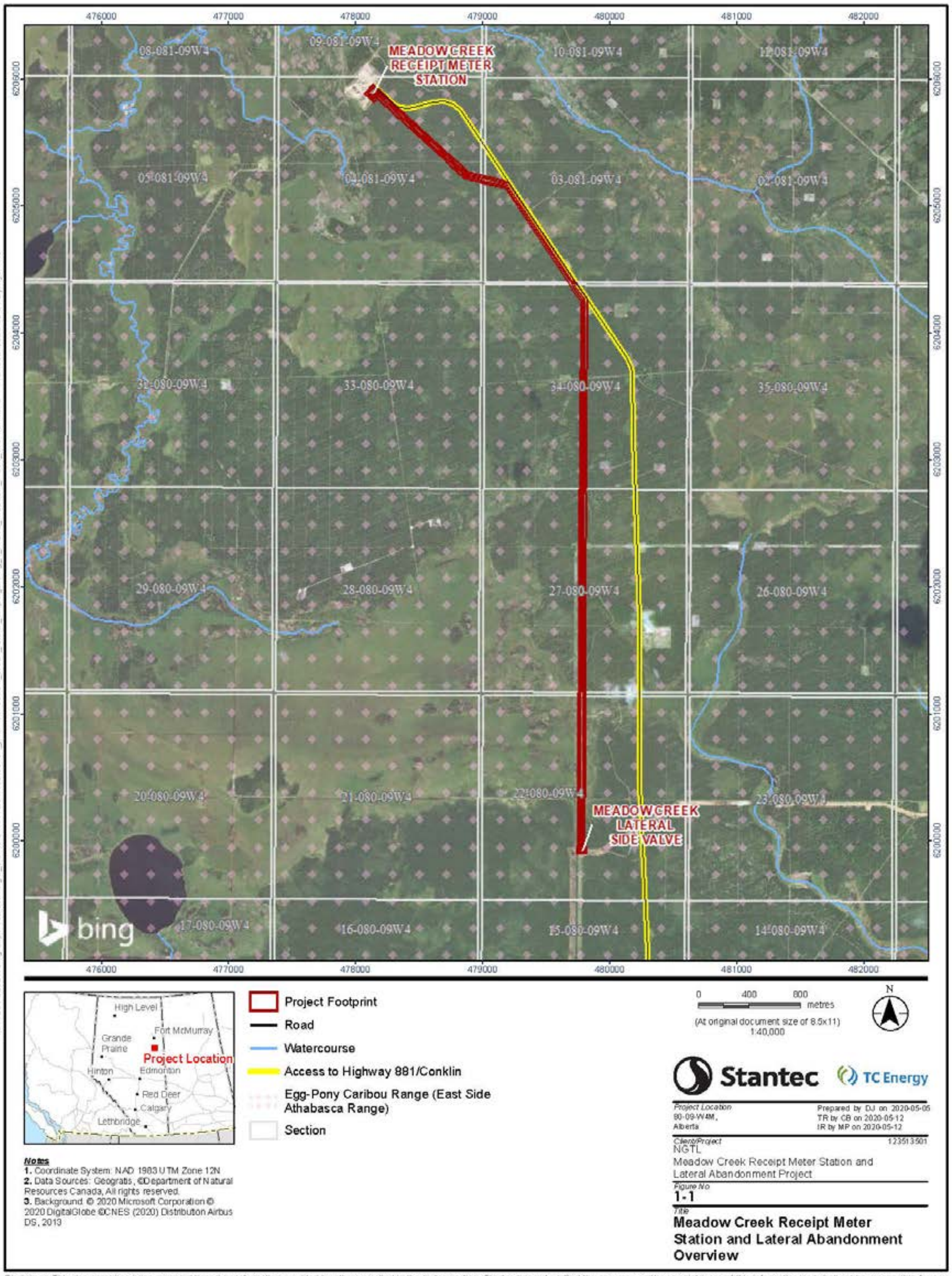
f. a schedule for implementation of restoration measures within the first year following physical abandonment activities; and,

g. a description of proposed actions to be taken by NGTL if the criteria described in e) are not met during the reclamation monitoring schedule outlined in Condition 8.[3]

The implementation of restoration measures for the Project are not complete with the filing of this CHRP. Condition 7 of Order ZO-008-2019 requires a Reclamation Report at regular intervals following the completion of initial restoration implementation (see Section 5.0).

This CHRP was developed in consideration of federal and provincial regulatory consultation, Aboriginal engagement, NGTL and industry experience, emerging applied research, and monitoring outcomes.

[3] Upon review of the Order, NGTL notes that Condition 6(g) erroneously refers to Condition 8; Condition 6(g) should refer to Condition 7.



Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 1-1: Meadow Creek Receipt Meter Station and Lateral Abandonment Overview

1.2 ORGANIZATION OF THE CHRP

This CHRP is organized to reflect the process logic of NGTL caribou habitat restoration planning and experience from past NEB and CER conditions regarding caribou for NGTL projects, experience with the Peace River Mainline Abandonment Revised Chinchaga Caribou Range Vegetation Restoration Plan filed on January 25, 2019,[4] and the structure of NGTL's most recently filed plan, the Northwest Mainline Loop (Boundary Lake North Section) Final Caribou Habitat Restoration and Offset Measures Plan, filed on January 31, 2020.[5] This CHRP is organized in eleven sections, as follows:

Section 1.0: introduction and organization of the plan

Section 2.0: strategic outcome, objective, goals and targets

Section 3.0: summary of caribou habitat restoration consultation and engagement with federal and provincial regulators and Aboriginal groups

Section 4.0: caribou habitat restoration plan

Section 5.0: description of future filings on caribou habitat restoration

Section 6.0: schedule for abandonment activity, habitat restoration, and future filings

Section 7.0: performance indicators that will be used to monitor and evaluate the success in achieving the CHRP objective, goals and targets

Section 8.0: monitoring, adaptive management, and reporting

Section 9.0: description of how field innovations and experience have been incorporated (i.e., continual improvement)

Section 10.0: literature review, on which the decision frameworks and selection of restoration measures were derived

Section 11.0: list of references cited in the document

[4] NEB Filing ID: A97635.
[5] CER Filing ID: C04467.

2.0 OUTCOME, OBJECTIVE, GOALS, AND TARGETS

This section identifies NGTL's strategic outcome, as well as the objective, goals, and targets for the measures discussed throughout the CHRP. These elements have been refined with experience gained across past NGTL projects and will be used to evaluate the performance and effectiveness of NGTL's caribou habitat restoration measures for the Project.

The objective, goals, and targets of the CHRP are intended to guide NGTL in the selection and assessment of caribou habitat restoration measures and reflect an evolution from earlier plans driven by a commitment to continuous improvement. The targets define specific aims for each goal and will be measured by quantifiable performance indicators as described in Section 7.0.

2.1 STRATEGIC OUTCOME

Combined with the contributions of other parties, NGTL's caribou habitat restoration measures contribute meaningfully to the conservation and recovery of woodland caribou in Canada.

2.2 OBJECTIVE

NGTL's objective for caribou habitat restoration investments is to apply active restoration techniques to further the relative succession of vegetation regeneration and restore caribou habitat attributes in a manner that aligns with provincial and federal policies, management plans, and priorities.

2.3 GOALS AND TARGETS

The goals and targets of the CHRP are, by function, similar to previously filed NGTL caribou habitat restoration plans, and caribou habitat restoration and offset measures plans.

Goal (G1) NGTL's caribou habitat restoration measures are ecologically relevant, practically located, and reasonably protected to reduce potential for redisturbance by human activity.

Target (T1) Access is lower on managed segments compared with unmanaged segments.

Target (T2) Continuous improvement of planning tools and environmental management systems to increase longevity of restoration measures.

Goal (G2) NGTL's caribou habitat restoration measures result in self-sustaining and ecologically appropriate vegetation communities that are on a trajectory to the compatible surrounding landscape.

Target (T3) The species composition of revegetated restoration areas resembles a typical path of ecological succession.

Target (T4) The sustained growth trend of revegetated restoration areas is comparable to that of the surrounding landscape.

Target (T2) in this CHRP has been refined from early NGTL project-specific caribou habitat restoration plans that had been filed with the NEB. In those early plans, each of habitat restoration, access management, and line-of-sight blocking were defined as targets. Target (T2) was previously related to achievement of a ≤ 500 m sight line when topography and materials allow. In practice and in consultation with stakeholders, line-of-sight reduction is generally a secondary effect of various restoration methods rather than a standalone target (e.g., planting trees or leaving suitably established naturally regenerating vegetation on an abandonment ROW, when available, can reduce line-of-sight). This is further discussed in Section 4.3. As a result of the removal of line-of-sight blocking as a mitigation measure, Target (T2) was updated to reflect NGTL's commitment to protect the restoration measures both on- and off-right-of-way (ROW).

3.0 CONSULTATION AND ENGAGEMENT

NGTL is committed to ongoing consultation with regulatory agencies, and engagement with Aboriginal groups, on the development and implementation of habitat restoration measures. The following sections summarize the outcomes of consultation and engagement as it pertains to this CHRP.

3.1 REGULATORY CONSULTATION

Table 3-1 presents a summary of NGTL's consultation with Alberta Environment and Parks (AEP) with respect to caribou habitat restoration for the Project. NGTL is committed to ongoing consultation with respect to planning and implementing caribou habitat restoration for the Project.

Table 3-1: Summary of Consultation with Alberta Environment and Parks

Who	When	What
Land Management Specialist, Lower Athabasca Region Operations Division, Approvals Branch, AEP	April 8, 2020	NGTL and AEP exchanged emails to schedule a conference call to discuss the caribou habitat restoration prescriptions proposed by NGTL for the Project.
	April 14, 2020	NGTL and AEP discussed the provincial caribou disposition conditions that have been part of previous CER approval conditions related to caribou, via conference call. The AEP inquired about the proposed planting prescriptions and what tree species will be planted and if they would be similar to what is currently present at the proposed locations. NGTL stated that coniferous tree species compatible with site conditions, forest succession, and the surrounding landscape will be planted. AEP acknowledged NGTL's approach to species selection and agreed with the intended approach to match ROW tree plantings with offsite vegetation characteristics. AEP did not express any other concerns with the proposed caribou habitat restoration plan during the call.

3.2 ABORIGINAL ENGAGEMENT

A key goal of ongoing engagement is to ensure that Project planning is compatible with the current use of lands and resources for traditional purposes. Inclusion of traditional knowledge shared through engagement will help ensure measures are implemented in a manner that avoids or minimizes disruption to traditional activities in the restoration areas. To date, no Aboriginal groups have raised concerns to NGTL regarding caribou or habitat restoration plans for the abandonment of the Meadow Creek Receipt Meter Station and Lateral during engagement for the Project. NGTL is committed to meeting with interested Aboriginal groups to discuss the implementation of this CHRP and the caribou habitat restoration measures, upon request.

4.0 HABITAT RESTORATION PLAN

This section of the CHRP describes the Project, its existing conditions, and measures for habitat restoration.

4.1 PROJECT DESCRIPTION

The Project consists of the abandonment of the Meadow Creek Receipt Meter Station located in NW 04-081-09 W4M and 6.82 km of the Meadow Creek Lateral from NW 04-081-09 W4M to SE 22-080-09 W4M northwest of Conklin, Alberta.

The Meadow Creek Lateral portion of the Project will be abandoned in-place in accordance with Order ZO-008-2019 and the *Canadian Standards Association Standard Z662-19: Oil and Gas Pipeline Systems* (CSA Z662-19) and the *Onshore Pipeline Regulations* (CER 2020). Abandonment activities will include two physical disturbance areas (PDAs): 1) the removal of above and below-ground facilities at the Meadow Creek Meter Station; and 2) the excavation of isolation points at either end of the Meadow Creek Lateral portion (see Figure 1-1).

4.2 EXISTING CONDITIONS

The Project is located entirely within the Egg-Pony caribou range (which is part of the East Side Athabasca Range (ESAR) of the boreal population of woodland caribou) and is contiguous (i.e., sharing a common border) with existing linear disturbance, pipeline ROWs, and industry roads or other dispositions for its entire length. The Meadow Creek Receipt Meter Station is adjacent to a cleared industrial area mineral surface lease. The valve site is adjacent to additional infrastructure (i.e., a highway, an industrial licenced lease and an existing ROW). The Project intersects several other dispositions for pipelines and access roads as well as an extensive area of 3D seismic grid lines.

An aerial reconnaissance of the Project was completed in October 2018 to characterize existing landscape and vegetation conditions on and adjacent to the ROW and to identify existing nearby disturbance and site-specific limiting factors for restoration.

The Project does not currently support the habitat characteristics, or biophysical attributes (e.g., mature conifer forest with abundant arboreal and terrestrial lichen) required to carry out some of the life processes necessary for the survival and recovery of boreal caribou. The existing naturally regenerating vegetation on the ROW is patchy low shrub and grass and is not currently on a trajectory to provide the biophysical attributes of caribou habitat.

4.2.1 Habitat Mapping

A ground survey was completed in October 2018 to verify vegetation and wetland types on and adjacent to the ROW; these field data, in combination with data gathered from the aerial reconnaissance, were used to delineate habitat restoration units on the ROW. These habitat restoration units were based on moisture regime and were defined as either upland or transitional forest, treed wetlands, or non-treed shrubby or graminoid wetland units based on guidance provided in the Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia (Golder 2015a). These habitat restoration units form the basis for establishing vegetation planting prescriptions (e.g., tree species and seedling densities) and restoration methods and targets.

4.2.2 Abandonment-in-Place

The Meadow Creek Lateral portion of the Project (10.7 ha) will be abandoned-in-place. Vegetation on this portion of the Project consists of grass and shrubs in upland and transitional forest units, and graminoid vegetation in non-treed wetland units. Because vegetation on the abandoned-in-place portion of the Project is not currently on a temporal trajectory to meet restoration targets, active habitat restoration measures will be used on most of the Meadow Creek Lateral ROW.

Restoration methods that will be used for the abandoned-in-place portion of the Project depend largely on the habitat restoration unit classification, but as necessary will also include site-specific topography, soil, vegetation characteristics, and adjacent mapped land cover type(s).

4.2.3 Physical Disturbance Areas

There are two PDAs where excavation, pipeline isolation, and facility removal will take place. The Meadow Creek Meter Station PDA (0.4 ha) is at the north end of the Project and is comprised of the meter station infrastructure and an existing undisturbed forested area. The forested area will not be cleared during abandonment activities. The Meadow Creek Lateral side valve PDA (< 0.1 ha) is at the south end of the Project. Habitat restoration measures will be implemented at both PDAs. Both PDAs are on previously disturbed areas and are accessible by existing access roads and ROWs.

4.3 HABITAT RESTORATION DECISION FRAMEWORKS

The Habitat Restoration Decision Frameworks for habitat restoration (Figure 4-1) and access management (Figure 4-2) are applied to provide guidance on selection of habitat restoration measure based on site-specific characteristics. The decision frameworks are principle-based logic models that inform habitat restoration decisions to achieve the objective and goals of this CHRP. They are based on NGTL’s pipeline construction and abandonment experience, information obtained from literature reviews, industry best management practices, industry consultation, consultation with regulators, and engagement with Aboriginal groups. The decision frameworks are continually revisited and updated based on findings from habitat restoration monitoring reporting results.

Caribou habitat restoration documents filed for past NGTL projects have previously included a decision framework for line-of-sight. This decision framework has been removed in this CHRP because the Project is contiguous with existing linear features, dispositions, and infrastructure. In addition, measures to reduce predator and human line-of-sight along the ROW are inherent in other restoration techniques (e.g., tree planting) and, therefore, the principles of line-of-sight management are part of the habitat restoration decision framework (Figure 4.1).

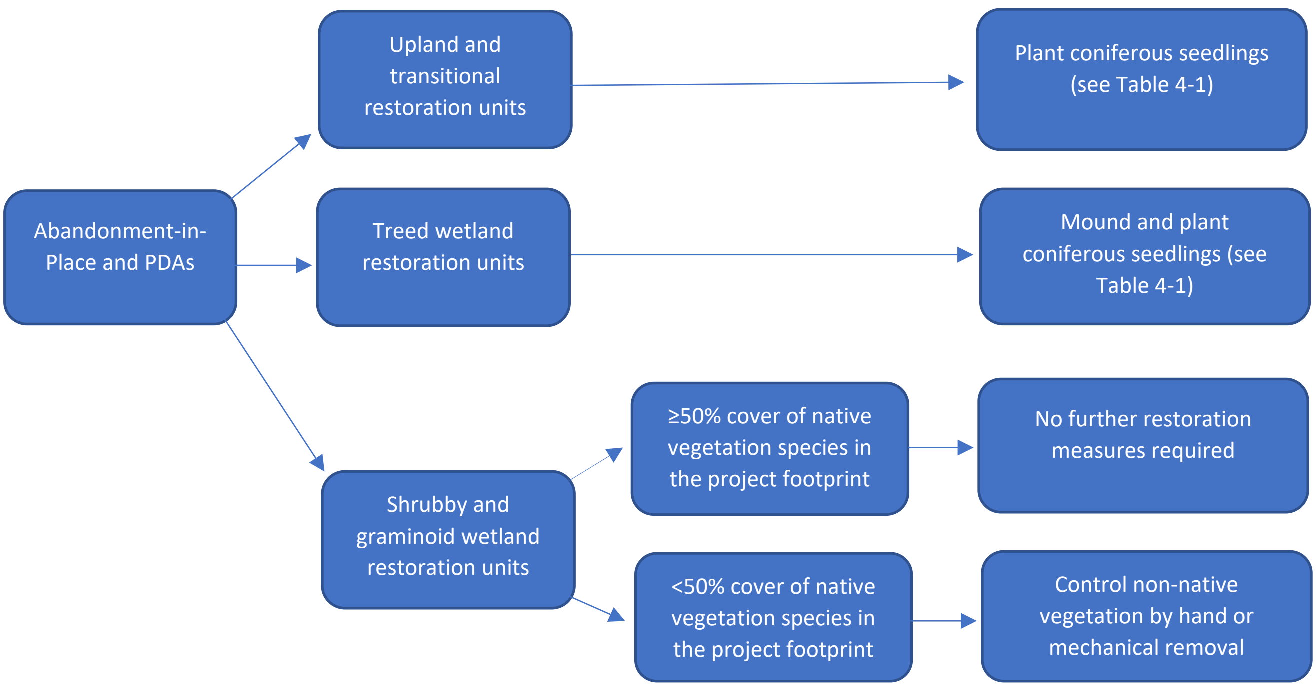


Figure 4-1: Habitat Restoration Decision Framework

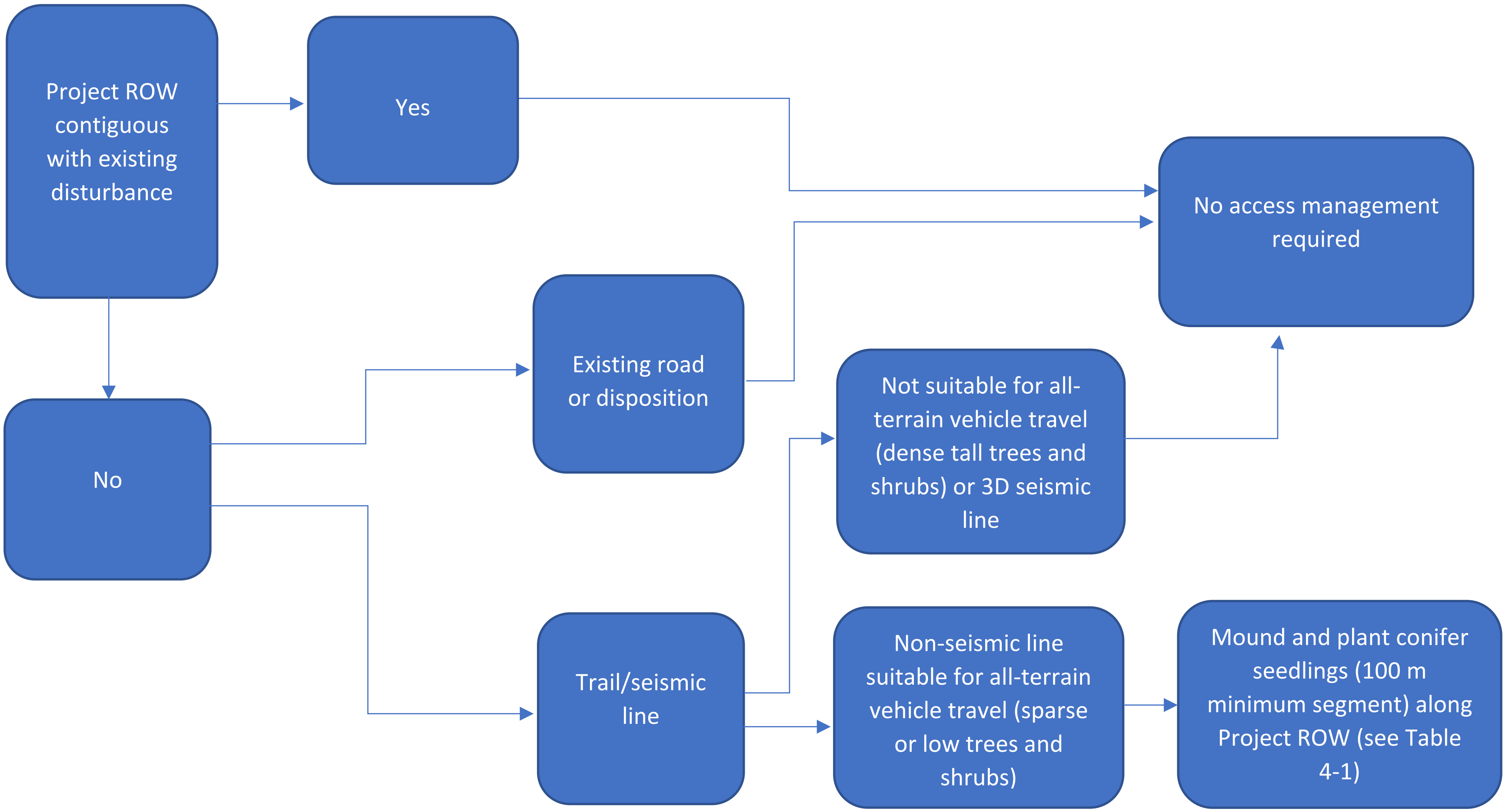


Figure 4-2: Access Management Decision Framework

4.4 HABITAT RESTORATION MEASURES

Site-specific habitat restoration measures have been selected under the guidance of the Habitat Restoration Decision Framework (see Section 4.3). The decision framework guides the selection of habitat restoration measures based on the habitat restoration unit, expected effectiveness, site-specific conditions, availability of suitable materials, and NGTL's habitat restoration experience from other projects. Potential restoration measures include reclamation and reforestation, maintenance of natural revegetation, access management, and line-of-sight blocking. Appendix B provides a 'toolkit' of potential habitat restoration measures that includes a summary of the expected effectiveness of each measure. Appendix C provides photographs of examples of potential habitat restoration measures. Appendix D provides construction schematics (i.e., typical drawings) of examples of potential engineered habitat restoration measures. Habitat restoration measures will be applied across three broad categories:

1. Abandoned-in-place portion of the Project where active restoration measures will be implemented on upland, transitional, and treed wetland units, and natural revegetation will be maintained in non-treed graminoid and shrubby wetland units.

2. The PDAs where physical abandonment activity will occur except where the PDA overlaps the disposition of an operational facility (i.e., a portion of the Meadow Creek Lateral side valve PDA).

3. Access management measures at appropriate locations along the ROW (i.e., at intersections where other linear features intersect or cross the Project ROW).

4.4.1 Active Habitat Restoration

Active habitat restoration is the use of site preparation techniques and planting of native tree or shrub seedlings to establish adequate vegetation in areas of the ROW where natural regeneration currently does not meet restoration targets.

Active habitat restoration measures will be applied to promote revegetation at each PDA and on most of the abandoned-in-place portion where tree establishment is expected to meet restoration targets given appropriate site preparation. Site preparation measures such as mounding, which promote tree growth and natural shrub establishment, will be considered at suitable areas (e.g., treed wetlands). Tree species compatible with site conditions, forest succession, and the surrounding landscape will be planted at appropriate densities and spacing at the feature level. Habitat restoration units for upland and transitional forest and treed wetlands account for 7.7 ha of the project footprint and are considered suitable for active revegetation as part of habitat restoration. The use of rollback or the spreading of coarse woody debris on the ROW will not be used as a restoration measure because clearing is not required, and materials will not be available for this restoration measure. Habitat restoration measures suitable for the Project (i.e., mounding and planting) are summarized in Table 4-1.

Table 4.1: Habitat Restoration Measures Selected for the Project

Restoration Measure	Purpose(s)	Considerations	Limitations
Coniferous seedling planting	Primary: Habitat restoration Secondary: Access management Reduce line of sight	• Primary restoration measure for both the abandoned-in-place and PDA portions of the Project • Coniferous seedling planting is considered a long-term habitat restoration measure, and an effective long-term access management and line-of-sight measure (it may take 10 or more years to achieve effectiveness, depending on site conditions). • Species selection (i.e., black spruce, white spruce, or pine) is determined based on the biophysical characteristics of the site, adjacent forest stand composition, and restoration targets. • Planting density is 2,000 seedlings/ha on upland and transitional sites and treed wetland sites.	Not suitable for shrubby or graminoid wetlands.
Mounding	Primary: Access management Habitat restoration (create microsites)	• Application suitable for linear feature intersects where access control measures will be applied and at PDAs and restored abandoned-in-place segments in treed wetland restoration units. • Mounding is used as an access management measure on pipeline ROWs, old roads, and on seismic lines to discourage off-road vehicle activity, and can be effective immediately following implementation. • Where mounding is used as an access management measure, alone or in combination with tree planting, mounds should be created by excavating to approximately 0.8 m depth, where conditions allow, and the excavated material placed immediately adjacent to the hole. At appropriate access management locations, mounding should be applied to the ROW in	Scheduling mounding for restoration during final cleanup, which typically requires freezing-in of soils, availability of specialized equipment and spatial separation of 5 m between the holes and the centreline of the operating pipeline.

Table 4.1: Habitat Restoration Measures Selected for the Project (cont'd)

Restoration Measure	Purpose(s)	Considerations	Limitations
Monitoring (cont'd)	See above	100 m minimum segment from intersecting disturbances. • Mounding is often a suitable habitat restoration measure that is used in conjunction with coniferous seedling planting, using 2 to 3 seedlings per mound, depending on the form and orientation of the mound. As a habitat restoration measure to create microsites for planted tree seedlings, mounding can be used in wet, low-lying areas to create better-drained microsites to restore seedling survival. Mounds created for microsite improvement should be approximately 0.6 m deep with the excavated material place adjacent to the hole. • For previous NGTL caribou habitat restoration projects on pipeline ROWs, the achievable range in mound density was approximately 700 to 1,400 mounds/ha with two to three seedlings per mound. Mound density is dependent on soil characteristics, extent of frost, and type of equipment used	See above

4.4.2 Natural Regeneration

In shrubby or graminoid wetland restoration units where site drainage and nutrient regimes prevent the establishment of trees, existing native vegetation cover will be maintained to promote the eventual natural revegetation of the ROW as shown in the decision framework (see Section 4.4). In upland, transitional, and treed-wetland habitat restoration units active restoration measures will be implemented.

4.4.3 Access Management

Access management for the Project will be planned to:

- Manage access along the pipeline ROW in a manner that discourages access, particularly motorized access.
- Maintain existing access at identified locations (e.g., third-party industry access, traditional access identified by Aboriginal groups through engagement activities)

Access management measures are most effective when implemented on non-contiguous segments of the ROW where they intersect existing disturbance suitable for motorized vehicle use. On segments where the ROW is contiguous on only one side, access management measures may be implemented on non-operational intersecting linear features where they intersect the non-contiguous side of the ROW. Locations where access management measures will be the most effective were determined through a review of satellite imagery and data on existing dispositions intersecting or contiguous with the Project.

Because the Project is contiguous with other existing linear disturbance, dispositions, and infrastructure on one or both sides, opportunities for access management are limited. The Project lies within a large grid of 3D seismic lines. Because the grid lines are spaced approximately every 100 m, access management measures on the ROW at each seismic line are unlikely to be effective at reducing overall human access in the area if the seismic lines are currently suitable for motorized access. Additionally, the Project is contiguous with other linear disturbances at most of the seismic line intersects. Therefore, access control measures will not be implemented on the ROW where it intersects seismic lines. Over time, natural revegetation of the seismic lines is expected to reduce their suitability for motorized travel.

The Project involves the abandonment and reclamation of an existing pipeline ROW; therefore, some access management measures appropriate for new-build ROWs may use materials (e.g., rollback, tree bending) or planning methods (e.g., extended trenchless crossings) that are not available or applicable to this Project. Access management measures suitable for the Project (i.e., mounding and planting) are summarized in Table 4-1.

4.4.4 Line-of-Sight Blocking

Current scientific research and ground monitoring has determined fabricated line-of-sight screens to be largely ineffective. However, line-of-sight blocking (such as the use of vegetation screens) can be effective when implemented on non-contiguous segments of the pipeline ROW. However, where NGTL is contiguous with other linear developments that do not have line-of-sight measures, NGTL’s measures would be rendered ineffective.

The Project is contiguous with other developments (see Section 4.2). Therefore, as discussed above, purposely installed line-of-sight measures (such as vegetation screens) will not be used for restoration of the project footprint unless, as for access management measures, a mechanism to catalyze cooperation with adjacent industrial disposition holders is developed by provincial regulators.

4.5 PROPOSED HABITAT RESTORATION PLAN

Habitat restoration measures will be implemented on the Project footprint to meet restoration targets for caribou and caribou habitat. The proposed habitat restoration plan for the Project is illustrated in Appendix E.

Tree seedling planting (black spruce and white spruce) is the primary habitat restoration measure planned for habitat restoration. Habitat restoration units too wet to expect adequate seedling survival will not be planted and will be left to naturally regenerate. Areas of existing disturbance that need to be maintained following abandonment of the Project, such as intersections with existing third-party permanent dispositions will not be included in habitat restoration.

The Project is contiguous with other linear disturbances (e.g., pipeline ROW, access road) at most intersections with perpendicular linear features. In such cases, unless access management is also applied to the contiguous linear disturbances, access management is unlikely to be effective. Therefore, access management will only be applied along the Project ROW at intersections where other linear features intersect or cross the Project ROW (see Section 4.3.2 and Appendix E).

Table 4-2 summarizes the area planned for active restoration, no additional treatment, and unrestored disturbance. The values in are based on assumptions; the actual values will differ based on the completed habitat restoration measures. The metrics are defined as:

- **Active Restoration:** area of the project footprint that is planned for active restoration such as tree seedling planting with or without mounding.
- **No Treatment – Natural Regeneration:** area of the project footprint considered too wet to expect adequate tree seedling establishment. Natural revegetation will be maintained.
- **No Treatment – Intersect with Other Disposition:** area of the project footprint that is disturbed and is under an existing disposition that will not be restored following Project abandonment.

Table 4-2: Restoration and No Treatment Areas for the Project

Spatial Boundary	Area (ha)		
	Active Restoration	No Treatment – Natural Regeneration	No Treatment – Intersect with Other Disposition
Meadow Creek Lateral ROW	7.6	2.9	0.2
Meadow Creek Meter Station PDA	0.4	0.0	0.0
Meadow Creek Lateral Side Valve PDA	<0.1	0.0	0.0

5.0 FUTURE FILINGS ON CARIBOU HABITAT RESTORATION

This section identifies NGTL's future filings to the CER on caribou habitat restoration measures for the Project that will be included in the reclamation monitoring reports, as per Condition 7 of Order ZO-008-2019,[6] as follows:

7. Reclamation Reporting

NGTL must file with the Commission:

a) on or before 31 January after each of the first (1st), third (3rd) and fifth (5th) complete growing seasons following the completion of Abandonment Activities, a reclamation report for the 2018 Program. The report shall include the following:
   i. a description of the methodology, including factors and criteria considered, used to evaluate equivalent land capability along the pipeline RoW upon completion of the abandonment activities;
   ii. a description of any environmental issues identified, the current status of the issues (resolved or unresolved), and the corrective actions taken or planned to be taken to resolve the issues; and,
   iii. information or documentation, including high-resolution photographs of the landscape on and off the pipeline RoW, either demonstrating that the state of land for the entire pipeline RoW has reached equivalent land capability or is on the trajectory of reaching the reclamation goal.

b) if equivalent land capability has not yet been achieved by the fifth year report, a reporting schedule for monitoring progress towards that objective.

[6] Condition 7 of Order ZO-008-2019 requires NGTL to submit reclamation reports detailing the restoration methods, environmental issues, and progress of the Project toward restoration targets. In the Letter Decision MH-003-2019, in which CER grants NGTL leave to abandon the facilities applied for as part of the Project, reclamation is defined as the process by which specified land is returned to an equivalent land capability through removal of structures and reconstruction of the land surface. The MH-003-2019 Decision defines restoration as the process of returning to ecological conditions (e.g., structure, function and composition) that existed prior to disturbance and is largely influenced by an ecological goal, such as restoring woodland caribou habitat suitability. As such, restoration report is the term used by NGTL; it is the same report as the reclamation report referred to in Condition 7.

6.0 SCHEDULE

NGTL has considered the seasonal sensitivity of caribou and has developed the abandonment and habitat restoration implementation schedule for the Project with this timing in mind. Project abandonment is planned to start in September 2021 after the end of the caribou restricted activity period (i.e., after July 15, 2020). Physical Abandonment Activities (e.g., facility removal and pipeline isolation) will take approximately three to four weeks to complete. Habitat restoration implementation is planned to occur in 2022. After restoration measures are implemented, NGTL will monitor the condition of the Project as it relates to restoration targets. A reclamation monitoring report, as required by Condition 7 of Order ZO-008-2019, will be filed on or before January 31 of the first, third, and fifth year of post-restoration monitoring, respectively. If the Project has not met or is not on a trajectory to meet restoration targets by the fifth-year report, NGTL will submit an updated reporting schedule for monitoring progress and implement site-specific adaptive management actions, as needed to meet the restoration target.

7.0 PERFORMANCE INDICATORS

After completion of the caribou habitat restoration measures, NGTL will implement a monitoring program to assess restoration performance in respect of the objectives, goals and targets described in Section 2.0 of this CHRP. The success of the restoration measures will be described quantitatively or qualitatively by the performance indicators outlined in Table 7-1. The primary measures below are taken from Table 4-1: Habitat Restoration Measures. The performance indicators are based on NGTL's experience with implementing and monitoring caribou habitat restoration measures for other projects.

Depending on the restoration measures implemented for the Project, additional performance indicators could be developed. The final performance indicators will be described in the habitat restoration monitoring report.

As outlined in Table 7-1, the performance indicators for Goal 2 include measurable parameters that reflect the habitat type affected, and a reasonable timeline to achieve restoration success. NGTL has chosen survival rate as the measure because it is not species dependent. The growth rates of conifer species can be variable and tree height over time can differ based on habitat characteristics and site-specific conditions. Given the differences in site conditions between upland and transitional units and lowland units, and the potential for site-specific influences and factors, tree height was not chosen as a monitoring metric.

Table 7-1: Performance Indicators to Measure Goals and Targets

Goal	Target	Primary Measures	Performance Indicator	Applicability to the Project
(G1) NGTL's caribou habitat restoration measures are ecologically relevant, practically located, and designed to reduce the potential for redisturbance by human activity	• (T1) Access is lower on managed segments compared with unmanaged segments.	Implement access management • Mounding	• Access control not bypassed or destroyed and no evidence of access from blocked linear feature to ROW • Vegetation on ROW not damaged by motorized vehicles	Applicable to non-contiguous portion of the Project
	• (T2) Continuous improvement of planning tools and environmental management systems to increase longevity of restoration measures.	• Development and implementation of a NGTL caribou range vegetation management plan/protocol in order to achieve protection of habitat restoration efforts	• Long term monitoring shows the progression and protection of restoration measures	Applicable to the Project
(G2) NGTL's caribou habitat restoration measures result in self-sustaining and ecologically appropriate vegetation communities that are on a trajectory to the compatible surrounding landscape.	• (T3) The species composition of revegetated restoration areas resembles a typical path of ecological succession • (T4) The sustained growth trend of revegetated restoration areas is comparable to that of the surrounding landscape	Implement habitat restoration • Plant coniferous seedlings at PDAs and suitable abandon-in-place portions of the Project	Upland and Transitional Habitat Restoration Units: • Achieve ≥80% survival rate of planted seedlings at one, three, and five years following implementation of restoration measures • All restoration locations demonstrate sustained growth trends across ≥80% of restoration locations at one, three, and five years following implementation of restoration measures Treed Wetland Habitat Restoration Units: • Achieve ≥50% survival rate for seedlings at one, three, and five years following planting • Demonstrate sustained growth trends across ≥50% of restoration locations at one, three, and five years following implementation of restoration measures	Applicable to the Project

Table 7-1: Performance Indicators to Measure Goals and Targets (cont'd)

Goal	Target	Primary Measures	Performance Indicator	Applicability to the Project
(G2) NGTL's caribou habitat restoration measures result in self-sustaining and ecologically appropriate vegetation communities that are on a trajectory to the compatible surrounding landscape.	See above	See above	Shrubby/Graminoid Wetland Habitat Restoration Units: • Sections with adequate natural regeneration have not sustained further disturbance • At one, three, and five years following implementation of restoration measures: • ≥50% cover of native vegetation species in the project footprint • No prohibited noxious and control of noxious weeds (as defined in Alberta's *Weed Control Act and associated Regulation* (2017))	See above

8.0 MONITORING, ADAPTIVE MANAGEMENT, AND REPORTING

Monitoring, adaptive management, and reporting are important elements to inform whether restoration investments are contributing meaningfully to the desired strategic outcome of the conservation and recovery of woodland caribou. To this end, NGTL will monitor the effectiveness of the habitat restoration implemented against monitoring targets to meet the performance indicators detailed in Section 7.0. The purpose of monitoring is to identify and manage issues requiring supplemental or remedial action to achieve habitat restoration goals. An adaptive management framework will be used to respond to monitoring results as they pertain to achieving monitoring targets and reporting of monitoring results will be completed for compliance and transparency.

8.1 MONITORING

NGTL will develop protocols to monitor the effectiveness of restoration measures implemented for the Project using knowledge gained from past and ongoing restoration projects.

8.2 ADAPTIVE MANAGEMENT

Adaptive management is the systematic process of monitoring and assessing outcomes and modifying habitat restoration measures, if necessary. NGTL will implement adaptive management by taking remedial action where warranted, to achieve the targets and goals, and ultimately, the objective of the monitoring plan using quantifiable performance indicators. Adaptive management is intended to:

- Evaluate restoration measures, performance, and effectiveness
- Identify the cause of underperforming measures (i.e., microsite conditions that are either not conducive or suitable for establishment of target vegetation)
- Address underperforming measures requiring supplemental or remedial action

The habitat restoration measures are considered successful when monitoring results indicate restoration has achieved, or is on trajectory to achieve, the performance indicators and, thereby, the restoration targets. No additional measures or monitoring will be considered necessary at that point. If performance measures indicate that restoration targets have not been achieved, or are not on trajectory to be achieved, the reasons for not achieving the targets will be evaluated and an appropriate course of action will be taken (e.g., supplemental restoration) and monitoring will continue until the targets are met.[7]

[7] In some instances, such as for natural fire events, monitoring may not be required if the fire “restarts” restoration by releasing seed stores. The need for ongoing monitoring following a natural disturbance will be evaluated on a case-by-case basis.

8.3 RESTORATION REPORTING

In accordance with Condition 7 of Order ZO-008-2019, NGTL will file with the CER reclamation reports outlining the results of reclamation and restoration monitoring (see Section 5.0).

9.0 CONTINUAL IMPROVEMENT

Continual improvement reflects the refinements of the quantification methodology and the incorporation of new information as it develops through:

- Finalization of provincial range plans and/or habitat restoration initiatives
- Available literature
- Research from industry associations
- Lessons learned from other NGTL projects
- Results from caribou habitat monitoring programs
- Consultation with applicable regulators, resource managers, and Aboriginal groups
- Adaptive management practices in the field

9.1 CARIBOU HABITAT RESTORATION MEASURES

Caribou research is a growing field and it is anticipated that methods to restore habitat will continue to be tested and refined. NGTL will continue to incorporate new information on caribou mitigation and habitat restoration planning and implementation. If new research identifies success with alternate methods of caribou habitat restoration, NGTL will determine if the methods are applicable for use on its pipeline ROWs. Where appropriate and applicable and supported by regulators, new habitat restoration measures will be incorporated into NGTL's habitat restoration toolkit (Appendix B) and decision frameworks. Similarly, habitat restoration measures that are determined to be ineffective will be removed from NGTL's toolkit and decision frameworks. Section 9.3 provides examples of lessons learned to date by NGTL regarding habitat restoration measures.

A wide range of initiatives have generated important lessons learned related to oil and gas development in caribou range, including which plant species to use, when and where to replant, development of effective techniques to promote natural revegetation, and a better understanding of methods to manage access. Initiatives focused on revegetation and access management, as well as limiting growth and establishment of plant species favourable to primary prey, are of particular relevance (e.g., CRRP 2007a,b; Golder 2010; Osko and Glasgow 2010). Other key initiatives are tree planting projects, coarse woody debris management best practices, habitat enhancement programs, and habitat restoration trials in caribou range (CRRP 2007a, b; Enbridge 2010; Golder 2010, 2011; COSIA 2019). Large-scale habitat restoration projects near Grande Prairie, Cold Lake, and Fort McMurray, Alberta, as well as NGTL's projects in caribou habitat have incorporated learnings from these initiatives.

9.2 INDUSTRY COLLABORATION

The Canada Oil Sands Innovation Alliance (COSIA) has four key focus areas: tailings, water, land, and greenhouse gases. Within the COSIA land focus area is a caribou habitat restoration initiative with the goal of improving woodland caribou habitat quality and herd survival through restoration of historic linear disturbances.

COSIA has developed the following habitat restoration initiatives:

- Determining effectiveness of different restoration techniques such as winter tree planting, mounding, seeding and placement of coarse woody debris. The winter tree planting trial was set up to determine the effectiveness of planting black spruce seedlings in wetland areas during winter. Results of the tree planting trial indicated 90% survival of the 900 seedlings planted.
- Development of the Landscape Ecological Assessment Planning (LEAP) tool to provide baseline levels of varying land use. LEAP can be used to determine the long-term effects of restoration in a given area, which can help guide planting initiatives.
- The Algar Historic Restoration Project takes an integrated regional approach, with six companies working together to repair fragmented habitat across an area of land outside their actual licence areas. This is a multi-year program to replant trees and shrubs along the linear footprint in the Algar Region, covering an area of approximately 570 squared km.
- The LiDea Project aims to restore linear disturbances using mounding and tree felling. Rigorous monitoring and measurement programs have been designed for the life of the LiDea Project and include 37,000 ha of active treatment area. During spring and summer, conifer seedlings are planted along older, mounded seismic lines. The LiDea Project is also experimenting with forest stand modification, which involves bending tree stems from the adjacent forest across the seismic line to create physical barriers and reduce sightlines along the linear corridor.

The Regional Industry Caribou Collaboration (RICC) is part of COSIA and is a multi-industry partnership focused on restoring caribou habitat through regional, collaborative, range-based efforts. The objectives of RICC are to coordinate habitat restoration in the short-term and long-term, coordinate future activity, support and lead scientific research, undertake applied trials, and align caribou habitat restoration programs with provincially led range plans and action plans.

Although NGTL is not currently an active member of RICC, NGTL has collaborated with its members on restoration projects. A major RICC research effort is to verify the effectiveness of restoration measures using a multi-scale predator/prey collaring program to address current knowledge gaps in habitat use and function. As new information on habitat restoration becomes available, NGTL will incorporate it into the planning and implementation process for its projects in caribou habitat.

NGTL has worked with other industry members through the Canadian Energy Pipeline Association (CEPA) and other multi-stakeholder working groups to engage provincial regulators on caribou recovery in Alberta and British Columbia (BC). NGTL is participating, through CEPA, on three caribou sub-regional task forces created by the Province of Alberta. These multi-stakeholder task forces are responsible for providing recommendations to government on sub-regional planning, including caribou recovery actions.

NGTL also supported research initiatives on boreal caribou in BC through the BC Oil and Gas Research and Innovation Society's Research and Effectiveness Monitoring Board. This research program was multifaceted but included restoration of caribou habitat, research into predator/prey relationships, and research on boreal caribou in relation to their habitat (e.g., wildlife responses to habitat restoration in the Parker Range).

9.3 LESSONS FROM NGTL HABITAT RESTORATION

NGTL has completed caribou habitat restoration plans in Alberta for the following projects: Northwest Mainline Loop (Boundary Lake North Section),[8] Smoky River Lateral Loop,[9] Peace River Mainline Abandonment,[10] Leismer to Kettle River Crossover,[11] Northwest Mainline Komie North Extension (Chinchaga Lateral Loop No. 3),[12] Liege Lateral Loop No. 2 (Thornbury Section),[13] Northwest Mainline Expansion,[14] and 2017 NGTL System Expansion.[15] First and third year monitoring results are available from on-ROW and offset area restoration for the Northwest Mainline Expansion Project, Leismer to Kettle River Crossover Project, and Northwest Mainline Komie North Extension (Chinchaga Lateral Loop No. 3).[16] Based on NGTL's experience with these projects, the following lessons learned were considered, and where appropriate, incorporated into the development of this CHRP:

- The application of discontinuous rollback across the width of a ROW as an access management measure has been removed from NGTL's toolkit. The ineffective use of rollback as an access management measures occurs primarily when a project ROW is contiguous with another ROW that is operated by another party. Unless there is

[8] CER Filing ID: C04467-1.
[9] CER Filing ID: C04473-1.
[10] NEB Filing IDs: A96593-1 and A97635-1.
[11] NEB Filing IDs: A48745, A56819 and A60689.
[12] NEB Filing IDs: A52951 and A69803.
[13] NEB Filing IDs: A71014, A72136 and A87455.
[14] NEB Filing IDs: A44778 and A56798.
[15] NEB Filing ID: A79253.
[16] NEB Filing IDs: A6S5K8 and A7D7H3.

agreement from the other party to apply continuous rollback across the width, and it is safe and operationally feasible to do so, discontinuous rollback will not be used for access management. Rollback may, however, be used to improve microsite conditions for vegetation recovery where appropriate and could indirectly discourage access.

- Rollback was used as firewood by land users when stacked as ladders. A random arrangement of wood piles intended to discourage wood removal is currently being tested.
- NGTL has found earth and woody debris berms to be ineffective. Over time these berms settle and compact and do not perform as line-of-sight breaks. Predators have been observed by field personnel using these features as vantage points, providing a clear view of the surrounding landscape. Also, earth and woody debris berms require large volumes of material that are generally not available during pipeline construction, particularly when minimal surface disturbance techniques are being implemented. Woody debris berms have also been deemed a fire hazard by local forestry officers.
- Tree planting on a linear corridor can have shading issues that are not seen on cutblocks (typical silvicultural practices). This could result in changes to the planting densities and planting considerations and configurations may be modified as the monitoring program progresses to reflect those site-specific conditions.
- Access management cannot be absolute because of safety, as well as operating and maintenance activities that must occur. On previous NGTL projects, lack of access resulted in restoration measures (specifically, access management measures) being destroyed or removed to access the ROW. In the future, access management locations will be strategically placed and managed to allow for operational access requirements and consideration of recreational, industrial, and traditional access needs.
- As mentioned in Section 4.3.3, line-of-sight measures will not be implemented where the pipeline is contiguous with existing infrastructure due to decreased effectiveness (see Appendix C, Plate 10). Although purposely installed line-of-sight measures (such as fabricated screens) will no longer be used, it is expected that as replanted trees grow on NGTL's restored ROWs, line-of-sight along the ROW will be reduced over time.
- While line-of-sight breaks and access management on contiguous ROWs have proven to be largely ineffective, NGTL has learned that such methods are effective on non-contiguous ROWs. This Project, and future projects that are contiguous with existing ROWs, will not include line-of-sight breaks as an option for on-ROW restoration, although they may be used in applicable offsetting applications. To increase the longevity of restoration measures, NGTL uploads the on-ROW restoration locations into a data management system (GeoFind) to identify locations across TC Energy Corporation.

- NGTL has implemented 'lattice style' access management in areas where the volume of appropriately sized timber is available (see Appendix C, Plate 13). The lattice style is designed to be more effective because it is harder to move without specialized equipment and can be effective over a reduced length of treatment.
- Where habitat restoration measures have failed or have been removed due to maintenance and operations, they will be replaced as part of adaptive management.

10.0 LITERATURE REVIEW

A literature review was completed to provide regulatory and ecological context relevant to boreal caribou and specifically to ESAR, including threats and management considerations for recovery of boreal caribou. This context provides an understanding of the current knowledge of the value and purpose of habitat restoration measures in caribou range.

In addition, available information on habitat restoration measures and habitat restoration methods was compiled and summarized in Section 4.3 (Table 4-1). This summary was used to provide the foundation for the toolbox of habitat restoration measures available to NGTL to effectively mitigate potential project effects on caribou and caribou habitat. Knowledge gaps that contribute to uncertainty in caribou habitat restoration are identified in Section 10.9. Based on the results of the literature review, the habitat restoration measures best suited for caribou range are identified.

10.1 LITERATURE REVIEW METHODS

The literature review incorporates regulatory and ecological context relevant to ESAR to inform the selection of appropriate habitat restoration measures. The key results from current boreal caribou literature, as well as from previous and ongoing habitat restoration initiatives, techniques implemented, and their reported successes and failures, were reviewed to inform this CHRP.

The literature review of habitat restoration measures was completed using a systematic approach and standard research techniques, which enabled NGTL to consider recent knowledge of caribou habitat restoration in this CHRP. Literature reviewed included federal and provincial recovery strategies and management plans, peer-reviewed primary scientific articles, previously submitted NGTL caribou habitat restoration filings to the CER, caribou habitat restoration filings to the CER from other proponents, publicly available government reports, in-house reference material and guidance documents from expert individuals/agencies.

The literature review for this CHRP included a systematic search of the following industry, government, scholarly, and internet information sources for queried keywords and phrases:

- Cumulative Environmental Management Association database, including Oil Sands Leadership Initiative historic filings
- ScienceDirect (https://www.sciencedirect.com/), JSTOR (https://www.jstor.org/), ISI Web of Science (https://isiknowledge.com/), and ELSEVIER (https://www.elsevier.ca/ca/) for biological and environmental science journal databases, including other related research fields and disciplines

- Expert individual websites (author-specific, where available) for published articles and associated links or documents related to the aforementioned sources
- Google Scholar
- Google

The following search terms (i.e., keywords and phrases) were used in the literature review:

- Caribou habitat restoration
- Boreal caribou
- Boreal forest and forested wetlands restoration
- Linear corridor restoration/reclamation
- Linear feature restoration in boreal forest and forested wetlands
- Alberta /caribou recovery/range plan/policy/action plan

The COSIA website (https://www.cosia.ca) was searched to gather knowledge on current habitat restoration programs, techniques, and monitoring results, including the COSIA Joint Industry Project Regional Industry Caribou Collaboration Project, LiDea Project, the Algar Historic Restoration Project, the Cenovus Caribou Habitat Restoration Project collaboration and Oil Sands Leadership Initiative environmental performance projects.

Several technical sessions related to habitat restoration for caribou were presented at the 15th, 16th, and 17th North American Caribou Workshops (NACW 2014, 2016, 2018). Information for caribou habitat restoration planning related to use of rollback, vegetation heights, seasonal use of linear corridors by both prey and predator, efficacy of seedling planting, and monitoring wildlife use of restored linear features is summarized in the relevant sections of the literature review.

Caribou habitat restoration is receiving increasing research attention and it is anticipated that methods to restore habitat will continue to be tested and modified. NGTL will continue to incorporate this new information into habitat restoration activities and post-construction monitoring.

10.2 REGULATORY POLICY, RECOVERY OBJECTIVES, AND GUIDELINES FOR BOREAL CARIBOU

NGTL began consultation and working collaboratively with provincial regulators, stakeholders, and industry partners in the early planning stages of the Project (see Section 3.0). NGTL will continue to work with provincial and federal regulators to align the

CHRP measures with current regulatory policies, recovery objectives, and guidelines for boreal caribou, including:

- Alberta Woodland Caribou Recovery Plan, 2004/05 to 2013/14 (Alberta Woodland Caribou Recovery Team 2005)
- A Woodland Caribou Policy for Alberta (Government of Alberta 2011)
- Draft Provincial Woodland Caribou Range Plan (Government of Alberta 2017b)
- Amended Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada (ECCC 2019)
- Report on the Progress of Recovery Strategy Implementation for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population in Canada for the Period 2012 to 2017 (ECCC 2017)
- Progress Report on Steps Taken to Protect Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. December 2018 (ECCC 2018a)
- Action Plan for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada - Federal Actions - 2018 [Final] (ECCC 2018b)
- Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (Government of Alberta 2017a)
- Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia (Golder 2015a)
- Boreal Caribou Habitat Restoration Monitoring Framework (Golder 2015b)
- Alberta's Master Schedule of Standards and Conditions (https://open.alberta.ca/publications/master-schedule-of-standards-and-conditions)

The Woodland Caribou Policy for Alberta (Government of Alberta 2011) identifies recovery strategies that include maintenance and restoration of caribou habitat, establishment of range-specific habitat objectives, management of other wildlife populations (predators and primary prey), adaptive management, as well as legislative and social considerations. A key strategy adopted by the Woodland Caribou Policy for Alberta is the development of range-specific assessments and objectives (i.e., action plans), which builds on the work of previous recovery strategies, such as the Alberta Woodland Caribou Recovery Plan 2004/05–2013/14 (Alberta Woodland Caribou Recovery Team 2005).

Similar to the provincial policy, the proposed amended federal Recovery Strategy (ECCC 2019) stresses the importance of landscape level planning, such as planning development activities at appropriate temporal and spatial scales, incorporating caribou habitat requirements in fire management plans, establishing key protected areas and incorporating adaptive management. One of the management approaches suggested in the proposed amended federal Recovery Strategy to address effects of habitat alteration on boreal caribou is to undertake coordinated actions to reclaim boreal caribou habitat through restoration efforts. This might include restoration of industrial features such as roads, seismic lines, pipelines, cut lines, and clearings (ECCC 2019).

NGTL is working with AEP to align the CHRP measures with the provincial caribou policy and caribou range planning. The Draft Canada-Alberta Agreement for the Conservation and Recovery of the Woodland Caribou in Alberta, under s.11 of the *Species at Risk Act*, was prepared to articulate caribou conservation actions over the next five years, including the development of range plans (ECCC 2018a; Government of Canada and Government of Alberta 2019).

The goal of the proposed amended federal Recovery Strategy is to achieve self-sustaining local populations in all boreal caribou ranges throughout their current distribution in Canada, to the extent possible (ECCC 2019). Population and distribution objectives identified in the proposed amended Recovery Strategy include, to the extent possible:

- Maintain current status of the 15 existing self-sustaining local populations
- Stabilize and achieve self-sustaining status for the 36 non-self-sustaining local populations (a group that includes the Chinchaga caribou range)

The habitat threshold that provides a measurable probability for a local caribou population to be self-sustaining is considered, with one exception, to be 65% undisturbed habitat within the range (ECCC 2019).[17]

The CHRP adopts the definition of caribou critical habitat provided in the proposed amended federal Recovery Strategy (i.e., “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species”).

The *Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta* outlines the Government of Alberta’s approach and restoration objective for caribou habitat restoration programs in Alberta, containing processes and expectations for program planning, delivery, quality control and monitoring (Government of Alberta 2017a). The document also outlines controls for data management. The Framework was developed to be applicable to provincially led restoration programs on caribou ranges in the province, subject to adjustments based on learnings as part of an adaptive management approach.

[17] The exception is the Boreal Shield caribou range for which the threshold is 40%.

In addition to the recovery planning and policy documents described above, NGTL considers the *Master Schedule of Standards and Conditions* in the development of caribou-specific habitat restoration measures. The approval standard conditions and recommended best management practices provided in the *Master Schedule of Standards and Conditions* are intended to achieve the following desired outcomes for caribou range:

- Reducing sources of human-caused direct mortality associated with anthropogenic features
- Reducing excessive predator-caused mortality
- Reducing habitat loss
- Reducing the partial avoidance demonstrated by caribou in relation to industrial features
- reducing potential increases in distribution and productivity of other prey species

Two other documents considered by NGTL in the development of this CHRP were prepared for the BC Oil and Gas Research and Innovation Society, as part of the BC Governments Boreal Caribou Implementation Plan. The *Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia* was prepared as an operational handbook and is intended to guide implementation of reclamation techniques for restoring caribou habitat. It is a toolkit of measures to address vegetation recovery of disturbed features, as well as recommending measures to address human and wildlife accessibility and mobility of these features. The toolkit includes guidance for:

- Reclamation of new disturbance and historical footprint
- Restoration both in and outside of lease holders' approvals
- Approved access management treatments and specifications
- Monitoring of treatment applications to determine success

The Boreal Caribou Habitat Restoration Monitoring Framework (Golder 2015b) describes the rationale and recommended protocols to monitor the effectiveness of boreal caribou habitat restoration treatments with consideration of both a project-level scale and a northeast BC restoration program-level scale. Performance measures and recommended targets defined within the framework are used to gauge the effectiveness of treatment measures applied over short-and long-term periods.

10.3 BOREAL WOODLAND CARIBOU ECOLOGY

The boreal population of woodland caribou is listed as Threatened on Schedule 1 of the *Species at Risk Act* and is listed as 'At Risk' under the Alberta *Wildlife Act* (AEP 2017a; Government of Canada 2019).

Woodland caribou in Alberta are found in bogs and fens with low to moderate tree cover and tend to avoid marshes, uplands, heavily forested wetlands, open bodies of water, and areas of human use (Thomas and Gray 2002). Local caribou population ranges encompass areas large enough for all life processes (calving, rutting, wintering). Therefore, woodland caribou require large tracts of continuous undisturbed habitat, especially when they disperse during calving and need to reduce predation risk (Vistnes and Nellemann 2001; Environment Canada 2011). Preferred habitat is typically mature coniferous forest (e.g., jack pine and black spruce) with abundant lichen, muskeg, and peatlands intermixed with upland or hilly areas (Brown et al. 1986; Bradshaw et al. 1995; Stuart-Smith et al. 1997; Rettie and Messier 2000; Neufeld 2006; O'Brien et al. 2006; Brown et al. 2007; Courtois and Ouellet 2007). Sufficient canopy cover or wind exposed areas are required to keep snow depth at low enough levels to allow foraging (Collins and Smith 1991; Schaefer and Pruitt 1991; LaPerriere and Lent 1977).

Boreal woodland caribou do not undergo seasonal migrations and remain in forest and peat habitats throughout the year (Alberta Woodland Caribou Recovery Team 2005). Forested peat complexes are the primary habitat for boreal caribou and they require large contiguous tracts of this preferred habitat to maintain low population densities across their range as an anti-predator tactic (Alberta Woodland Caribou Recovery Team 2005). Boreal caribou maintain spatial separation from other ungulates by occupying habitat that has a lower density of other ungulate species (ASRD and ACA 2010).

The rutting season occurs in early to mid-October, and caribou have a gestation period of 7.5 to 8 months. In northern Alberta, most calves are born in the first two weeks of May (ASRD and ACA 2010). Compared with other forest-dwelling ungulate species, woodland caribou exhibit low reproductive potential. Adult cows are typically three years old before they begin producing young and only produce a single calf annually thereafter (ASRD and ACA 2010).

10.4 THREATS AND LIMITING FACTORS

Threats to boreal woodland caribou identified in the proposed amended federal Recovery Strategy (ECCC 2019), in descending order of direct impact on caribou population trend, are:

- predation
- habitat alteration from human land-use activities
- natural disturbance of habitat
- hunting
- climate change and severe weather

Other threats, considered to have a lower level of concern, include parasites and disease, stress responses associated with sensory disturbance (noise and light), vehicle collisions, and pollution.

Available literature supports apparent competition as the likely causal pathway for woodland caribou population declines, whereby primary prey species (e.g., moose, deer) increase with increasing proportions of early seral habitat on the landscape, causing a numerical response [increase] of predators (Seip and Cichowski 1996; Thomas and Gray 2002; Wittmer et al. 2005; Latham 2009; ECCC 2019). Wolves are considered the primary predators of caribou across northern Canada and predation by wolves has been implicated as the most common cause of death for adult caribou in northeastern Alberta (McLoughlin et al. 2003). Black bear can also be a common predator of caribou (Rettie and Messier 1998; Zager and Beecham 2006).

Increases in predator numbers can subject caribou to unsustainable levels of predation, causing population decline (Wittmer et al. 2005). Predator densities capable of causing caribou declines are usually sustained by abundant primary prey sources, such as moose or white-tailed deer (Thomas and Gray 2002; Wittmer et al. 2005; Peters et al. 2013). Predation on caribou is thought to be largely incidental, given the low densities of woodland caribou compared with much more abundant prey species (Wittmer et al. 2005).

The selection of peatlands and old-growth forest by caribou, and non-use of these areas by moose, wolves (Rettie and Messier 1998), and black bears (Latham et al. 2011) was determined to result in spatial separation (James et al. 2004). This strategy is believed to be used to combat the widespread influence that wolves have in an ecosystem (Ripple and Beschta 2004; Ripple et al. 2014). Removal or alteration of habitat (e.g., forest harvesting [McCutchen 2007]) will degrade the area that spatially separates caribou and primary prey (e.g., moose). Following forest harvest, moose were more likely to use the same habitats as woodland caribou, which in turn attracts wolves to these areas and subsequently an increase in wolf predation rates on woodland caribou (Peters et al. 2013).

The influence of anthropogenic linear feature density on predation rates might be equally as important to caribou mortality as the density of predators (Whittington et al. 2011). The ultimate cost to caribou habitat suitability appears lower for linear feature induced changes compared with forestry induced changes (i.e., cutblocks) (DeCesare et al. 2012).

Linear feature-induced changes have been previously linked to changes in predator functional response (predator kill rate) while forestry induced changes have been previously linked to changes in predator numerical response (predator density).

Evidence shows scale dependent variation in caribou resource selection, where habitat selection at the population and individual seasonal home range scale is affected by forestry cutblocks (DeCesare et al. 2012). Forestry cutblocks are linked to increased predator densities (Latham et al. 2011). Conversely, caribou distribution is shown to be strongly influenced by linear disturbance at the finer (location level) scale (DeCesare et al. 2012).

Linear corridors provide improved access for predators such as wolves. Several studies have found that linear corridors are attractive to bears (McKay et al. 2014) and especially wolves as easy travel routes (Thurber et al. 1994; Stuart-Smith et al. 1997; James 1999; James and Stuart-Smith 2000; Whittington et al. 2011). As a result, linear disturbances can influence predator/prey dynamics (Bergerud et al. 1984; Edmonds and Bloomfield 1984; Rohner and Kuzyk 2000). Wolves travel faster along linear disturbances (James 1999; McKenzie et al. 2012) and encounter rates between wolves and caribou have been shown to increase near linear features (Whittington et al. 2011).

Furthermore, it is suggested that while wolves increase movement rates on linear disturbance features, their movement rates decrease in proximity to disturbance features. This implies behaviour closely associated with prey searching and hunting (Ehlers et al. 2014). However, modelling the dynamic use of the landscape by wolves, primary prey (moose), and caribou showed that wolves experience no additional advantage accessing caribou from linear features, although they do benefit in accessing primary prey species (McCutchen 2007; Mummel et al 2016). This is supported by a study that found that kill sites were no closer to linear features than random (Latham et al. 2011).

Caribou are sensitive to anthropogenic disturbance (e.g., industrial activity [Dyer et al. 2001], Dyer et al. 2002) and habitat alteration (e.g., forestry [Peters et al. 2013]), and to natural disturbance (e.g., burns [Schaefer and Pruitt 1991]). Long-term reduction in habitat effectiveness adjacent to linear features can occur as caribou have been shown to partially avoid habitats near ROWs (Dyer 1999; Oberg 2001). Avoidance of habitat near anthropogenic disturbances leads to indirect habitat loss through reduced habitat effectiveness for caribou (Dyer et al. 2001).

Methods and study populations vary among research studies that demonstrate caribou avoidance of disturbances by varying distances: 70 m (seismic lines and maintained trails [DeCesare et al. 2012]), 250 m (roads and seismic lines [Dyer et al. 2001]) and 1,000 m (industrial developments such as well sites [Dyer et al. 2001]). The federal Recovery Strategy for boreal caribou defines disturbance of critical habitat as the area affected by human-caused disturbance that is visible on Landsat at a scale of 1:50,000, including a 500 m buffer around the disturbance to account for avoidance by caribou, and/or the area affected by fire less than 40 years old (ECCC 2019).

Restoration of disturbance assumes that caribou will return to being spatially separated from primary prey (moose, deer) and predators, and hence natural levels of mortality risk (Athabasca Landscape Team 2009).

Management of boreal caribou habitat to maintain viable populations over time will require both minimizing the impact of future development and recovery of the existing industrial footprint.

Woodland caribou populations are very low in many areas and, therefore, populations simply might not rebound due to increasing rates of inbreeding and other, well-defined detrimental effects of genetic drift that are characteristic of small, genetically isolated populations (Bijlsma et al. 2000; Hedrick and Kalinowski 2000; Keller and Waller 2002; Frankham 2005). This phenomenon, known as the Allee effect, was suggested to likely occur in the boreal population of woodland caribou in Alberta (Serrouya et al. 2012; Hervieux et al. 2013).

10.5 CARIBOU RECOVERY AND HABITAT RESTORATION

Boreal lowland habitat types naturally have very slow rates of vegetation establishment and growth, making tree seedling establishment and growth in a 15-year period unpredictable. Guidelines for wetland restoration associated with oil sands mining (CEMA 2014) focus on disturbance types that are not applicable to pipeline construction and operation. Furthermore, reclamation of bogs and fens is in experimental stages. Historically there have not been standards and guidelines specific for reclamation of linear corridors including pipelines and seismic lines. As a result, restoration criteria and guidelines for forested areas in Alberta and reforestation standards in Alberta specific to the project area (AENV 2001, 2008, 2010; AESRD 2013a, b, c) were used to develop appropriate specifications for the CHRP habitat restoration measures. Earlier NGTL caribou plans were guided by documents specific to disturbance types such as open pit mining or well-sites (e.g., *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* [AENV 2010a], *2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* [AENV 2010b]). These documents include specifications for various indicators using an end land use approach that targets reclamation to commercial forests, which conceptually provide other ecosystem functions including wildlife habitat. The application of these guidelines to NGTL's projects needs to be approached with caution because they relate to a different disturbance type (i.e., bitumen mining vs. pipeline ROW) and were developed for different objectives.

With these limitations in mind, it is recognized that the AENV guidelines for oil sands reclamation are developed for boreal forests with similar attributes to those on NGTL's projects and, therefore, some of the thresholds and indicators were used to guide the development of targets and performance indicators for NGTL's caribou plans.

In particular, quantifiable targets associated with treed lowland and shrubby/graminoid lowland habitat types incorporate the concept of plant community composition as an appropriate indicator to assess reclamation status and progress in these wetland habitats (AENV 2010a,b). This is supported by the suggestion that the number and abundance of characteristic species (i.e., species typically found in undisturbed native wetland plant communities) and the number of restricted weeds are measures for plant community health (Ciborowski et al. 2012).

A common approach in reclamation of forested land in Alberta is the application of provincial standards developed to achieve equivalent land capability to support target end land uses, often with a focus on merchantable forest stands (e.g., AENV 2010a; AESRD 2013a). In relation to oil sands mining in northeastern Alberta, Straker and Donald (2011) and Hawkes (2011) have suggested that current reclamation standards might not be suitable where there is a broader set of management objectives such as maintenance of biodiversity, creating functional forest ecosystems, or restoration of species-specific wildlife habitat.

The Reclamation Assessment Criteria for Pipelines (AENV 2001) recommends that equivalent land capability should account for natural variability, which considers the range of landscape attributes that are encountered and influenced by slope, drainage, coarse fragments, vegetation growth and composition, and soil colour, texture, and aggregate strength and size.

The Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (AESRD 2013a) provides reclamation criteria that apply to well site leases and access roads, and associated facilities such as pits, campsites and offsite sumps. Criteria are provided to determine whether a reclaimed site meets equivalent land capability, based on function and operability of the land to support the production of goods and services consistent in quality and quantity with the surrounding landscape. A minimum 25% cover of herbaceous and woody species is recommended for naturally regenerating and planted sites in forested lands. The document suggests that ecosystem function can be determined when natural processes are evident, such as proper drainage, moisture retention and cycling, soil and site stability, and nutrient cycling (i.e., litter formation). Recommendations for assessing reclamation success are provided for various factors such as drainage, erosion, soil stability, woody debris, plant community composition and cover, litter and organic horizon development, and soil characteristics.

The Alberta Regeneration Standards for the Mineable Oil Sands (AESRD 2013b) are similarly applicable to reforestation of oil sands mines. The standards outline protocols for establishment and performance surveys to determine reforestation establishment and continued growth, where commercial forestry is the end land use. Seedling planting or target densities are not specified. The standard does, however, provide guidance on determining poorly revegetated areas based on the size (≥ 0.5 ha) and proportion (≥ 25%) of trees affected by mortality, foliage loss/discolouration, missing or low density, physical damage, or poor form or vigour.

In response to the lack of clarity around habitat restoration objectives, treatment quality, monitoring, and establishment targets, the Government of Alberta released in 2017 the *Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta* (Government of Alberta 2017a). The framework outlines requirements for government-led restoration programs on legacy linear features and provides recommendations for voluntary based industry-led programs to move toward a common restoration objective. Indicators of restoration success are established within the framework to determine whether habitat is on a trajectory to become effective habitat. These indicators include:

- Restoration programs and locations have been selected based on relevance to woodland caribou and contribute to efforts to restore large tracts of woodland caribou habitat
- Where advanced regeneration is not evident, treatments have addressed site limiting factors and have established appropriate tree species and stem densities based on the adjacent habitat
- Where advanced regeneration is already present and to the degree feasible, this advanced regeneration has been protected
- The treatments limit human and predator movement on the landscape (Government of Alberta 2017a)

Habitat restoration planning steps are outlined including site selection, treatment delivery and quality control, survival assessment (years 2–5) and establishment survey (years 8–10). Establishment monitoring targets are provided with consideration for upland and transitional sites versus lowland treed sites, and in consideration of treated areas versus an advanced regeneration site. Regenerating trees must have reached a minimum height target by years 8–10 to count toward the stocking objective. Data management for provincial programs is also outlined as well as a commitment to adaptive management.

10.6 VEGETATION REESTABLISHMENT

Restoration of disturbed habitat has become one of the key components for caribou conservation identified through the proposed amended federal Recovery Strategy (ECCC 2019) and in provincial boreal caribou recovery planning (Alberta Woodland Caribou Recovery Team 2005; Government of Alberta 2011; Government of Alberta 2016). This section summarizes information from habitat restoration guidelines and frameworks, previous caribou habitat restoration initiatives, and published research. Information on restoration methods employed and effectiveness or success of restoration is included.

10.6.1 Tree Planting and Natural Regeneration

Research has shown positive results for establishing native vegetation on seismic lines and other linear features using techniques such as planting tree and shrub seedlings, and site preparation to create microsite conditions that are conducive to both planted seedling growth and natural vegetation encroachment (CRRP 2007a; Fuse Consulting 2014; Golder 2015c; Golder and CNRL 2016; Cody 2017; Peters 2017; COSIA 2019). Measures such as the use of coarse woody debris can address site condition issues, including competition from non-target or undesired plant species, erosion, frost, and heat or moisture deficiencies (CRRP 2007a; Pyper and Vinge 2012; Vinge and Pyper 2012). These methods are consistent with the approach adopted by NGTL in previous caribou habitat restoration initiatives.

Golder (2015c) monitored the growth of planted and natural ingress seedlings on upland and lowland seismic lines in the Little Smoky caribou range. Mounding with black spruce seedlings planted was the primary site preparation method applied. Planted black spruce on treated sites were significantly taller and had significantly greater leader growth than ingress spruce. Black spruce on treated lowland sites were significantly taller and had significantly greater leader growth than those on upland sites. Overall, lowland sites had taller seedlings, with planted seedlings taller than ingress seedlings. Treatment age, shrub cover, and depth to water did not have a significant effect on the height of planted and natural ingress black spruce seedlings. Mounding and planting of black spruce on wetter sites accelerated recovery time of vegetation to a height of 1.4 m by a minimum of 4 to 5 years compared to natural ingress on treated lines, and by 10 years compared to natural recovery on untreated lines. Use of site preparation in lowland sites followed by seedling planting decreased the time for seedling establishment to reach 1.5 m in height by 5 years when compared to natural ingress (Golder 2015c).

Natural revegetation and successful planting initiatives benefit from construction practices that minimize disturbance during development of the footprint. Minimum disturbance pipeline construction techniques that avoid grubbing and grading are effective at facilitating rapid regeneration of native vegetation in the ROW, particularly in areas with a deciduous vegetation component (TERA 2011a, b, 2012). Implementation of minimum disturbance construction can be limited by such factors as terrain that requires grading, ground conditions (e.g., non-frozen soils) and construction methods (e.g., crossings of third-party dispositions).

A trial natural revegetation response inventory program in west–central Alberta reported that 85% of disturbed sites did not require artificial recovery because a natural recovery projection was observed on previously disturbed sites (CRRP 2007b). Similarly, a study on the natural vegetation recovery of Low Impact Seismic (LIS) lines was noted to mirror general recovery patterns reported for conventional lines whereby upland and deciduous forest types had taller and greater recovery of woody biomass compared to lowland and wetland forest types (Golder and Explor 2016). Controlling for forest type, LIS lines typically supported shrubs > 0.8 m high within 10 years. For mulched LIS lines between 1–10 years old, recovery of shrub cover was prevalent and shrub height was greater than the 0.5 m tall (Golder and Explor 2016); landscape-level recovery of shrubs and small conifers that exceed 0.5 m height has been shown to mediate the effects of wolf movement along linear features (Dickie et al. 2017). In the LIS trial study over half of sampled LIS lines in lowland ecosites supported black spruce seedlings. Many lowland lines supported seedlings > 0.5 m tall immediately after they were mulched (i.e., 1 year after being mulched). These results confirm that by mulching, line preparation is preventing the ground disturbance impacts from conventional disturbance methods (Golder and Explor 2016). Line orientation, mulch distribution pattern, and ecosite type had a significant effect on the average height of vegetation regenerating on LIS lines. Vegetation height was significantly greater on lines with a north-south orientation compared to lines with an east-west orientation. Compared to lines with a continuous mulch distribution, lines with scattered mulch or no mulch supported significantly higher vegetation. Lines that occur in wetlands, lowlands, and upland coniferous ecosites had significantly shorter vegetation compared to lines occurring in deciduous uplands (Golder and Explor 2016).

Although regenerating conifers provide a better visual barrier, the faster growth rates of deciduous species provide for effective results more quickly (Diversified Environmental Services 2004). Research suggests that planting shrubs along with trees allows trees to grow healthier, faster, and with less competition for nutrients and water from fast-growing grasses (COSIA 2019). It might also provide important habitat benefits for wildlife, compared with only planting tree seedlings, by providing hiding cover (Bayne et al. 2011). However, within caribou range, the benefits of using deciduous species are outweighed by the predator risk to caribou created by planting species that are attractive browse for moose and deer.

Conventional seismic lines have been reported to have very slow reforestation rates (Revel et al. 1984; Osko and MacFarlane 2000), and recovery is strongly influenced by the characteristics of the adjacent forests (e.g., site productivity, tree and shrub species and heights) (Bayne et al. 2011). Conventional seismic lines cleared by bulldozer have been reported to take as long as 112 years to reach 95% recovery to woody vegetation in the absence of restoration efforts (Lee and Boutin 2006). Slow tree regeneration has been attributed to root damage from the original disturbance, compaction of the soil in tire ruts, insufficient light reaching the forest floor, maintenance of apical dominance from surrounding stands, introduction of competitive species (i.e., planted seed mixes), site drainage (i.e., regeneration slowest on poorly drained sites with low nutrient availability such as bogs), and repeated disturbances (e.g., all-terrain vehicles [ATVs], animal browsing, repeated exploration) on seismic lines (Revel et al. 1984; MacFarlane 1999, 2003; Sherrington 2003; Lee and Boutin 2006).

Van Rensen (2014) and van Rensen et al. (2015) explored the conditions that result in natural vegetation regeneration on linear disturbances. Data suggest that for linear disturbances where natural regeneration has occurred within boreal ecosystems, mesic sites are the most likely to regenerate naturally without restoration treatments implemented (all things being equal); linear disturbances on bogs or fens is least likely to regenerate naturally. Natural regeneration to 3 m vegetation height within 30 years is inversely related to terrain wetness, line width, proximity to roads as a proxy for human use of lines, and lowland ecosites such as fens and bogs (van Rensen 2014). Areas adjacent to major rivers illustrate high probability of regeneration. Overall, terrain wetness and the presence of fens have the strongest negative effect on natural regeneration. Passive restoration was defined as leaving a treatment candidate site to vegetate naturally to 3 m vegetation height within 30 years without implementing revegetation techniques such as planting seedlings or using a seed product (van Rensen et al. 2015).

As tree regeneration on seismic lines is a key determinant of caribou recovery success (MacFarlane 2003), factors that hinder revegetation efforts should be mitigated. Although seismic lines and pipeline ROWs are both linear disturbances, drawing parallels between regeneration success on these different features should be done with caution. Restoration issues on seismic lines might not be comparable to pipeline ROWs, given differences in disturbance mechanisms, degree of soil and vegetation disturbance, reclamation practices, and width of the features (i.e., the wider openings of ROWs allow more light and insolation than narrow seismic lines, which might facilitate better vegetation regrowth).

Evidence presented at the 15th North American Caribou Workshop demonstrated that winter tree planting and mechanical bending/felling live trees into a linear disturbance are emerging mitigation options that are being implemented in caribou habitat restoration programs (NACW 2014; Bentham and Coupal 2015a; Golder and CNRL 2016). More recently, tree-bending is also being piloted in the Parker caribou range in northeast BC (Golder 2015d; 2016). Tree bending/felling might be particularly promising as it promotes natural revegetation by increasing cone deposition onto the disturbance footprint and creating microsites through shading and dropped dead woody debris (Cody et al. 2016). Note that these treatments have been applied on seismic lines that are substantially narrower than pipeline ROWs and do not require continued operational activities, as do pipelines. Bentham and Coupal (2015a, 2015b, 2016) explore the lessons learned from habitat restoration programs implemented on pipeline and other ROW projects as a comparison to historical seismic line recovery.

10.6.2 Transplanting and Seeding

Transplanting native vegetation appears to be difficult to implement on a large scale as part of a habitat restoration program for the following reasons (Golder 2012a):

- Inconsistent availability of vegetation suitable for transplant
- Potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands
- Transplanting programs often result in the storage of plant materials under less than ideal conditions due to uncontrollable factors (i.e., weather)
- Other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison

An alternative to salvage and transplanting vegetation is to seed disturbed areas using seed collected from the same geographic region as the restoration project. Broadcasting seed either aerially or using ground methods (by hand or mechanically) is also an option. However, because pipeline ROWs are relatively narrow openings (compared with cutblocks, for example), sufficient natural seed ingress from the adjacent undisturbed habitat can facilitate natural recovery without additional seed application. Logistically, the feasibility of seeding can be constrained where the reclamation project is a substantial distance from an airport or airfield (i.e., for aerial seeding), or where ground access during non-frozen conditions is restricted by wet soils. Furthermore, direct seeding of conifers is not a preferred reforestation technique, partly due to problems with seed predation (BC MOF 1997).

10.7 EFFECTS OF HUMAN USE ON RESTORATION

The ability of linear features to recover to a natural forested state is affected considerably by human use. Recovery of conventional seismic lines to functioning mountain caribou habitat was identified to occur within 20 years following disturbance in west–central Alberta (Oberg 2001).

Seismic lines in the Little Smoky caribou range that were allowed to revegetate naturally reportedly achieved an average height of 2 m across all ecosite types within 20 to 25 years when they had not been recently disturbed by human activity (e.g., re-cleared to ground level for winter access or seismic program use [Golder 2009]). The average age of trees on the control lines (disturbed sites, cleared areas with minimal vertical cover of vegetation and vegetation regrowth of 0.5 m or less) was only 10 years, suggesting that sites which are continually disturbed or re-cleared by human activity take longer to regenerate.

Restoration efforts have also failed when ATVs destroyed seedlings after planting (Enbridge 2010; Golder 2011, 2012b). Evidence of the effects of repeated motorized access on vegetation establishment and regrowth supports the use of access management tools to enhance restoration success (Golder 2015d).

Subjective expert ratings suggest that the effectiveness of most physical access management measures (e.g., berms, excavations, rollback, visual screening) varies considerably between negligible and high effectiveness in managing human access (Golder 2007). Effectiveness of access management measures likely depends on suitable placement (e.g., placed to prevent detouring around an access management point), enforcement, and public education of the intent of the access management (AXYS Environmental Consulting Ltd. 1995). Public education (e.g., signs) can facilitate respect for the purpose of, and compliance with, access management measures, although tangentially there has been evidence of signs being vandalized or outright removed in areas where caribou habitat restoration measures have been implemented.

Mounding has been found to discourage human access (i.e., truck and ATV) during snow-free periods; mounds also create microsites that improve vegetation establishment (reviewed in Golder 2007; Golder 2017a). Excavator mounding is a well-researched and popular site preparation technique in the silviculture industry (Macadam and Bedford 1998; Roy et al. 1999; MacIsaac et al. 2004). Target density of mounding for access management and/or microsite creation purposes can vary from 1,400 to 2,000 mounds/ha (AENV 2010a; Golder 2012a; Golder 2015a and 2015d). However, these mound densities relate to restoring seismic lines that were not frozen-in to allow heavy equipment access. Given the challenges of the wet conditions and frost requirements for accessing the project footprint (i.e., freezing-in the peat for access can make it difficult to excavate small mounds), the size of mounds could potentially be substantially larger than mounds achieved on previous seismic line restoration projects (e.g., Golder 2017b). Furthermore, mounds cannot be excavated within 5 m of the operating pipeline, which reduces the mound density relative to disturbances that do not have similar restrictions (Bentham and Coupal 2014). As a result, the mound density that can realistically be achieved in a pipeline ROW is likely lower.

Human access on open and closed (i.e., gated, barriered, and recontoured) roads was monitored using remote cameras (Switalski and Nelson 2011). That study found that the frequency of detection of humans on closed roads was significantly lower than on open roads, but not significantly different among road closure types. The monitoring results also indicated significantly higher levels of hiding cover and lower line of sight distances on barriered and recontoured roads compared with open roads (Switalski and Nelson 2011). A similar study investigated the effectiveness of different approaches (i.e., year-round closure, seasonal closure, deactivation, and deactivation and closure) at limiting motorized vehicle traffic on unpaved roads designed to support forestry operations (i.e., resource roads) (Hunt and Hupf 2014).

Results demonstrated that closure or deactivation approaches significantly reduced traffic on resource roads (about 78%), with year-round closure being the least effective while seasonal (i.e., hunting) closure was among the most effective approach (Hunt and Hupf 2014). The effectiveness of different approaches did not depend on road quality (Hunt and Hupf 2014). Physical access management measures provide short-term solutions to manage access and allow for natural regeneration (Golder 2009). Once linear features have regenerated to a pole sapling or young forest structural stage, they no longer facilitate ATV access (Sherrington 2003).

The techniques described above to block human access also contribute to achieving enough revegetation to block line of sight. Short term management for access and line of sight blocking should ultimately lead to long term access management by way of revegetation of disturbed areas (Golder 2007).

Expediting growth of visual barriers along linear features can be achieved by concentrating restoration efforts on productive upland habitats, because woody vegetation species grow more quickly on these sites compared with lowland sites. Although regeneration of conifer species provides the best year-round visual barrier, their growth can be slow. Using combined plantings of conifer and fast-growing deciduous woody species in small areas (e.g., narrow strips of plantings across the ROW) can establish visual barriers in the short to medium term, while maintaining the objective of regenerating conifer leading vegetation in the long term.

Coarse woody material (rollback) can be effective at managing human access and conserving soil moisture, moderating soil temperature, providing nutrients as debris decomposes, limiting soil erosion, providing microsites for seed germination, and protecting introduced tree seedlings (Pyper and Vinge 2012; Vinge and Pyper 2012). Rollback is effective immediately following implementation, provided adequate material is available and properly applied. Debris should be spread evenly across the entire footprint width at a coverage/density that will not restrict the ability to plant seedlings or limit planted or natural seedling growth. Where sufficient material is available, the suggested woody debris coverage at selected locations is 60–100 m^3/ha on upland sites and 25–50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012). Where sufficient material is available, woody debris coverage of 150–200 m^3/ha along ROWs can be used to manage human and wildlife access (Vinge and Pyper 2012). The storage and placement of woody debris must consider reducing ladder fuels to reduce fire hazard (Pyper and Vinge 2012). Short segments (i.e., < 100 m) of rollback might be less effective at deterring human access because ATV and snowmobile riders might try to ride through the debris or traverse around it in adjacent forest stands (Vinge and Pyper 2012). Complete rollback (i.e., over an entire linear disturbance) could be used to prevent motorized access (Pyper and Vinge 2012), however, availability of material may be a limiting factor. The Integrated Standards and Guidelines for the Enhanced Approval Process recommend a 25 m rollback-free fuel break be placed every 250 m along segments of rollback (AER 2013).

10.8 WILDLIFE USE OF REGENERATING LINEAR DISTURBANCE

Increasing research effort has been placed on assessing how wildlife use, particularly travel by predators, is influenced by regenerating seismic lines (e.g., Bayne et al. 2011; Finnegan et al. 2014; Dickie 2015; Dickie et al. 2017) and treated restoration areas (e.g., Hawkes 2011; Cody 2017; Peters 2017).

A pilot study in the Little Smoky caribou range measured effects of revegetating linear disturbances on wildlife use and mobility (Golder 2009). Data were collected for a group of predators (i.e., cougar, wolf, coyote, lynx, grizzly and black bears) and prey (i.e., moose, deer, caribou). Results of the pilot study indicated that revegetated seismic lines (i.e., minimum 1.5 m vegetation regrowth) were preferred by both predator and prey species compared with control lines (i.e., vegetation regrowth of 0.5 m or less), and control lines were used primarily for travel (i.e., both predators and prey species were constantly moving as opposed to standing or foraging). In addition, human use was almost exclusively limited to the control lines. The line of sight measured on the revegetating lines was typically less than 50 m long. It was suggested that moose and deer might have been attracted to the revegetated lines for forage availability and perceived cover protection (Golder 2009). The preference for regenerating seismic lines by wolves can be explained as a response to increased prey use of these lines (Golder 2009). The study also showed that caribou travelled more quickly (running more frequently) and did not engage in standing-related behaviour on control lines, whereas on revegetating lines, running was rare and standing-related behaviour occurred more often.

Vegetation height has been shown to be a significant factor in influencing wolf selection of linear disturbance features (Dickie 2015; Dickie et al. 2017). Dickie et al. (2017) demonstrated that small increases in vegetation height, cover, and roughness slows wolf travel. For example, wolves travelled 1.5 to 1.7 km/hr slower when the average Least Cost Path (LCP) vegetation height was > 0.5 m tall compared to < 0.50 m. Further, wolf movement rates were slowed to that of rates in forested habitats when at least 30% of a linear feature had vegetation exceeding 4.1 m.

Similar results were reported by Finnegan et al. (2014) with movement rates of both wolves and grizzly bears decreasing by up to 70% on historical seismic lines where vegetation heights exceeded 1.4 m. Human use of seismic lines was also affected by vegetation height, which declined markedly once vegetation height exceeded 2.0 m (Finnegan et al. 2014). Finnegan et al. (2014) classified seismic lines with vegetation heights less than 1.4 m as high human/predator use, vegetation heights between 1.4 m and 2 m as moderate human/predator use, and seismic lines with vegetation height greater than 2 m as low human/predator use. When LiDAR measurements of vegetation regeneration on seismic lines was linked to GPS telemetry data, the relationship between vegetation height and the use of seismic lines by grizzly bear, wolf, and caribou within five caribou ranges was investigated. Over 55,300 km (77%) of seismic lines established before 1995 have a current average vegetation height of less than 1.5 m. Animal response to seismic lines varied seasonally and was related to regeneration stage. Results suggest that bear use of seismic lines is primarily governed by access to food while wolves and caribou may use seismic lines for travel.

Finnegan et al. (2016) described a planning tool to prioritize lines for restoration based on the probability of overlap between caribou and predators. This research is the first to prioritize habitat restoration for caribou based on connecting animal response to regeneration and yields important tools towards initiating restoration of caribou habitat across the boreal forest. MacDonald et al. (2020) suggest that prioritizing restoration of pipelines in mixedwood ecosites in caribou range may be more beneficial to caribou with respect to reducing predator movement.

Another project in northern Alberta involving the Cold Lake caribou herd (Multi-Scale Responses by Predators and Prey to Deactivation/Restoration of Habitat Disturbance Features: Individual and Population Components [McNay et al. 2014]) is investigating the responses of predator and prey species to the deactivation or restoration of habitat disturbance features. The goal of the project is to determine how different species (wolves, bears, moose and caribou) use the landscape, and how the presence or absence of linear disturbances might influence the functional and numerical response of predators (McNay et al. 2014). Preliminary results suggest that among the four species seasonal and annual movements are variable, with substantial overlap between the range extents of all four species. Additionally, in these range overlaps, were 19 instances where predator and prey could have encountered one another. Preliminary results present 11 deaths of 94 collared animals: two caribou, three moose, one bear and five wolves. Predator kill sites identified included 143 bear sites and 93 wolf sites. These kill sites were implicated in the deaths of 11 caribou, 22 moose and six deer. Ongoing data collection and processing will provide future results from scat analysis, prey body condition, and habitat modelling and mapping.

The Multi-Scale Responses project aims to address several management questions regarding: 1) the desired vegetative and spatial characteristics on the landscape to reduce caribou mortality, 2) how silvicultural techniques and habitat restoration measures can be implemented to achieve these characteristics, 3) the association between specific characteristics and predator efficiency and/or density, and 4) when can deactivated linear features be considered to have lost their disturbance function (McNay et al. 2014). This project is associated with the RICC initiative.

Mechanically bending or felling live trees over a linear disturbance (often referred to as line blocking, particularly when used in conjunction with other treatments such as mounding) is another potential measure that might have benefits for managing access and reducing wolf use (e.g., Golder and CNRL 2016; Cody 2017). Trees are typically bent or felled from both sides of the linear disturbance. Tree felling entails cutting trees at the base from the edge of the linear disturbance and allowing them to fall across the linear disturbance.

Tree bending requires mechanical bending from the base of the tree, and partially exposing the roots, so that the tree leans over the linear feature, close to the ground. Tree bending can be expensive, and the process is time consuming. A preliminary assessment of tree felling along seismic lines to block access was completed in the Little Smoky caribou range in Alberta during summer and fall 2004 (Neufeld 2006). While results of that study showed no statistical significance between wolf use of blocked versus non-blocked seismic lines, there was an indication that wolves tended to use areas with unblocked seismic lines more often than areas with blocked seismic lines (Neufeld 2006).

Based on these results, it was concluded that if tree felling is to be used as a line blocking measure, it should be investigated more thoroughly, and not relied on solely as a mitigation tool (Neufeld 2006). Preferably, line blocking should be used with other management actions such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. As previously described, tree felling, or bending is often completed in conjunction with other measures, such as mounding, spreading coarse woody debris, or seedling planting to achieve line-blocking. As presented at the 15th North American Caribou Workshop, preliminary results of linear feature blocking programs suggest that this type of mitigation can be effective in reducing wildlife use of linear features (Cody et al. 2016; Donnelly et al. 2016).

10.9 KNOWLEDGE GAPS AND LIMITATIONS OF THE LITERATURE REVIEW

The literature review included in this CHRP provided the opportunity to identify the following knowledge gaps:

- Restoration criteria (e.g., defined guidelines or quantifiable objectives) for restoration of boreal ecosystems for wildlife habitat values, in particular habitats that do not support merchantable timber (e.g., treed bogs and fens), are lacking.
- Although research programs have begun to understand the functional responses of caribou, wolves, and primary prey (e.g., moose, deer) to restoration treatments, understanding movements and habitat use of reclaimed habitats in various stages of successional progression, as well as to access and line-of-sight management, continues to be a knowledge gap.
- Long-term monitoring of vegetation recovery on linear disturbances and of predator response to access management measures is increasing, but certainty of outcomes in terms of caribou population recovery is low to moderate.

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Appendix A

Glossary of Terms

CURRENT TERMS (2020)

Term	Definition*
CHRP	Caribou Habitat Restoration Plan – a CHRP addresses on-site habitat restoration of a project's footprint as it pertains to caribou habitat.
CHR&OMP	Caribou Habitat Restoration Plan & Offset Measures Plan – a plan that is comprised of a *CHRP* and an *OMP*.
CHROMP	Alternate acronym for *CHR&OMP*.
CHROMMP	Caribou Habitat Restoration and Offset Measures Monitoring Program – a CHROMMP is complimentary to a *CHRP* and *OMP*; it is the program through which the effectiveness and accountability of habitat restoration and offsetting measures are monitored for performance with respect to specific targets and the overall goal(s) of the *CHRP* and *OMP*.
Delivery Risk Multiplier	An offset multiplier that pertains to the challenges and uncertainty of a habitat restoration measure and its implementation technique, and whether it can be effective or achievable; applied in the calculation of the *Initial Offset Value* and the *Final Offset Value*.
Direct Project Effect	The area of the project footprint within caribou habitat, less areas that will not be directly disturbed (e.g., horizontal directional drill sections), and areas that overlap non-vegetated anthropogenic disturbances (e.g., sections that intersect existing roads). Direct Project Effect is a component in the quantification of the *Residual Project Effect*. Same as the retired terms *Direct Disturbance, Direct Disturbance (Before Restoration), Incremental Disturbance*, and *Incremental Direct Disturbance (Before Restoration)*.
Disturbance	As defined in a federal recovery strategy for woodland caribou (i.e., Boreal Population; Southern Mountain Population).
Inherent Effect Multiplier	A discount factor that allows for a potential project effect (and the resulting offset value) to account for similar existing effects. Can potentially incentivize developers to use existing disturbance to the extent possible, and fully restore the full width of existing linear features. Applies only to linear projects (e.g., right-of-way). Applied in the calculation of the *Initial Offset Value* and the *Final Offset Value*.
Initial Offset Value (IOV)	Determination of the IOV is the first stage in the calculation of a caribou habitat offset; based on the planned project footprint and the areas and measures planned for on-site (on-right-of-way) habitat restoration. An 'Updated IOV' is used once the as-built footprint is known and planned on-site habitat restoration

	measures have been implemented. The IOV accounts for delivery, temporal, and spatial risks, and inherent effects associated with linear features.
Final Offset Value (FOV)	Final stage in the calculation of a caribou habitat offset; based on the as-built project footprint and actual areas and measures used for on-site (on-right-of-way) habitat restoration (i.e., the 'Updated *Initial Offset Value*'), and on the selection of offset locations and measures. The FOV accounts for delivery, temporal, and spatial risks, and inherent effects associated with linear features.
Offset	A means for compensating for the *Residual Project Effect* (i.e., direct and indirect effects) that cannot be restored on-site (e.g., the unrestored portions of the project footprint) with the goal of no net loss of caribou habitat.
Offset Ratio	*Final Offset Value* divided by *Residual Project Effect*.
OMP	Offset Measures Plan – An OMP describes the methods and steps for calculating the *Initial Offset Value* and the *Final Offset Value* and provides decision frameworks for selecting an appropriate offset(s).
Planned (or Implemented) Restored Footprint	The area of the project footprint that is planned for restoration (e.g., temporary workspace) or the area of the project footprint on which habitat restoration has been implemented. Planned (or Implemented) Restored Footprint is a component in the quantification of the *Residual Project Effect*. Same as the retired term *Restored Footprint*.
Residual Direct Disturbance Value (RDDV)	The areas classed as new cut or contiguous alignment, accounting for the inherent effect of contiguous alignment; (calculated as the *Direct Project Effect* times the *Inherent Effect Multiplier*). In the case of a non-linear project, RDDV is the total area classed as planned (or implemented) habitat restoration or unrestored. RDDV is a component in the formula to calculate the *Initial Offset Value*.
Residual Direct Project Effect	*Direct Project Effect* minus the *Planned (or Implemented) Restored Footprint*; that is, the unrestored area of the project footprint (e.g., operational right-of-way). Residual Direct Project Effect is a component in the quantification of the *Residual Project Effect*. Same as the retired term *Remaining Direct Disturbance (Operational Access Corridor)*.
Residual Indirect Disturbance Value (RIDV)	The area represented by a 500-m permanent disturbance buffer applied to the unrestored project footprint (e.g., operational right-of-way), less areas of existing direct or indirect permanent anthropogenic disturbance. RIDV is a component in the formula to calculate the *Initial Offset Value*.
Residual Indirect Project Effect	The area represented by a 500-m permanent disturbance buffer applied to the unrestored project footprint (e.g., operational right-of-way), less areas of existing

	direct or indirect permanent anthropogenic disturbance. Residual Indirect Project Effect is a component in the quantification of the *Residual Project Effect*. Same as the retired terms *Remaining Indirect Disturbance* and *Incremental Indirect Disturbance*.
Residual Post-Restoration Value (RPRV)	The residual effect that remains after on-site restoration has been implemented. The RPRV accounts for applicable temporal risk and delivery risk associated with the on-site restoration measures used and is a component in the formula used to calculate the *Initial Offset Value*.
Residual Project Effect	The Residual Project Effect is the sum of the *Residual Direct Project Effect* and the *Residual Indirect Project Effect*. Same as the retired term *Total Remaining Disturbance*.
Spatial Risk Multiplier	An offset multiplier that pertains to the spatial relevance of the habitat restoration measure in relation to caribou habitat affected; applied in the calculation of the *Initial Offset Value* and the *Final Offset Value*.
Temporal Risk Multiplier	An offset multiplier that pertains to when each habitat restoration measure would be expected to be achieved, accounting for the time (in years) between when the effect commences (i.e., vegetation is cleared) and when restored habitat becomes ecological or functionally suitable for caribou and/or not suitable for wolves and alternate prey; applied in the calculation of the *Initial Offset Value* and the *Final Offset Value*.
Unrestored Existing Maintained Disturbance	Area of the project footprint that is disturbed at baseline (e.g., an existing disposition) and will not be restored following project construction.

* Italicized terms are defined separately in this glossary

RETIRED TERMS*

Term	**Definition****
Direct Disturbance	Same as ***Direct Project Effect****, Direct Disturbance (Before Restoration)*, *Incremental Direct Disturbance*, and *Incremental Direct Disturbance (Before Restoration)*.
Direct Disturbance (Before Restoration)	Same as ***Direct Project Effect****, Direct Disturbance, Incremental Disturbance*, and *Incremental Direct Disturbance (Before Restoration)*.
Incremental Direct Disturbance	Same as ***Direct Project Effect****, Direct Disturbance, Direct Disturbance (Before Restoration)*, and *Incremental Direct Disturbance (Before Restoration)*.
Incremental Direct Disturbance (Before Restoration)	Same as ***Direct Project Effect****, Direct Disturbance, Direct Disturbance (Before Restoration)*, and *Incremental Direct Disturbance*.

Incremental Indirect Disturbance	Same as ***Residual Indirect Project Effect*** and *Remaining Indirect Disturbance*.
Incremental Project Disturbance	Collective term for *Incremental Direct Disturbance* and *Incremental Indirect Disturbance*. Equivalent to *Total Habitat Disturbance*.
Remaining Direct Disturbance (Operational Access Corridor)	Same as ***Residual Direct Project Effect***.
Remaining Indirect Disturbance	Same as ***Residual Indirect Project Effect*** and *Incremental Indirect Disturbance.*
Restored Footprint	Same as ***Planned Restored Footprint***.
Total Habitat Disturbance	Equivalent to *Incremental Project Disturbance*.
Total Remaining Disturbance	Sum of *Remaining Direct Disturbance* and *Remaining Indirect Disturbance*. Same as ***Residual Project Effect***.

* Used in some NGTL caribou plans up to the end of 2019

** Italicized terms are defined separately in this glossary; boldface italicized terms are the current terms

Appendix B

Habitat Restoration Measures Toolkit

Habitat Restoration/Offset Measure	Expected Effectiveness
Discrete Barriers (fences/berms)	There is little information on the effectiveness of discrete barriers in the literature, but they are considered to have value in terms of limiting line-of-sight and reducing human, and possibly predator, access. Based on standard operating practices and examples from use on other linear projects, berms should be at least 1.5 m tall, and fences 2-3 m tall, to be considered effective: • BC MOE (2011) • Golder (2015a) • NGTL (2015) The delivery risk multiplier developed by Northern Resource Analysts (2016) is directly linked to effectiveness of the offset measure. For ‘Discrete Barriers (fences/berms)’, the delivery risk multiplier ranges from 2.0 to 2.5, depending on whether a low or high intensity application is used. The expected effectiveness of this offset measure is considered low to moderate relative to other offset measures.
Barrier Segments (rollback/mounding) * variations of mounding include bar mounding (soil piles are created in rows perpendicular to lines) and angle slicing (an angled ditch and mound along a line) (Pyper et al. 2014)	Compared to discrete barriers, there is better information on the effectiveness of barrier segments (rollback/mounding) in the literature. These measures are used primarily to deter human and predator access, but can also serve to limit line-of-sight. Based on standard operating practices and examples from use on other linear projects, barrier segments that use rollback should be implemented at lengths at least 100 m along the ROW, and at a volume between 150-250 m^3/ha to be considered effective. If mounding is used, mounds should be applied at 600-1,200 mounds/ha with a depth of 0.75 cm to be considered effective. The effectiveness of barrier segments (rollback/mounding) is supported by: • AER (2013) • Bentham and Coupal (2014) • CLMA and FPAC (2007) • Dickie et al. (2016) • EOS (2009) • Golder (2012) • Golder (2015a) • NACW (2014) • Pyper et al. (2014) The delivery risk multiplier developed by Northern Resource Analysts (2016) is directly linked to effectiveness of the offset measure. For ‘Barrier Segments (rollback/mounding)’, the delivery risk multiplier ranges from 1.5 to 2.5, depending on whether a low or high intensity application is used, or how long the application segment is. The expected effectiveness of this offset measure is considered low to high relative to other offset measures, depending on intensity of application.

Habitat Restoration/Offset Measure	Expected Effectiveness
Barrier Segments (tree bending, hinging, or felling)	Barrier segments (tree-bending, hinging, or felling) can be used to achieve functional and ecological restoration objectives. For barrier segments (tree-bending, hinging, or felling) to be effective at the landscape scale, it is typically applied to several kilometers, either continuously along a single line, or to multiple lines that form a linear network, with the goal of restoring landscape connectivity. Finding linear features to apply barrier segments (tree-bending, hinging, or felling) to can be challenging, especially when the offset proponent has no land tenure or when long-term securement is needed, has been shown to be challenging (Northern Resource Analysts 2016). In British Columbia however, a preliminary analysis of potential seismic lines that may be eligible for restoration (pending site-specific review and Aboriginal consultation) have been identified for the South Peace Northern Caribou herd ranges, including the Graham LPU (Government of British Columbia 2018). The largest linear feature removal program currently underway is the Cenovus Linear Deactivation program in Alberta (Pyper et al. 2014). The program includes two study sites within the range of the Cold Lake caribou herd range; the program aims to treat 250 km of seismic lines. The deactivation treatments include combinations of mounding, tree planting, woody material recruitment (through tree felling, tree bending, and rollback of existing material), fill planting, and natural revegetation. A similar, but much smaller (4.75 km), linear deactivation program was implemented by Canadian Natural Resources Ltd. for the Kirby In Situ Oil Sands Expansion Project in the East Side Athabasca River caribou herd range (Pyper et al. 2014). The deactivation treatment applied was primarily tree felling to deter access and reduce line-of-sight; tree-hinging, which places the fallen log on top of an elevated stump, was also applied. Tree-bending or felling is also being piloted in the Parker caribou range of the Boreal Caribou population (Golder 2015b). The expected effectiveness of this offset measure is dependent on the combination of above-mentioned measures used. However, tree-bending, hinging, or felling applied in segments of at least 200 m is considered relatively effective at blocking access, limiting line of site, and fostering natural or planting vegetation regrowth. The effectiveness of barrier segments (tree-bending, hinging, or felling) is supported by: • Dickie et al. (2016) • Government of British Columbia (2018) • Golder (2015b) • Pyper et al. (2014) A delivery risk multiplier for barrier segments (tree-bending, hinging, or felling) was not developed by Northern Resource Analysts (2016). However, through extrapolation, a review of current information on the success of the method, and when applied with other restoration techniques (e.g., tree planting between segments), it is expected to have moderate effectiveness in terms of achieving functional and ecological restoration goals. Subsequently, the delivery risk multiplier has been estimated to range from 1.5 to 2.0, depending on whether tree seedlings or natural regeneration are used between segments. The expected effectiveness of this offset measure is considered moderate to high relative to other offset measures and depending on application.

Habitat Restoration/Offset Measure	Expected Effectiveness
Tree Planting for Future Barrier	There is little information in the literature specific to this offset measure. However, the measure is essentially a smaller, more discrete, application of the 'Tree Planting to Accelerate Reforested State' measure (see below). Tree planting, or vegetation screening, is identified as a viable option for managing line-of-sight; in caribou range, coniferous species are considered more effective than deciduous species: • CLMA and FPAC (2007) • Culling et al. (2004) • Pyper et al. (2014) The delivery risk multiplier developed by Northern Resource Analysts (2016) is directly linked to effectiveness of the offset measure. For 'Tree Planting for Future Barrier', the delivery risk multiplier is 1.25. As with 'Tree Planting to Accelerate Reforested State', there is a temporal lag that can delay effectiveness. The temporal delay is based on planting tree seedlings, but the temporal delay could be lessened if older (taller) trees are planted. The expected effectiveness of this offset measure is considered high relative to other offset measures.
Tree Planting to Accelerate Reforested State	By following recommended restoration techniques (e.g., soil handling; site preparation) and replanting standards (e.g., stem density; species composition; spacing) for the ecosystem units being restored, and measuring restoration performance over a period of up to 20 years within the context of an adaptive management framework, the expected effectiveness of this offset measure is considered high. The expected effectiveness is based on the following references: • AENV (2010) • AESRD (2013) • BC MFLNRO (2014) • Brown and Naeth (2014) • Lee and Boutin (2006) • Golder (2012, 2015a) • Osko and Glasgow (2010) • Pyper and Vinge (2012) • Pyper et al. (2014) • Vinge and Pyper (2012) The delivery risk multiplier developed by Northern Resource Analysts (2016) is directly linked to effectiveness of the offset measure. For 'Tree Planting to Accelerate Reforested State', the delivery risk multiplier is 1.25, indicating high effectiveness, or low delivery risk. The expected effectiveness of this offset measure is considered high relative to other offset measures.

Habitat Restoration/Offset Measure	Expected Effectiveness
Seeding and Left for Natural Revegetation Shrub Planting and Left for Natural Revegetation	Seeding or shrub planting have lower value as an offset measure because of long temporal delays and increased delivery risk. The planting of shrubs will be consistent with the BC Forest Practices Code and Riparian Area Restoration Guidelines: • BC FPC (1995) • BC MOF (2002) A delivery risk multiplier for seeding and shrub planting was not developed by Northern Resource Analysts (2016), but reasonable extrapolation can be inferred from delivery risk multipliers applied to other offset measures. For 'Seeding and Left for Natural Revegetation' and 'Shrub Planting and Left for Natural Revegetation', the delivery risk multiplier is 2.5 (i.e., half as effective as 'Tree Planting to Accelerate Reforested State'), based on the expectation that there would be greater competition among plants (primarily from faster-growing deciduous species), lower rate and density of coniferous seedling establishment, and greater seed predation or browsing pressure. The temporal delay to achieve delivery effectiveness is also greater (i.e., 3.3 multiplier) compared to 'Tree Planting to Accelerate Reforested State'. The expected effectiveness of this offset measure is considered moderate relative to other offset measures.
Linear Feature Removal or Deactivation * this measure is comprised of one or more of the above-mentioned habitat restoration measures. It is typically applied to several kilometers of legacy lines (e.g., seismic) that are not currently on a trajectory toward natural recovery.	The purpose of this offset measure is to achieve habitat restoration by removing the function of a linear feature from the landscape such that it prevents motorized access; limits predator movement (primarily wolves) to a rate that is equal to, or lower than, rates observed off linear features; and allows for caribou use. For linear feature removal to be effective at the landscape scale, it is typically applied to several kilometres, either continuously along a single line, or to multiple lines that form a linear network. Finding locations to remove linear features, especially when the offset proponent has no land tenure or when long-term securement is needed, has been shown to be challenging (Northern Resource Analysts 2016). The largest linear feature removal program currently underway is the Cenovus Linear Deactivation program in Alberta (Pyper et al. 2014). The program includes two study sites within the range of the Cold Lake caribou herd range; the program aims to treat 250 km of seismic lines. The deactivation treatments include combinations of mounding, tree planting, woody material recruitment (through tree felling, tree bending, and rollback of existing material), fill planting, and natural revegetation. A similar, but much smaller (4.75 km), linear deactivation program was implemented by Canadian Natural Resources Ltd. for the Kirby In Situ Oil Sands Expansion Project in the East Side Athabasca River caribou herd range (Pyper et al. 2014). The deactivation treatment applied was primarily tree felling to deter access and reduce line-of-sight; tree-hinging, which places the fallen log on top of an elevated stump, was also applied. The expected effectiveness of this offset measure is dependent on the combination of above-mentioned measures used.

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Appendix C

Photoplates

Plate 1: Example of the effectiveness of minimal disturbance construction in forested areas. Photo shows growth after one growing season. Photo source: NGTL.

Plate 2: Example of coarse woody debris rollback for access management on a non-parallel pipeline ROW. The debris also creates microsites to enhance vegetation establishment and growth. Photo source: NGTL.

Plate 3: Example of conifer seedling planting on a pipeline ROW. The upland area has sufficient drainage and suitable soils for seedling establishment and growth. Photo source: CH2M Hill.

Plate 4: Example of access management implemented on a ROW with parallel developments. Note the ATV tracks that divert around the woody debris rollback. Photo source: NGTL.

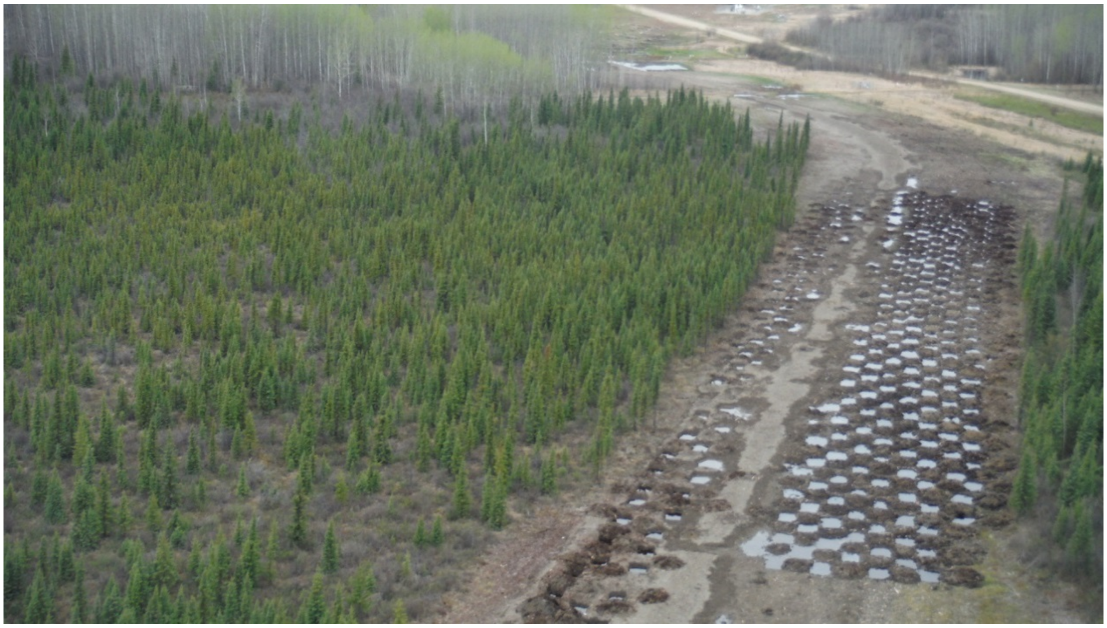


Plate 5: Aerial view of mounding in lowland on a non-parallel portion of the ROW. Photo source: NGTL.

Plate 6: Aerial view of combination rollback and mounding as access management on a non-parallel portion of the ROW. Photo source: NGTL.

Plate 7: Example of a wood berm designed to deter access and reduce line-of-sight. This measure is no longer used due to the risks associated with forest fires. Photo source: NGTL.

Plate 8: Example of a vegetation screen retained along edge of pipeline right-of-way at intersection with an existing linear disturbance. Vegetation screens block line-of-sight and can effectively manage access. Photo source: CH2M Hill.

Plate 9: Example of a ramp-over area where a snow ramp was packed over vegetation in a treed lowland. The resultant vegetation screen will also contribute to natural regeneration. This measure can only be used in seasons with high snowfall. Photo source: CH2M Hill.

Plate 10: Fabricated line-of sight on a ROW paralleled by another ROW and a power line. This measure is not fully effective due to the presence of adjacent developments where no line-of-sight measures are implemented. Photo source: NGTL.

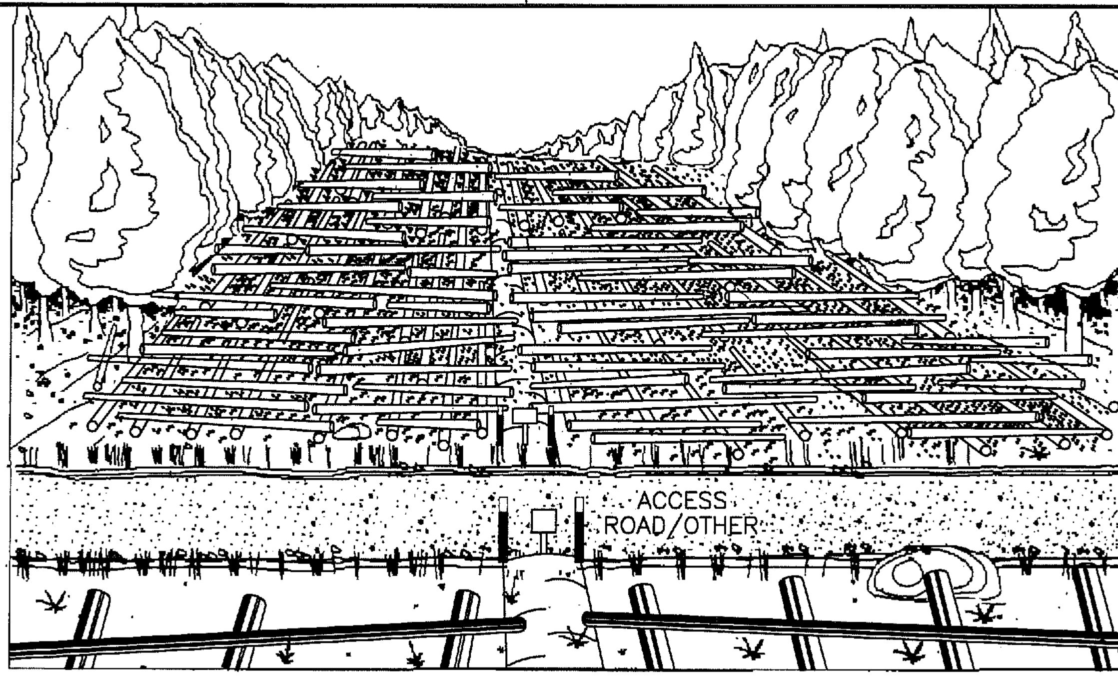
Plate 11: Example of mounding combined with conifer seedling planting on a ROW. The combination of measures is intended to manage access, and facilitate revegetation of conifers. Photo source: NGTL.

Plate 12: Example of shrub staking in the riparian area at a watercourse crossing. Photo source: NGTL.

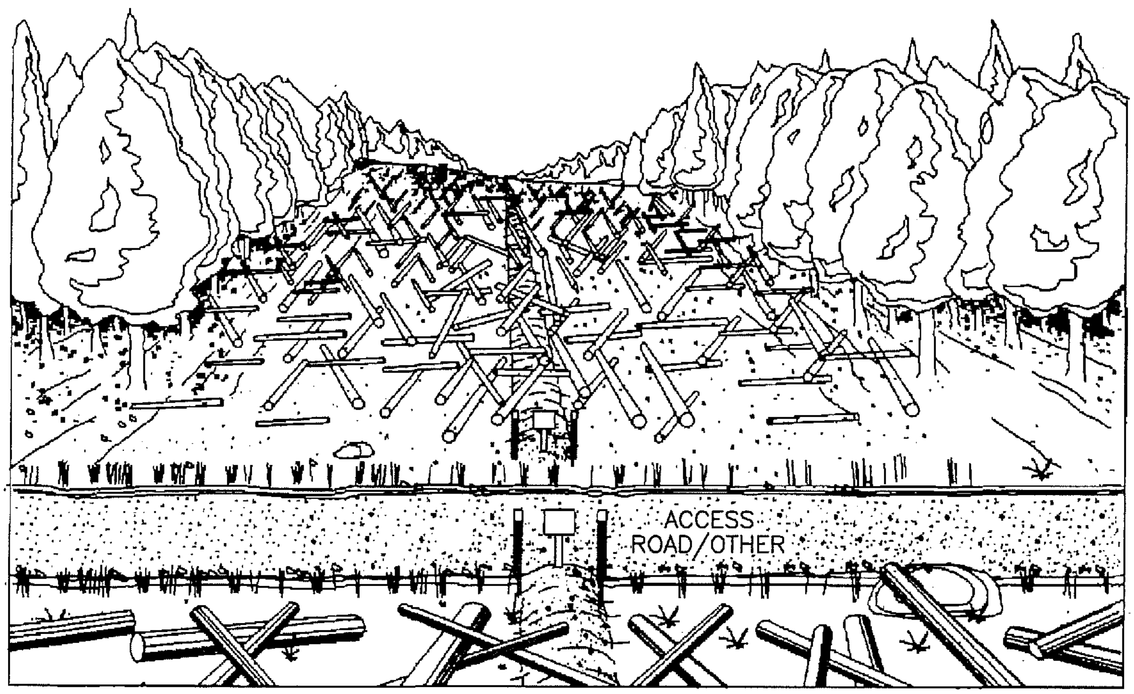
Plate 13: Example of lattice placement of rollback. Photo source: NGTL.

Appendix D

Typical Drawings



OPTION A



OPTION B

1. PLACE ROLLBACK AS INDICATED ON THE DRAWING (OPTION A OR B). REFER TO THE EPP FOR SITE SPECIFIC DETAILS. THE COMPANIES AUTHORIZED REPRESENTATIVE WILL DETERMINE THE OPTION AND LOCATION OF ROLLBACK TO FIT WITHIN THE RIGHT–OF–WAY.
2. ENSURE ROLLBACK IS EXTENDED TO THE TRENCH ROACH AND TO THE EDGE OF THE CONSTRUCTION FOOTPRINT (STANDING TIMBER WHERE APPLICABLE). TO ENSURE EFFECTIVENESS, TYPICAL LENGTH AND DENSITY OF ROLLBACK IS APPROXIMATELY 500 M3/HA.
3. IF SITE CONDITIONS WARRANT MODIFICATIONS TO THE PROCEDURE, THE COMPANY'S AUTHORIZED REPRESENTATIVE SHALL ENSURE THE MODIFICATIONS MEET THE INTENT OF THE MITIGATION MEASURE.

REVISIONS	
00	DRAWING SUPERSEDES SK–1543
01	GENERAL ISSUE – REVIEWED FOR 2015 SPEC
02	GENERAL ISSUE

TransCanada

DESIGNER: M.D. S... NAME OCT 31/17 DATE
CHECKED BY: KL
DESIGN CHECKER: JH

DESIGN STANDARD

FIA # STDS	CHAINAGE:	DISCIPLINE # 03

TITLE: TYPICAL ROLLBACK FOR ACCESS CONTROL

SCALE N.T.S. | DWG No STDS–03–ML–05–312 | REV 02

ID — TIME — DESIGNFILE

TC_A4_EE.DWG 210X280

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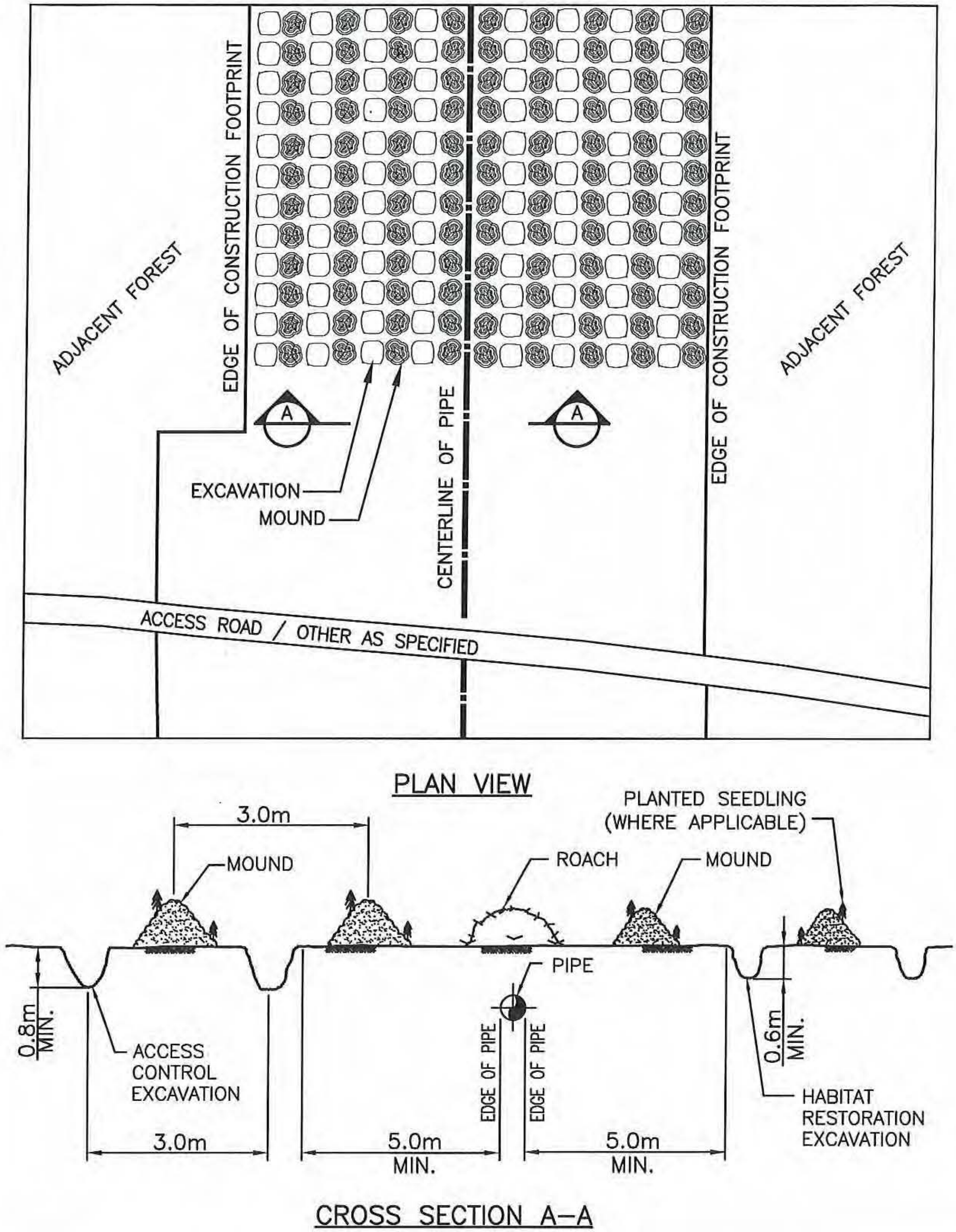

TransCanada	DESIGNER: NAME DATE	DESIGN STANDARD	
		FIA # STDS	CHAINAGE:	DISCIPLINE # 03
		TITLE: MOUNDING AND HABITAT RESTORATION (SHEET 1 OF 2)	
	CHECKED BY: / DESIGN CHECKER:	SCALE N.T.S.	DWG No STDS–03–ML–05–314	REV 00

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NOTES:

1. MOUNDING WILL BE USED PRIMARILY FOR ACCESS CONTROL IN AREAS SPECIFIED ON PROJECT PLANS, AND AS DIRECTED BY THE COMPANY. MOUNDING WILL BE COMBINED WITH HABITAT RESTORATION MEASURES WHERE INDICATED IN PROJECT PLANS, AND AS DIRECTED BY THE COMPANY.
2. EXCAVATIONS SHALL NOT BE CONDUCTED WITHIN 5m OF THE COMPANY'S PIPELINE. ENSURE APPLICABLE COMPANY AND THIRD PARTY PERMITS AND AGREEMENTS ARE IN PLACE AND ADHERED TO.
3. THE EDGE OF THE EXCAVATION SHALL BE JUST BEYOND THE 5m BUFFER LIMIT AND THE MOUND SHALL BE PLACED WITHIN THE 5m BUFFER LIMIT ADJACENT TO THE COMPANY'S PIPELINE.
4. FOR ACCESS CONTROL PURPOSES, THE EXCAVATED AREA SHALL BE MINIMUM 0.8m DEEP AND APPROXIMATELY 1m IN DIAMETER, WHERE SITE CONDITIONS ALLOW.
5. WHERE MOUNDING IS COMBINED WITH HABITAT RESTORATION MEASURES, THE EXCAVATED AREA SHALL BE APPROXIMATELY 0.6m DEEP AND APPROXIMATELY 1m IN DIAMETER, WHERE SITE CONDITIONS ALLOW.
6. THE EXCAVATED MATERIAL IS PLACED BESIDE THE HOLE TO CREATE THE MOUND.
7. MOUNDS SHALL BE SPACED APPROXIMATELY 3m APART, WITH FINAL SPACING IMPLEMENTED TO ENSURE ACCESS BY OFF-ROAD VEHICLES IS DETERRED.
8. DENSITY SHALL BE A MINIMUM OF 700 MOUNDS/HA. MOUND DENSITY IS DEPENDENT ON SOIL CHARACTERISTICS, AMOUNT OF FROST AND TYPE OF EQUIPMENT USED. TYPICAL LENGTH OF MOUNDING TO MEET THE MINIMUM DENSITY IS APPROXIMATELY 50m.
9. WHERE MOUNDING IS COMBINED WITH HABITAT RESTORATION MEASURES, LIVE SEEDLING PLANTING DENSITY SHALL BE A MINIMUM OF 2 SEEDLINGS PER MOUND, OR 1,400 TO 2,000 SEEDLINGS/HA.
10. IF SITE CONDITIONS WARRANT MODIFICATIONS TO THE PROCEDURE, THE COMPANY'S AUTHORIZED REPRESENTATIVE SHALL ENSURE THE MODIFICATIONS MEET THE INTENT OF THE MITIGATION MEASURE.

GENERAL:

- MOUNDING IS TYPICALLY CONDUCTED DURING FINAL CLEANUP AND NOT IN THE SAME SEASON AS CONSTRUCTION/ INTERIM CLEANUP.
- PRECAUTIONS SHALL BE TAKEN TO MINIMIZE FROST PENETRATION WHERE PRACTICAL IN AREAS WHERE MOUNDING IS SPECIFIED. DEEPER FROST PENETRATION CAN LIMIT THE ABILITY TO EXCAVATE HOLES AND SUBSEQUENT EFFECTIVENESS OF THE MITIGATION MEASURES.
- SITE SPECIFIC SOIL PROPERTIES (E.G. SUBSTRATE AND DRAINAGE) MAY AFFECT THE HOLE AND MOUND SIZE, STABILITY AND OVERALL STRUCTURE.
- MOUNDING MAY ALSO BE USED IN COMBINATION WITH HABITAT RESTORATION BY CREATING MICROSITES FOR PLANTED SEEDLINGS.

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	CHECKED BY: / DESIGN CHECKER:	TITLE: MOUNDING AND HABITAT RESTORATION (SHEET 2 OF 2)
		SCALE N.T.S. — DWG No STDS-03-ML-05-315 — REV 00

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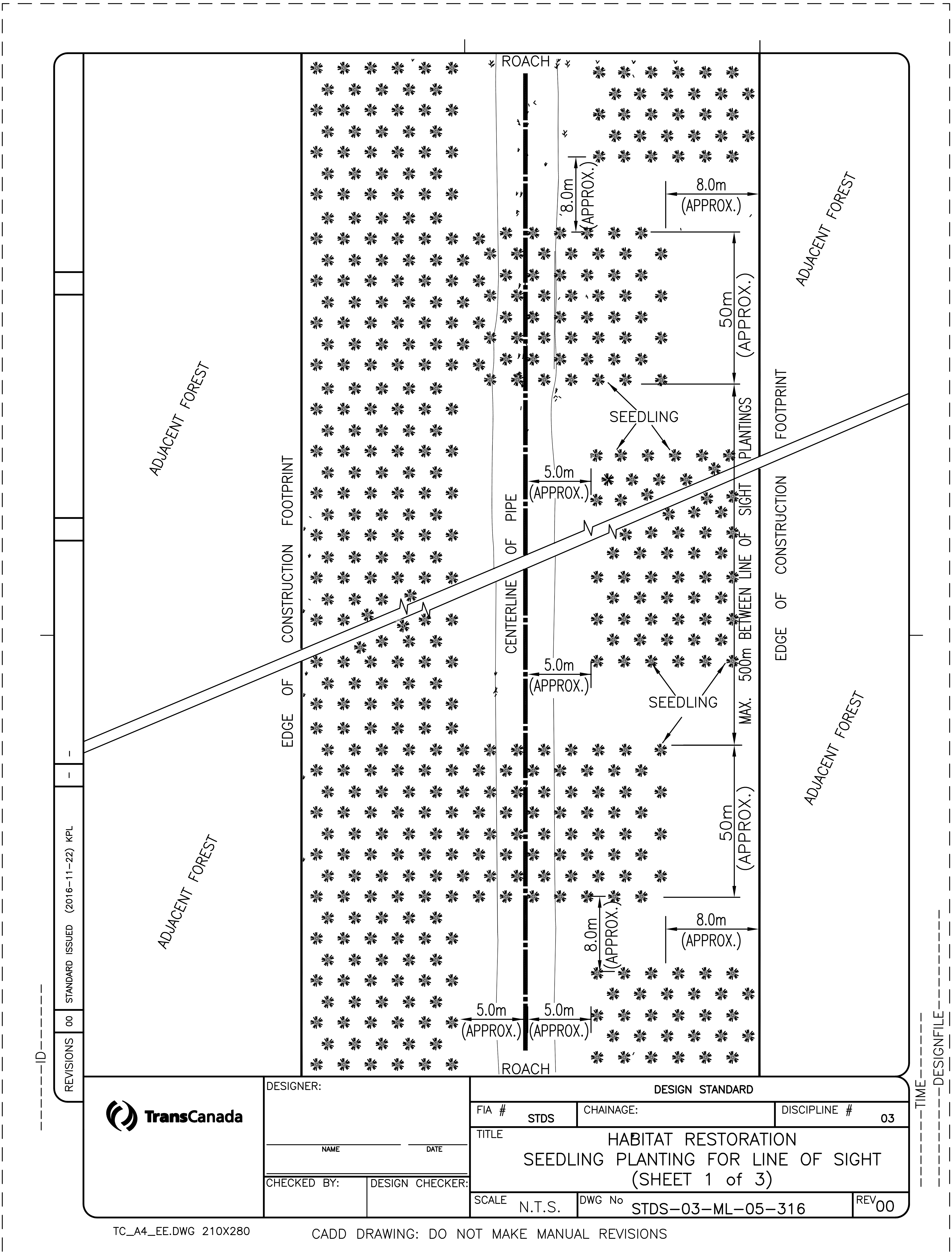
ROACH
ADJACENT FOREST
EDGE OF CONSTRUCTION FOOTPRINT
CENTERLINE OF PIPE
8.0m (APPROX.)
50m (APPROX.)
SEEDLING
5.0m (APPROX.)
MAX. 500m BETWEEN LINE OF SIGHT PLANTINGS
EDGE OF CONSTRUCTION FOOTPRINT
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ID
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DESIGNFILE
TransCanada
DESIGNER:
NAME
DATE
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DESIGN CHECKER:
DESIGN STANDARD
FIA # STDS
CHAINAGE:
DISCIPLINE # 03
TITLE
HABITAT RESTORATION
SEEDLING PLANTING FOR LINE OF SIGHT
(SHEET 1 of 3)
SCALE N.T.S.
DWG No STDS-03-ML-05-316
REV 00
TC_A4_EE.DWG 210X280
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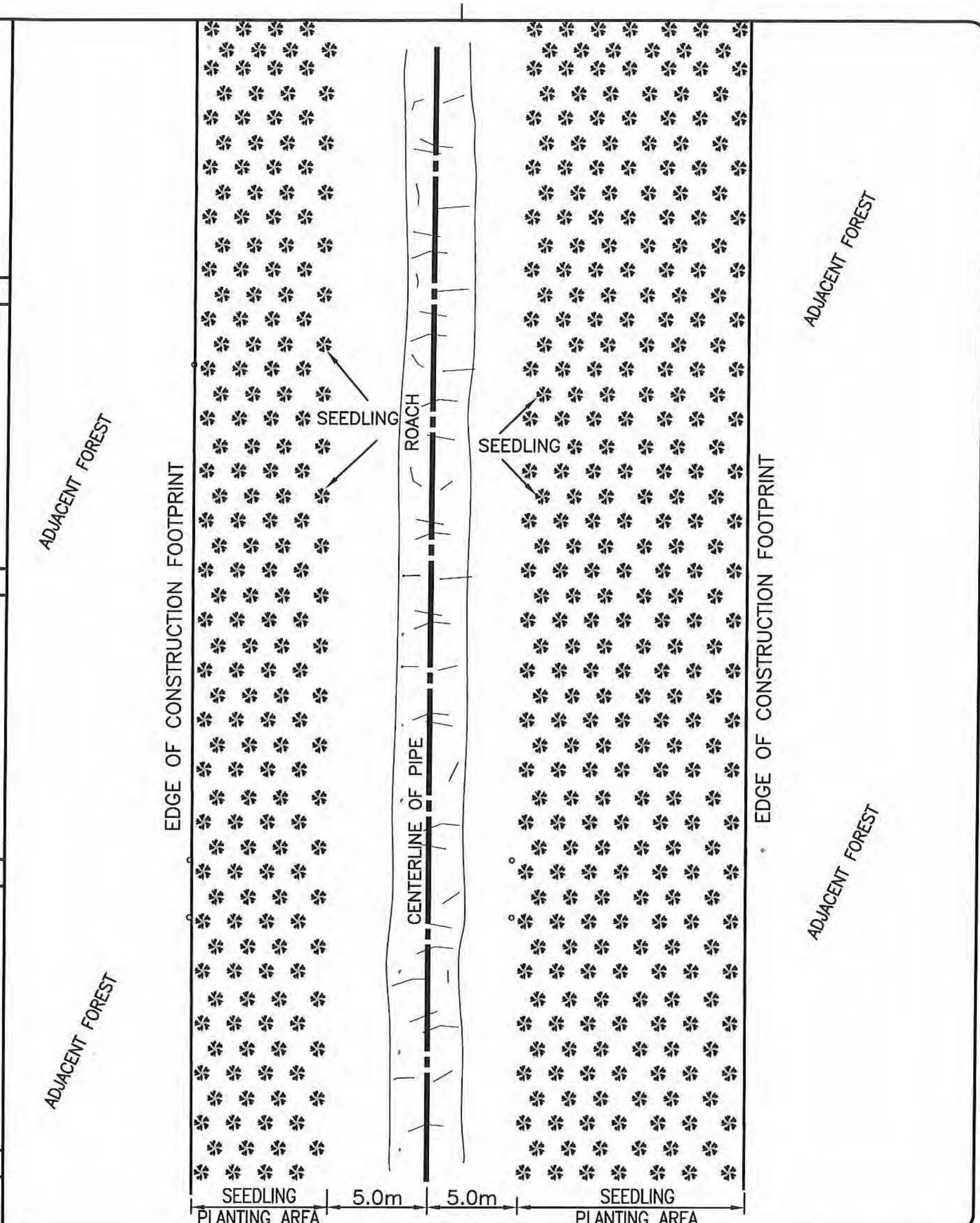

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NAME DATE

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DESIGN STANDARD

FIA # STDS | CHAINAGE: | DISCIPLINE # 03

TITLE HABITAT RESTORATION SEEDLING PLANTING (SHEET 2 OF 3)

SCALE N.T.S. | DWG No STDS-03-ML-05-317 | REV 00

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NOTES:

1. CONDUCT SEEDLING PLANTING FOR HABITAT RESTORATION AND LINE OF SIGHT WHERE INDICATED IN PROJECT PLANS, AND AS DIRECTED BY THE COMPANY. FIELD SUPERVISION OF SEEDLING PLANTING MUST BE CONDUCTED BY A REGISTERED FOREST PRACTITIONER.

2. ENSURE APPLICABLE COMPANY AND THIRD PARTY AGREEMENTS ARE IN PLACE AND FOLLOWED.

3. SEEDLING PLANTING SHALL BE CONDUCTED IN NON-FROZEN GROUND CONDITIONS IN THE SEASON FOLLOWING WINTER FINAL CLEANUP, AND OUTSIDE OF APPLICABLE RESTRICTED ACTIVITY PERIODS WHERE WAIVERS ARE NOT OBTAINED.

4. DO NOT PLANT IN THE SEASON FOLLOWING CONSTRUCTION/ INTERIM CLEANUP UNLESS APPROVED IN PROJECT PLANS OR DIRECTED BY THE COMPANY.

5. SEEDLING PLANTING DENSITY SHALL BE (A) 1,600-2,000 STEMS PER HA IN UPLAND (CONIFER /DECIDUOUS); (B) 1,200-2,000 STEMS PER HA IN LOWLAND (CONIFER ONLY). PLANT IN A STRAIGHT LINE PARALLEL TO THE ROACH. OFF-SET THE ADJACENT PARALLEL LINE OF PLANTING TO AVOID A GRID PATTERN.

6. WHERE THE LINE OF SIGHT PROCEDURE IS REQUIRED, IT SHOULD BE IMPLEMENTED AT MAXIMUM 500m SPACING OR AS DIRECTED BY THE COMPANY. TO ADDRESS ACCESS REQUIREMENTS DURING PIPELINE OPERATIONS, THE LINE OF SIGHT PLANTING PATTERN SHALL ENSURE AN APPROXIMATE 8m WIDE GAP IS LEFT UNPLANTED ADJACENT TO THE EDGE OF THE CONSTRUCTION FOOTPRINT. WHERE ACCESS IS REQUIRED ADJACENT TO THE OPERATING PIPELINE, PLANTING SHALL NOT BE CONDUCTED WITHIN 5m OF THE PIPELINE.

7. SEE DRAWING STDS-03-ML-05-316 AND STDS-03-ML-05-317 FOR EXAMPLES OF THE ALTERNATING PLANTING PATTERN AND LAYOUT TO BE APPLIED FOR HABITAT RESTORATION AND LINE OF SIGHT LOCATIONS.

8. ALTERNATING PLANTING PATTERN SHALL BE APPROXIMATELY 50m IN LENGTH OR AS INDICATED BY THE COMPANY TO MEET THE INTENT OF THE LINE OF SIGHT REQUIREMENTS.

9. IF SITE CONDITIONS WARRANT MODIFICATIONS TO THE PROCEDURE, THE COMPANY'S AUTHORIZED REPRESENTATIVE SHALL ENSURE THE MODIFICATIONS MEET THE INTENT OF THE HABITAT RESTORATION MITIGATION MEASURES.

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		FIA # STDS / CHAINAGE: / DISCIPLINE # 03
	CHECKED BY: / DESIGN CHECKER:	TITLE HABITAT RESTORATION AND LINE OF SIGHT SEEDLING PLANTING NOTES (SHEET 3 OF 3)
		SCALE N.T.S. / DWG No STDS-03-ML-05-318 / REV 00

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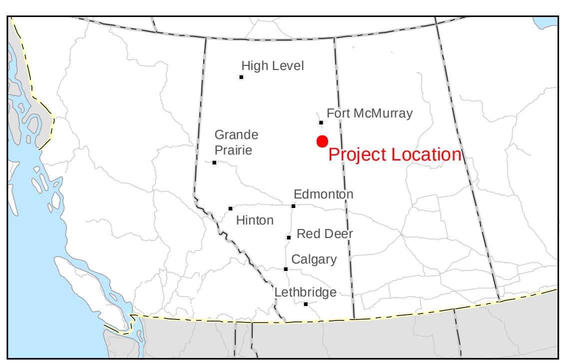
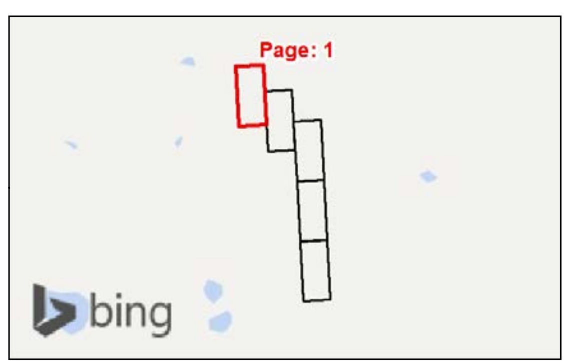
Appendix E

Footprint Elements and Planned Habitat Restoration Measures





Footprint Elements

- PDA
- ROW (Abandon in Place)
- Egg-Pony Caribou Range (East Side Athabasca Range)
- Road
- Watercourse
- Access to Highway 881/Conklin
- Quarter Section

Restoration Measures

- Plant
- Access Control, Plant
- Mound, Plant
- Mulch, Spray, Plant
- No Treatment - Other Disposition
- No Treatment - Wet
- Disposition
- Egg-Pony Caribou Range (East Side Athabasca Range)
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Notes
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Stantec | TC Energy

Project Location
80-09-W4M,
Alberta

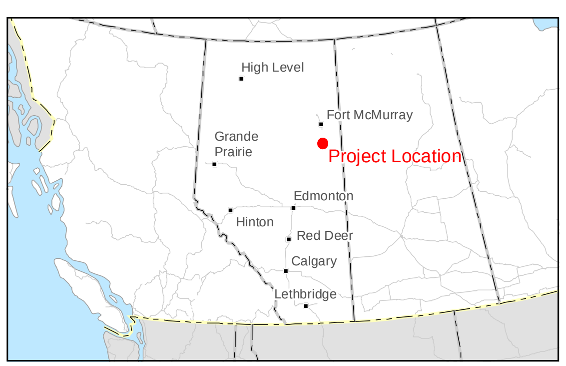
Prepared by DJ on 2020-05-05
TR by CB on 2019-05-12
IR by MP on 2019-05-12

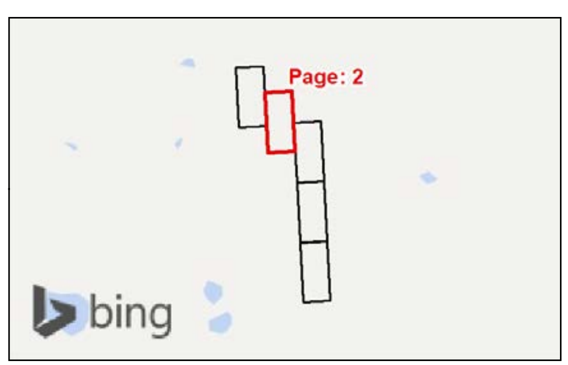
Client/Project
123513501
NGTL
Meadow Creek Meter Station and
Lateral Abandonment Project

Figure No.
Appendix E

Title
Meadow Creek Receipt Meter Station and Lateral Abandonment Footprint Elements and Planned Restoration Measures

Page 1 of 5





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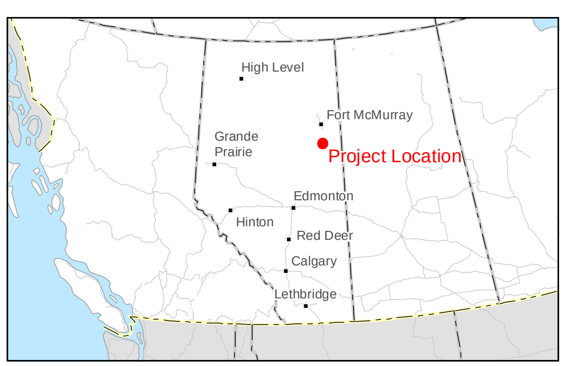

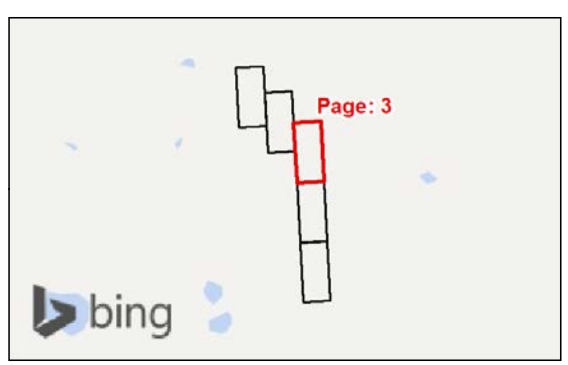

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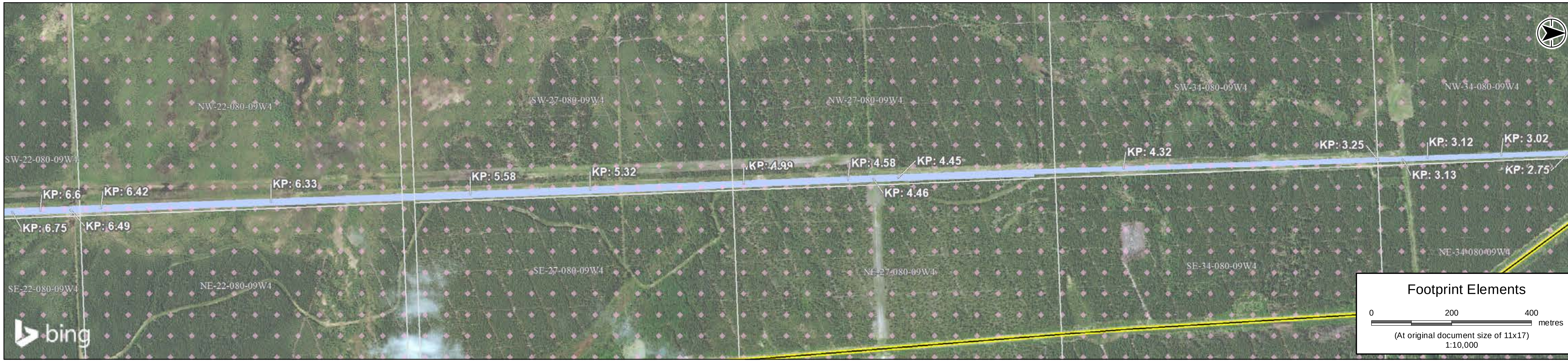

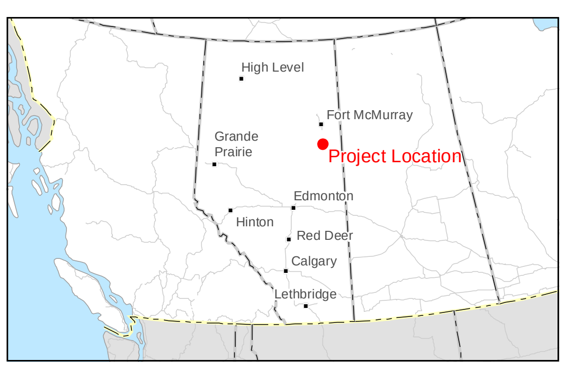

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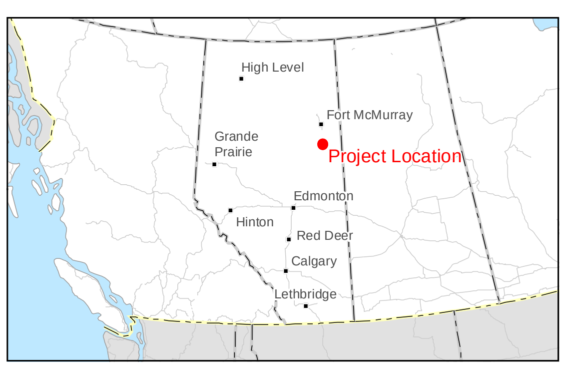

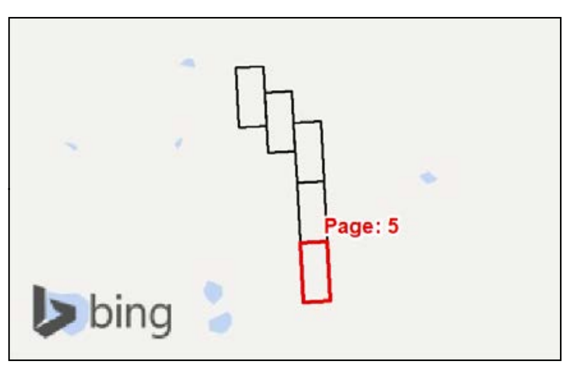

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