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January 31, 2020

Filed Electronically

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

Attention: Ms. L. George, Secretary of the Commission

Dear Ms. George:

Re: NOVA Gas Transmission Ltd. (NGTL)
Northwest Mainline Loop (Boundary Lake North Section) (Project)
Order XG-N081-021-2018 (Order)
Caribou Habitat Restoration and Offset Measures Plan (CHR&OMP)
OF-Fac-Gas-N081-2017-31 01

As part of NGTL's Project commitments, enclosed is the final Caribou Habitat Restoration and Offset Measures Plan (CHR&OMP).

NGTL filed a Preliminary CHR&OMP for the Project on December 15, 2017,[1] and stated that a Final CHR&OMP was to be filed in June 2019. NGTL notes that this was a clerical error. Because the final CHR&OMP includes a description of the as-built footprint of the Project within caribou habitat and the Project was not expected to be completed until early 2020, it was not possible for NGTL to draft and file a final CHR&OMP for June 2019.

If the CER requires additional information with respect to this filing, please contact me by phone at (403) 920-5214 or by email at jaron_dyble@tcenergy.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Jaron Dyble
Regulatory Project Manager
Regulatory Facilities, Canadian Natural Gas Pipelines

Enclosure

cc: Heather Dodds, Canada Energy Regulator
Carolyn Crook, Environment and Climate Change Canada

[1] Filing ID: A88650.

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1.0 INTRODUCTION AND ORGANIZATION

This section introduces the Final Caribou Habitat Restoration and Offset Measures Plan (CHR&OMP) for the Northwest Mainline Loop (Boundary Lake North Section) Project (the Project) and outlines how this document is organized.

1.1 INTRODUCTION

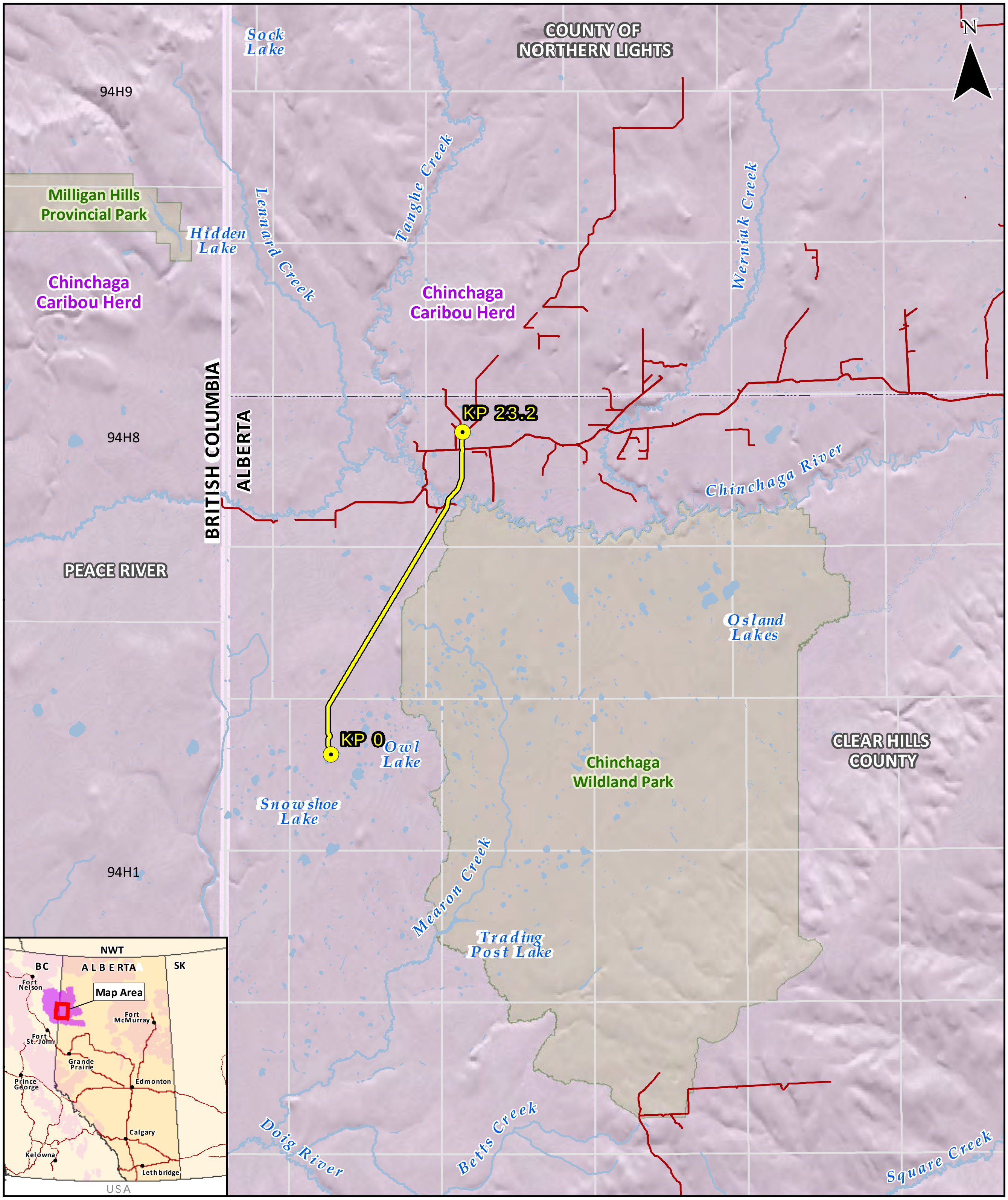
NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada PipeLines Limited (TransCanada), and affiliate of TC Energy Corporation, received approval from the National Energy Board (NEB), predecessor to the Canada Energy Regulator (CER), to construct and operate the Project (Order XG-N081-021-2018).[1] This Final CHR&OMP has been prepared because the Project interacts with the Chinchaga caribou range (see Figure 1-1).

NGTL filed a Preliminary CHR&OMP for the Project[2] (NGTL 2017a) on December 15, 2017.[3] In the Preliminary CHR&OMP, it is stated that a Final CHR&OMP would be filed in June 2019. However, NGTL notes that this was a clerical error and that the actual timing of filing a Final CHR&OMP was to coincide with the completion of construction (i.e., January 2020).

In the form of a Project commitment, the Preliminary CHR&OMP (NGTL 2017a [Section 5.1.1]) defines the scope of the Final CHR&OMP as follows:

> *The Final CHR&OMP will be submitted after construction is complete and prior to implementation of restoration and offset measures, and will include the following:*
>
> - *an update from the Preliminary CHR&OMP to describe the caribou habitat restoration sites*
> - *updated consultation summaries and updates or considerations based on relevant provincial range or action plans and learning from previous projects*
> - *quantification of the total area of direct habitat to be restored*
> - *quantification of the Final Offset Value*
> - *description of the offset restoration sites and measures that will be implemented*

[1] Filing ID: A93328.
[2] Previous NGTL projects have filed restoration plans and offset measures reports as standalone documents. In order to streamline reporting and monitoring, these documents were combined into one, the CHR&OMP, for the Project (see NGTL 2017a for details).
[3] Filing ID: A88650-8.



- Kilometre Post
- Proposed Pipeline
- Road
- Hydrology
- Waterbody
- Municipal/ Regional Boundary
- Provincial Boundary
- Park/Protected Area
- Caribou Range

FIGURE 1-1

NORTHWEST MAINLINE LOOP BOUNDARY LAKE NORTH SECTION RELATIVE TO THE CHINCHAGA CARIBOU RANGE

PROPOSED NOVA GAS TRANSMISSION LTD. 2020 EXPANSION PROGRAM - NORTHWEST MAINLINE LOOP (BOUNDARY LAKE NORTH SECTION) PROJECT

ch2m

UTM Zone 11N
Proposed KP, Pipeline Routing: NGTL 2017; Road: AltaLIS 2016, NRCan 2015; Hydrology, Waterbody: AltaLIS 2014; BC FLNRO 2008; NRCan 2007-2011; Municipal Boundary: AltaLIS 2017; Regional Boundary: BC MFLNRO 2007; Provincial Boundary: AltaLIS 2009; Parks/Protected Area: ATPR 2012, BC MFLNRO 2008; Caribou Range: AEP, GOA 2016, BC MOE 2008; ATS Grid: AltaLIS 2009; HillShade: TERA Environmental Consultants 2008.
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

TransCanada *In business to deliver*

SCALE: 1:350,000 (0 2 4 6 8 km) (All Locations Approximate)	December 2017	694879
	Mapped By: PMS	Checked By: JB

694879_Wildlife_Caribou_Figure1-1_RegionalLocation_Rev0

Consistent with this Project commitment, the implementation of restoration and offset measures for the Project is not complete with the filing of this Final CHR&OMP (i.e., January 2020). Conditions 10 and 11 of Order XG-N081-021-2018 require separate filings pertaining to the implementation of habitat restoration and offset measures (see Section 6.0).

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

1.2 ORGANIZATION OF THE FINAL CHR&OMP

This Final CHR&OMP is organized to reflect the process logic of NGTL caribou habitat restoration and offset planning, experience from past CER conditions regarding caribou for NGTL projects, and the structure of NGTL's most recently filed plan, the North Montney Mainline Project Preliminary Caribou Habitat Offset Measures Plan (NGTL 2019)[4], filed on April 30, 2019. This Final CHR&OMP is organized in 12 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 and offset implementation consultation and engagement with federal and provincial regulators and Aboriginal groups

Section 4.0: residual project effects and caribou habitat restoration, including updated residual direct and indirect project effects and a summary of potential and planned habitat restoration measures

Section 5.0: offsetting, including offset strategy and framework, offset multipliers, calculation of the initial offset value, offset decision planning, potential offset measures, offset decision framework, and calculation of final offset value

Section 6.0: description of future filings on caribou habitat restoration and offset measures

Section 7.0: schedule for construction, habitat restoration, offset measures implementation, and future filings

Section 8.0: performance indicators that will be used to monitor and evaluate the success in achieving the CHR&OMP objective, goals and targets

Section 9.0: monitoring, adaptive management, and reporting

[4] Filing ID: A99182-1.

Section 10.0: description of how field innovations and experience have been incorporated (i.e., continual improvement)

Section 11.0: literature review, on which the decision frameworks, selection of restoration and offset locations, and determination of offset multipliers were derived

Section 12.0: list of references cited in the document

In general, this Final CHR&OMP retains the content of the Preliminary CHR&OMP. Substantive updates to the content per the commitment for the Final CHR&OMP (see Section 1.1) appear in Sections 3.0, 4.0, and 5.0. Updates to Sections 6.0, 7.0, and 9.0 are primarily related to conditions in Order XG-N081-021-2018 and are specific to future filings.

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 Final CHR&OMP. These elements have been refined with experience gained across past projects and will be used to evaluate the performance and effectiveness of NGTL's caribou habitat restoration and offset measures for the Project.

The objective, goals, and targets of the Final CHR&OMP are intended to guide NGTL in the selection and assessment of caribou habitat restoration and offset 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 8.0.

2.1 STRATEGIC OUTCOME

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

2.2 OBJECTIVE

NGTL's caribou habitat restoration and offset investments reduce the predicted residual project effects and offset the Project's contribution to cumulative effects on caribou and caribou habitat in a manner that aligns with provincial and federal policies, management plans, and priorities.

2.3 GOALS AND TARGETS

Goal (G1) NGTL's caribou habitat restoration measures are ecologically relevant, practically located, and reasonably protected to minimize 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 and offset 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 and offset areas resembles a typical path of ecological succession.

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

Target (T2) in this Final CHR&OMP has been refined from earlier NGTL project-specific caribou habitat restoration plans filed with the CER. In previous 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 $\leq$ 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., planning around landscape features and trenchless crossings can give line-of-sight reduction). 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 and offsetting measures both on- and off-right-of-way (ROW).

The goals and targets of the Final CHR&OMP are, by function, similar to previously filed NGTL caribou habitat restoration and offset plans. However, offsetting options for the Project include portions of existing, non-project, NGTL ROWs within the Chinchaga caribou range, which is an approach to caribou habitat offsets developed in consultation with Alberta Environment and Parks (AEP), as well as with Environment and Climate Change Canada (ECCC) (see Section 3.1 for additional information on regulatory consultation).

3.0 CONSULTATION AND ENGAGEMENT

NGTL is committed to ongoing consultation with regulatory agencies, and engagement with Indigenous groups, on the development and implementation of habitat restoration and offsetting measures. The following sections summarize the outcomes of consultation and engagement as it pertains to this Final CHR&OMP.

3.1 REGULATORY CONSULTATION

NGTL has had ongoing consultation with provincial and federal regulators to align the caribou habitat restoration measures with provincial and federal policies and to discuss offset options for implementation. Consultation with ECCC and AEP has led to changes in NGTL's approach to offset plans resulting in a decision to identify offset opportunities on existing, non-project, NGTL ROWs within the caribou range affected by a project. This is a notable change from previous offset plans, which focused on implementing offsets off NGTL ROWs (i.e., on third-party ROWs). NGTL has met with AEP and ECCC to discuss implementing this approach for the Project.

A detailed summary of NGTL's consultation with AEP and ECCC on caribou habitat restoration and offset measures generally, and the Project's CHR&OMP specifically, is provided in Appendix A. NGTL is committed to ongoing consultation with respect to planning and implementing caribou habitat restoration and offset measures for the Project. Outcomes from regulatory consultation to date, that have been applied to this Final CHR&OMP, are:

- AEP and ECCC agreed with NGTL that access management will generally be ineffective when an access management measure does not span the full width of the ROW (i.e., one ROW or two or more contiguous ROWs); however, access management will be implemented at intersecting linear disturbances (e.g., seismic and ROW).
- AEP and ECCC encouraged restoration of existing pipeline disturbances as offsets. NGTL is investigating offsets on existing, non-project, NGTL ROWs.
- ECCC encouraged the implementation of offsets within existing caribou ranges. AEP encouraged prioritizing offsets with emerging provincial restoration plans. NGTL will implement offsets at locations that were reviewed with AEP and identified as priority offset locations within the Chinchaga caribou range (see Section 5.0).
- NGTL is committed to ongoing consultation with AEP on opportunities for restoration within the area of the ROW where vegetation is managed.
- NGTL is committed to ongoing consultation with AEP and ECCC on the implementation of the Final CHR&OMP.

3.2 ABORIGINAL ENGAGEMENT

A key goal of ongoing engagement is to align on-the-ground offset planning with compatible and existing traditional land use practices. Inclusion of traditional land use information gained through engagement will help improve the likelihood that measures will be implemented in a manner that avoids or limits disruption of traditional activities in restoration and offset areas.

Details on NGTL's engagement with potentially affected Aboriginal groups up to December 2017 are provided in Attachment 16 of the Project Application (NGTL 2017b)[5]. The following is a summary of NGTL's engagement activities with potentially affected Aboriginal groups, regarding the CHR&OMP, from February 2, 2019, to January 27, 2020.

Dene Tha' First Nation (DTFN):

- On April 12, 2019, NGTL met with DTFN to discuss details for a meeting with DTFN community members and NGTL's response and proposed mitigation to the information from DTFN's TK report.
- Between April 16 and April 29, 2019, NGTL and DTFN exchanged emails to confirm details and the agenda for a meeting with DTFN community members. DTFN noted that DTFN's concerns regarding minimizing impacts to caribou and caribou habitat from increased disturbances within Chinchaga range and Protective Notations, are outstanding. DTFN noted that it would like to discuss the next steps of engagement and advised NGTL that an Elder and community participants would be attending the meeting to share their concerns, particularly related to wildlife.
- On May 1, 2019, NGTL met with DTFN. NGTL provided an update on the Project and discussed next steps of engagement. NGTL invited DTFN participants to participate in a helicopter flyover after the caribou restricted activity period to undertake field validation of proposed caribou habitat restoration and access management measures, and to discuss logistics for a follow-up telephone call to further discuss DTFN's involvement on the Project.
- On May 15, 2019, NGTL emailed DTFN regarding the helicopter flyover and ground-truthing of the Project and noted that this would provide an opportunity for DTFN to provide input on the proposed planting prescriptions and access management measures. NGTL provided a DTFN-specific work plan outlining Project specific tasks and action items. On May 16, 2019, DTFN responded by email to acknowledge receipt of NGTL's email.
- On September 18, 2019, NGTL and DTFN, which included four community members, undertook a Project flyover as part of the community engagement on the CHR&OMP.

[5] Filing ID: A88650-12.

- On October 30, 2019, NGTL met with DTFN to review the draft mitigations that were discussed on the flyover for the Project's caribou habitat restoration. A set of draft alignment sheets with preliminary caribou habitat restoration and access management measures was provided to DTFN to take back to community members for their input and feedback.
- During a meeting with DTFN and NGTL held on December 20, 2019, NGTL committed to arranging an additional meeting with DTFN to continue discussions on the implementation of the Project's proposed caribou habitat restoration and access management measures.
- During a meeting with DTFN and NGTL held on January 23, 2020, NGTL committed to continuing discussion on the implementation of the Project's proposed caribou habitat restoration and access management measures.

Doig River First Nation (DRFN):

- On February 4, 2019, NGTL received an email from DRFN in follow-up to a January 31, 2019, meeting providing an industry partner's PowerPoint presentation about mine reclamation planning in a high elevation caribou range. DRFN requested that NGTL forward the PowerPoint presentation to the other NGTL attendees from the January 31, 2019, meeting. On February 5, 2019, NGTL replied by email to DRFN to acknowledge receipt of the PowerPoint presentation.
- Between March 7 and April 8, 2019, NGTL and DRFN exchanged emails regarding arranging a meeting in April 2019 to continue discussions related to caribou habitat restoration and access management. DRFN requested NGTL's decision framework for caribou management and offsets in NGTL's CHR&OMP. NGTL provided direction to DRFN on where the decision framework is found in the Preliminary CHR&OMP.
- On April 10, 2019, NGTL and DRFN met to progress discussions on DRFN's participation in NGTL's caribou habitat restoration and access management plans. DRFN expressed it has concerns with the Preliminary CHR&OMP and NGTL's offset calculations. NGTL and DRFN agreed to set up a follow-up conference call to further discuss technical details of NGTL's caribou habitat restoration and access management. NGTL and DRFN agreed to set up a field verification and helicopter flyover towards the end of July 2019, after the caribou restricted activity period, for DRFN Elders and students to provide input into the proposed caribou habitat restoration and access management plans. NGTL agreed to follow up with DRFN to provide NGTL's schedule once they had a chance to confirm helicopter availability and availability of their environmental consultants for the field visit, once that was finalized.
- On April 23, 2019, NGTL and DRFN held a conference call and NGTL provided information related to DRFN's concerns regarding caribou habitat restoration and access management plans. NGTL and DRFN discussed the potential for DRFN to

do a helicopter flyover for the Project. NGTL followed up the meeting the same day with an email providing clarification on the planting and restoration schedule for the Project.

- On April 24, 2019, NGTL emailed DRFN typical drawings illustrating the minimal surface disturbance construction technique, and typical drawings of rollback and mounding for access management. NGTL indicated these drawings were included in the EPP filed with the NEB for the Project.
- Between May 13 and 22, 2019, NGTL and DRFN exchanged emails regarding timelines for the Project. NGTL provided an update on the timeline for filing the Final CHR&OMP. NGTL advised that activities still need to occur after the caribou RAP (July 15, 2019) before the CHR&OMP will be finalized. NGTL indicated the next step for DRFN is to undertake a helicopter flyover and field verification of the Project during with the week of July 15 or 22, 2019 once the RAP has closed. NGTL advised this would be an opportunity for DRFN to provide input on the proposed planting prescriptions and access management planning. NGTL and DRFN discussed logistics for arranging a meeting to be held on June 12, 2019.
- On June 12, 2019, NGTL met with DRFN. NGTL provided updates regarding the Project and did a presentation to review how NGTL derived its offset calculations. NGTL and DRFN discussed logistics for the upcoming field verification and helicopter flyover planned for mid-July 2019.
- On June 12, 2019, NGTL received an email from DRFN providing DRFN's availability for the field verification and helicopter flyover in mid-July 2019. NGTL replied by email the same day acknowledging the dates and noting NGTL will provide the flyover date when confirmed.
- Between June 24–25, 2019, NGTL and DRFN exchanged emails, and NGTL provided caribou habitat mapping and offset multiplier calculation as reviewed in the meeting on June 12, 2019.
- On September 17, 2019, NGTL and DRFN, including an environmental consultant (caribou specialist) and three community members, participated in a Project flyover as part of the community engagement on the CHR&OMP.
- On October 23, 2019, NGTL emailed DRFN to advise that the Project has updated the caribou restoration mapping and inquired if DRFN would be interested in reviewing the updated maps. On November 6, 2019, NGTL and DRFN exchanged emails regarding availability for a meeting.
- On November 26, 2019, NGTL emailed DRFN to follow-up on the meeting request from November 6, 2019. NGTL advised the Project would like to review the proposed restoration and access management alignment sheets with DRFN prior to filing the Final CHR&OMP with the CER, planned for January 2020.

- On December 6, 2019, NGTL received an email from DRFN requesting the CHR&OMP to review. NGTL replied the same day and provided draft restoration and access management alignment sheets for DRFN to review. NGTL advised that the Project team can meet with DRFN prior to submitting the Final CHR&OMP in January 2020. DRFN replied the same day advising they would review the restoration and access management alignment sheets and may potentially request a meeting in January.
- On January 16, 2020, NGTL received an email from DRFN with an attached capacity funding proposal for DRFN to contribute to the Project's CHR&OMP.
- On January 17, 2020, NGTL sent an email to DRFN to request a meeting to discuss DRFN's proposal.

4.0 RESIDUAL PROJECT EFFECTS AND CARIBOU HABITAT RESTORATION

This section of the Final CHR&OMP describes and updates effects of the Project on caribou habitat since the Preliminary CHR&OMP was filed in December 2017. The residual effects calculations provided in this section are used to estimate the Initial Offset Value (IOV) in consideration of habitat restoration measures that are planned for implementation on the project footprint.

4.1 PROJECT IMPACTS TO CARIBOU HABITAT

The Project is located in the Chinchaga caribou range for its entire length (23.09 km), and is contiguous (i.e., parallel) with existing disturbance for 99% of its length (Table 4-1). The non-contiguous (i.e., new cut) segment between KP 0+126 and KP 0+370 (i.e., 244 m) is a minor deviation that is no more than 60 m from the existing nearby ROWs and access roads. The ROW width required to construct the Project varies from approximately 26 to 32 m, based on workspace needed and the development paralleled, plus the addition of temporary workspace such as log decks, crossings, and areas to be graded. The project footprint is 83.2 ha; the incremental direct permanent effect is 21.8 ha, which is the area directly affected by the operational access (i.e., a width of up to 10 m over the ditchline of the ROW subject to periodic vegetation management [see Section 5.2]) minus existing permanent disturbance. By applying a 500 m indirect disturbance buffer to the operational access, the Project incrementally adds 25.5 ha of permanent indirect effect.

Table 4-1 Project Interaction with the Chinchaga Caribou Range

Caribou Range	Provincial and Federal Status Designation	Current Population Trend	Project Linear Disturbance in Caribou Range (km)		
			Total Length	Contiguous Alignment	Non-contiguous Alignment
Chinchaga	Threatened[1,2]	Declining[3]	23.09 km	22.85 km (99.0%)	0.24 km (1.0%)

Notes:
[1] Alberta provincial status designation under the *Wildlife Act* (AESRD 2017).
[2] Status designation under Schedule 1 of the *Species at Risk Act* (Government of Canada 2019).
[3] Population trend reported by ECCC (2017, 2019), and Government of Alberta (2017b).

Table 4-2 Summary of Existing Direct Disturbance Overlapping the Project Footprint

Disturbance Duration	Disturbance Type	Area (ha)
Permanent/Long term	Settlement/community	--
	Airport	--
	Primary road	--
	Quarry	< 0.01
	Facility	0.71
	Secondary road	0.17
	Railway	--
	Well site	1.95
	Tertiary road	--
	Building	--
	Recreational area	--
	Agriculture/cropland	--
	Pipeline	6.28
	Transmission line	--
	Subtotal	**9.12**
Temporary	Cutline (seismic)	1.40
	Recreational trail	--
	Cutblock	--
	Fire <40 years	--
	Subtotal	**1.40**
	TOTAL	**10.52**

4.2 QUANTIFICATION OF RESIDUAL PROJECT EFFECTS BEFORE IMPLEMENTATION OF HABITAT RESTORATION

Quantification of residual project effects is required to estimate an offset value. Residual project effects are the spatial area of direct and indirect disturbance after mitigation and before implementation of habitat restoration measures. The approach used to calculate residual project effects (i.e., disturbed versus not disturbed habitat in respect of the federal 65% undisturbed habitat threshold) is consistent with the *Amended Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada* (hereafter the 'proposed amended federal Recovery Strategy', ECCC 2019).

To calculate residual project effects, disturbance types were classed as either temporary or permanent as a means for quantifying disturbance longevity and assumed effects on caribou habitat. Temporary disturbances are those that can reasonably recover in the short term (i.e., 40 years or less per the definition of disturbed habitat in the proposed amended federal Recovery Strategy), and permanent disturbances are those that are not likely to recover within 40 years. Temporary disturbances include forest cut blocks, low-impact seismic lines, and burned areas, and permanent disturbances include pipelines, transmission lines, roads, railways, conventional seismic lines, recreational areas and trails, well sites, quarries, agriculture/cropland, buildings, airports, and settlements. For the Project, the operational (maintained) ROW is considered permanent, and the remaining workspace that is planned for restoration is considered temporary.

Effects associated with temporary and permanent disturbances are partitioned into direct and indirect effects. Direct effects are based on the areal representation of disturbance footprints, and indirect effects are based on the areal representation of a 500 m buffer around those footprints, less permanent effects. Burned areas that are 40 years old or less are included as a temporary disturbance feature, but these areas are not buffered by 500 m, consistent with methods used in the proposed amended federal Recovery Strategy. Baseline and project disturbances are organized hierarchically by effect duration (i.e., permanent or temporary) and effect type (i.e., direct or indirect), as illustrated in the ‘standard disturbance hierarchy’ (Figure 4-1).

The disturbance hierarchy functions to provide an accurate accounting of residual project effects on caribou habitat when the project footprint and its 500-m buffer area are overlaid on existing disturbance footprints and their associated buffer areas. An example illustration of the steps taken to quantify residual direct and indirect project effects is provided in Figure 4-2.

The extent of the direct and indirect baseline disturbance and the incremental project disturbance are illustrated in Appendix B.

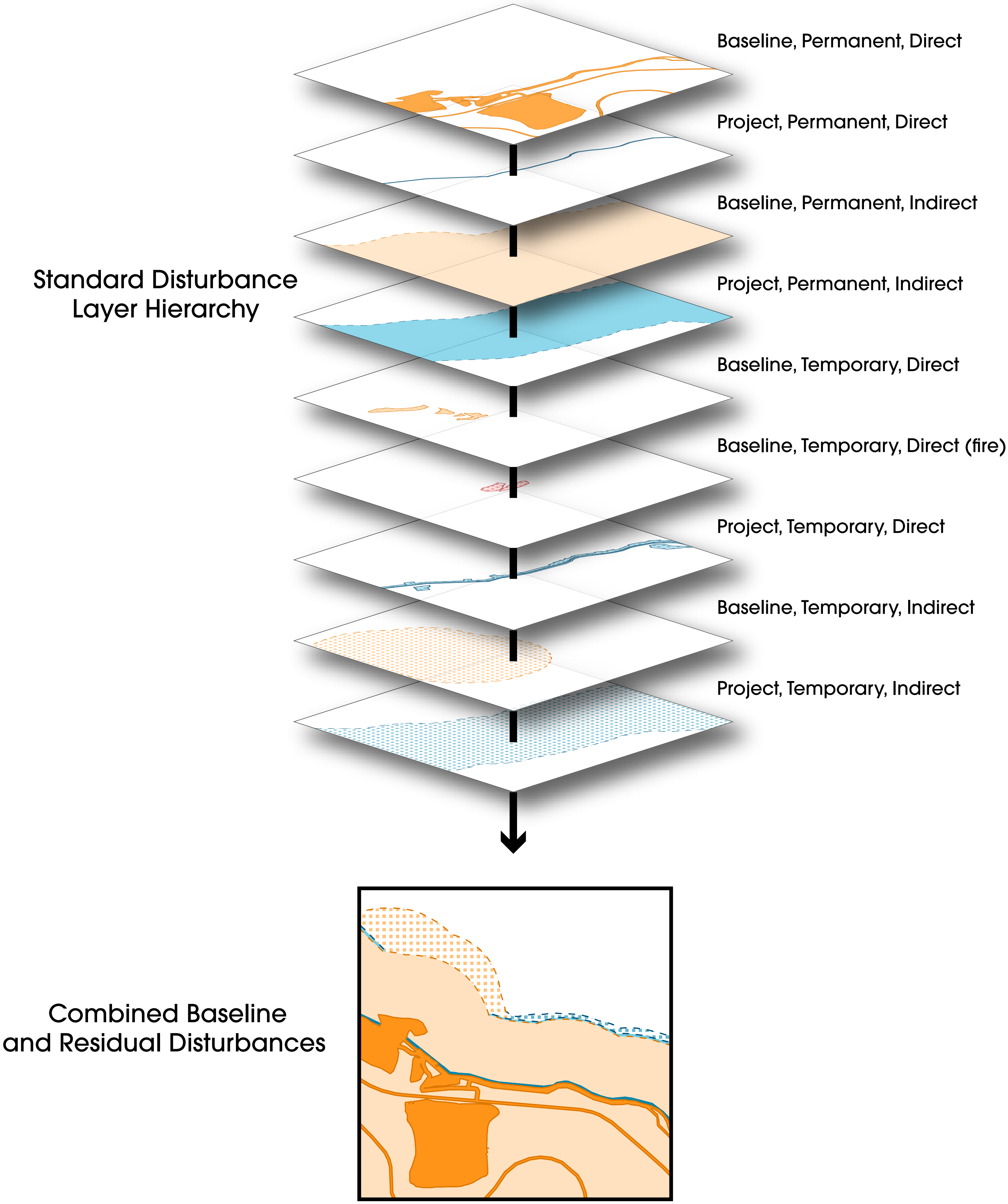


Figure 4-1 Standard Disturbance Hierarchy Process Used to Quantify Residual Effects

Figure 4-2 Step-wise Approach for Quantifying Residual Project Effects

4.3 HABITAT RESTORATION MEASURES

Site-specific habitat restoration measures will be selected under the guidance of the Habitat Restoration Decision Frameworks (see Section 4.4). These habitat restoration measures may include reclamation and reforestation, access management, and line-of-sight blocking, as outlined in the following sections. Selection of habitat restoration measures will be based on expected effectiveness, site conditions, availability of appropriate materials, and NGTL's habitat restoration experience from other projects. Appendix C provides a 'toolkit' of potential habitat restoration and offset measures that includes a summary of the expected effectiveness of each measure. Appendix D provides photographs of examples of potential habitat restoration measures. Appendix E provides construction schematics (i.e., typical drawings) of examples of potential engineered habitat restoration measures.

In addition to habitat restoration measures, NGTL uses minimal surface disturbance techniques during construction (i.e., mowing/mulching in the ROW during frozen conditions to reduce disturbance of surface soils, except where grading is necessary). Minimal surface disturbance techniques lay the foundation for natural regeneration and rapid re-establishment of planted vegetation on pipeline ROWs so are an important part of the NGTL's caribou habitat restoration program.

4.3.1 Reclamation and Reforestation

Established reclamation and forestry reforestation practices will be applied to promote revegetation (i.e., advanced silviculture practices). Restoration measures that create more favorable microsite conditions (e.g., mounding) and planting trees and shrubs, will be considered where site conditions allow. Rollback, if available, may be used to enhance site restoration by providing shade and microsites for planted seedlings. Tree species comparable to the surrounding landscape (i.e., uplands versus lowlands) will be planted to mimic natural variation and complexity by optimizing density and spacing at the feature level. Selection of suitable tree species will be based on professional forestry expertise and comparison to nearby and/or adjacent ecotypes or timber types.

4.3.2 Access Management

Access management for the Project and/or its offset areas in caribou habitat will be planned to:

- Manage access along the pipeline ROW in a manner that discourages access, particularly motorized access
- Maintain managed access necessary for safe pipeline operations compliant with applicable regulations and guidelines

- Maintain existing access at identified locations (e.g., third-party industry access, traditional access identified by Aboriginal communities through engagement activities)

Site Selection and Monitoring

A Geographic Information System (GIS) is used to identify preliminary access management and monitoring locations, which in turn are used to establish the baseline condition (of level of existing access) when determining access management locations for the Project. The sites are chosen based on a review of the Project's construction alignment sheets and proposed access management treatment locations. Locations are further refined during the construction phase to consider site-specific conditions and construction requirements. Performance indicators used to evaluate the effectiveness of access management measures will be included in the Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP; see Sections 6.3 and 8.0).

Access Management Measures

Access management measures are most effective when implemented on non-contiguous segments of the ROW and at intersections of the pipeline with existing perpendicular linear features relative to contiguous segments. Because the Project parallels existing linear disturbance for 99% of its length (all of which is in caribou range), access management will be limited to intersecting perpendicular access on the new cut side of the ROW as well as targeting access management measures where there is evidence of existing human access and/or at intersections with other linear features. Typically, access management measures are sited on active intersections with other linear features such as roads, utility corridors, seismic lines or watercourses. Potential access management measures include:

- Extended trenchless crossings
- Vegetation screens
- Rollback
- Fencing and signs
- Vegetation planting
- Mounding

As nearly the entire length of the Project is contiguous with other developments, including pipeline ROWs, roads, and facilities, access management measures across the project ROW will be ineffective and will not be installed unless a mechanism to catalyze cooperation with adjacent industrial disposition holders is developed by provincial regulators.

4.3.3 Line-of-Sight Blocking

Line-of-sight blocking can be effective when implemented on non-contiguous segments of the pipeline ROW. However, where NGTL parallels developments that do not implement line-of-sight measures, NGTL's measures are rendered ineffective. As discussed above, the Project is contiguous with other developments for 99% of its length. Purposely installed line-of-sight measures (such as fabricated screens) will not be effective on the contiguous segments of the Project and 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.

4.4 HABITAT RESTORATION DECISION FRAMEWORKS

The Habitat Restoration Decision Frameworks (Figure 4-3 and Figure 4-4) are applied to provide guidance on habitat restoration measure selection 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 Final CHR&OMP. They are based on NGTL's pipeline construction 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 Final CHR&OMP because 99% of the project footprint is contiguous with existing linear features 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 4-4).

If the results of engagement with Indigenous groups identified areas where ongoing access is required for traditional use or trapper access, the decision frameworks to identify applicable access measures were not used for those locations. For the remaining potential locations, the decision frameworks were used during construction to identify candidate sites for access management on the project footprint.

Figure 4-3 and Figure 4-4 are presented in chronological order of implementation: access management is determined and installed first, and habitat restoration is typically implemented after final clean-up. The decision frameworks provide the logic process for potential restoration measures or tools that could be applied to the project footprint.

Note: Where bore installation is planned and appropriate vegetation exists, feasibility of extending the bore to create access management will be considered.
*merchantable timber is required for rollback used for access management, however, merchantable and/or a non-merchantable can be used when used to augment habitat restoration.

Figure 4-3 Access Management Decision Framework

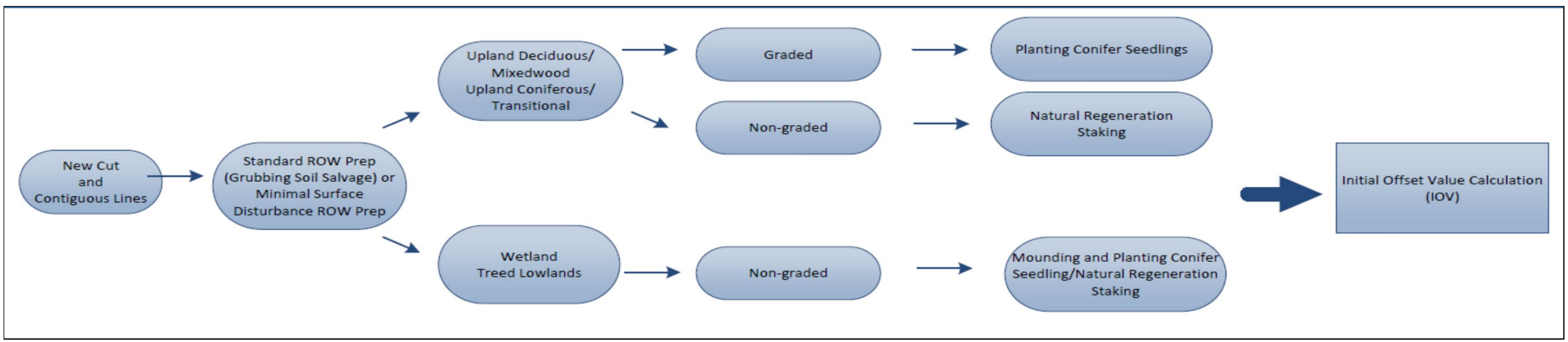


Figure 4-4 Habitat Restoration Decision Framework

4.5 PROPOSED HABITAT RESTORATION PLAN

Habitat restoration measures will be implemented on the project footprint to reduce residual effects of the Project on caribou and caribou habitat. However, residual effects after the implementation of habitat restoration measures will remain for two reasons:

1. There will be an associated temporal delay and delivery risk associated with the implementation of on-ROW habitat restoration measures, and;

2. Some areas of the project footprint will not be restored (i.e., the operational ROW).

The proposed habitat restoration plan for the Project is illustrated in Appendix F.

Tree seedling planting (black spruce, white spruce, lodgepole pine) is the primary habitat restoration measure planned for on-ROW habitat restoration. The operational ROW will not be seeded except where erosion control is needed. During operation, NGTL periodically manages vegetation within 5 to 10 m of the ditchline of the ROW, in accordance with TC Energy operational procedures for integrity monitoring under Canadian Standards Association (CSA) Z662-15 (CSA 2015), to allow for inspection and operational access as needed. Managed (maintained) operational access is considered a direct disturbance. Therefore, maintained operational access points will be quantified and included in the calculation of the total remaining disturbance of caribou habitat. For areas of existing permanent disturbance that need to be maintained following construction of the Project, such as existing dispositions, those areas will not be included in the offset determination.

Access management is not planned to go across the project footprint ROW because access management would be ineffective when not applied across the adjacent and contiguous ROW (see Section 3.1). The new cut section is short (240 m) and within 60 m of other permanent linear features (i.e., road and pipeline) and within the disturbance buffers of existing permanent access (see Appendix B). Subsequently, access management is also not planned for the new cut section as it is not expected to provide functional value in the context of existing disturbance. Access management is planned at intersecting and perpendicular locations along the ROW (see Section 4.3.2 and Appendix F).

Table 4-3 summarizes the preliminary direct and indirect project effects in the context of existing disturbance (determined as described in Section 4.2), before risk multipliers are applied to determine initial and final offset values. The values in Table 4-3 are based on assumptions; the actual values will differ based on the completed habitat restoration measures. Final direct and indirect effects will be based on the completed planting program and will be reported in the Caribou Habitat

Restoration Implementation Report and Status Update (see Section 6.1). The metrics are defined as:

- **Planned Restored Footprint:** area of the project footprint that is planned for restoration (i.e., temporary workspace and portions of the non-maintained ROW). Risk multipliers will be applied to these areas in the IOV calculation to account for temporal risk and delivery risk.
- **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.
- **Residual Direct Project Effect:** unrestored area of the project footprint (i.e., operational [maintained] ROW). This area will be calculated as the length of the operational ROW multiplied by 10 m wide.
- **Residual Indirect Project Effect:** area represented by a 500-m permanent disturbance buffer applied to the unrestored project footprint (i.e., operational [maintained] ROW), less areas of existing direct or indirect permanent anthropogenic disturbance.
- **Residual Project Effects:** the sum of the area of Residual Direct Project Effect and Residual Indirect Project Effect.

Table 4-3 Residual Project Effects on Caribou Habitat

Spatial Boundary	Area (ha)				
	Planned Restored Footprint	Unrestored Existing Maintained Disturbance	Residual Direct Project Effect	Residual Indirect Project Effect	Residual Project Effects
Project Footprint (83.2 ha)	28.9	9.0	45.3	n/a	45.3
Within 500 m of operational ROW	n/a	n/a	n/a	25.5	25.5
				Total	70.8

5.0 OFFSETTING

Consistent with the mitigation hierarchy (see Section 11.10), NGTL plans to avoid, reduce, and restore areas affected by construction of the Project to the extent feasible. However, as identified in Section 4.0, residual project effects on caribou and caribou habitat are predicted to remain following construction and during operation. The overarching goal of this Final CHR&OMP is to offset residual project effects in a manner that aligns with provincial and federal policies, management plans, and priorities.

Conservation and biodiversity offsets are defined as measurable conservation outcomes or environmental values resulting from actions designed to compensate for residual adverse effects arising from a development after appropriate mitigation measures (i.e., avoid, reduce, restore) are applied. Offsets are the last step in the mitigation hierarchy and are developed after other reasonable measures to mitigate potential adverse effects are exhausted. The following sections describe NGTL's offsetting strategy and framework, and describe how risk multipliers, decision planning, and offset measures are identified and used to calculate an offset value for residual project effects.

Potential offset measures that will be implemented for the Project will align with the habitat restoration measures and decision frameworks presented in Section 4.0. Offset measures will be selected considering NGTL's experience with previous caribou habitat offset initiatives, as well as the site characteristics in the areas to be offset (e.g., habitat type, moisture and nutrient regime, aspect, soils, climatic conditions, land use).

5.1 OFFSET STRATEGY AND FRAMEWORK

This Final CHR&OMP uses a strategy consistent with conservation offset development specific to the conservation needs of woodland caribou (boreal population), and is supported by a literature review (Section 11.0). This Final CHR&OMP follows a like-for-like habitat restoration framework, where offsets are directed toward physical habitat restoration measures rather than indirect measures such as contributions to research programs or other financial mechanisms. Indirect offset measures are not, therefore, contemplated for this Final CHR&OMP.

5.2 RISK MULTIPLIERS

Risk multipliers[6] are a component of offset determination that take into account challenges and uncertainties associated with habitat restoration time lags (temporal), effectiveness (delivery), and spatial relevance (spatial). NGTL surveyed subject matter experts in industry, government, and academia through a questionnaire to quantitatively evaluate the expected effectiveness and acceptance of caribou habitat restoration practices (Northern Resource Analysts 2014). In addition to the results of the questionnaire, NGTL has also reviewed peer-reviewed and technical literature, national and international offsetting practices, recent caribou habitat offsetting plans filed with the NEB (e.g., Stantec 2018b; NGTL 2019), and recent results from ongoing monitoring programs (e.g., NGTL 2018) to inform and refine the risk multipliers. NGTL has also considered consultation feedback received from government agencies and Aboriginal groups both on past projects, and on this Project, to inform the risk multipliers. When formal offsetting frameworks and direction are available for the Province of Alberta, NGTL will review the new guidance and, if necessary, modify multipliers as appropriate.

The current delivery and temporal risk multipliers that NGTL uses, and are used in this Final CHR&OMP, are provided in Table 5-1, and spatial risk multipliers are provided in Table 5-2. These risk multipliers are consistent with those used in approved caribou habitat offset measures plans for other CER-regulated projects, and where appropriate have been adjusted to reflect new or updated information as described in the literature review (see Section 11.0). One notable change is the removal of different multipliers for ‘continuous’ versus ‘discontinuous’ application of access or line-of-sight measures. If access or line-of-sight measures cannot be applied across the full width of a ROW (new cut or contiguous with another ROW), then the measure is not likely to be effective and the objective unachievable (i.e., in most instances, discontinuous application is not a viable measure). Another notable change is that the temporal risk multiplier to be used in the offset calculation will be based on multiple criteria (see notes in Table 5-1).

To address uncertainty and time lags associated with habitat restoration measures, NGTL applied the Department for Environment, Food and Rural Affairs (2011) discrepancy risk approach. The underlying principles of the discrepancy approach were developed considering the risk factors associated with habitat restoration. The risk factors associated with habitat restoration measures employed in this Final CHR&OMP are as follows:

- delivery risks associated with the effectiveness and achievability of each measure (i.e., challenges and uncertainty of the restoration technique)

[6] Risk multipliers are not the same as offset ratios. Risk multipliers are used to account for temporal lag, uncertainty, and spatial relevance of a given offset measure. The offset ratio is the result of dividing the offset value (after risk multipliers are applied) by the residual project effect being offset.

- spatial risks associated with the proximity of measures to affected caribou and caribou habitat (i.e., spatial relevance within caribou range)
- temporal risks associated with the ability of each measure to achieve full effectiveness (i.e., short or long-term time lags)

Table 5-1 Temporal and Delivery Risk Multipliers[1,2]

Habitat Restoration Measure	Restoration Application[1]	Temporal Risk Multiplier	Delivery Risk Multiplier[2,3]
Discrete Barriers (fences/berms)	250-m intervals (high intensity)	1.0	2.0
	500-m intervals (low intensity)		2.5
Barrier Segments (rollback/mounding)	201–400+ m segments/ 250-m intervals (high intensity)	1.0	1.6
	100–200 m segments / 500-m intervals (low intensity)		2.0
	< 100-m segments / 250-m or 500-m intervals		2.5
Barrier Segments (tree bending, hinging, or felling)	Minimum 200-m segments; tree seedlings and/or mounding between segments	1.0	1.5
	Minimum 200-m segments; natural regeneration between segments		2.0
Tree Planting for Line-of-Sight[2]	250-m intervals (high intensity) or 500-m intervals (low intensity)	No delay = 1.0 5-year delay = 1.2 10-year delay = 1.4 15-year delay = 1.7 20-year delay = 2.0 25-year delay = 2.4 30-year delay = 2.8 35-year delay = 3.0 40-year delay = 3.3	1.25
Tree Planting to Accelerate Reforested State	At or above required stocking density (includes areas where Minimum Surface Disturbance construction is applied)	No delay = 1.0 5-year delay = 1.2 10-year delay = 1.4 15-year delay = 1.7 20-year delay = 2.0 25-year delay = 2.4 30-year delay = 2.8 35-year delay = 3.0 40-year delay = 3.3	1.25

Table 5-1 Temporal and Delivery Risk Multipliers[1,2]

Habitat Restoration Measure	Restoration Application[1]	Temporal Risk Multiplier	Delivery Risk Multiplier[2,3]
Seeding and Left for Natural Revegetation, or; Shrub Planting and Left for Natural Revegetation	Temporary workspace (high intensity)	40- to 50-year delay = 4.0	2.5

NOTES:

Adapted from Northern Resource Analysts (2014, 2016)

[1] Intensity of application for linear disturbances will either be low or high; for non-linear disturbances, intensity of application will default to high intensity unless otherwise specified. Tree-planting that meets or exceeds recommended stocking standards is considered high intensity.

[2] In the case of Tree Planting for Line-of-Sight, a temporal multiplier of 1.0 is used when trees are 1.2–1.5 m tall at the time of planting; if tree-seedlings are used for line-of-sight, a larger temporal multiplier is used in consideration of delay factors for tree seedlings (see Note 3).

[3] For Tree Planting to Accelerate Reforested State, the temporal multiplier used in the offset calculation takes into account the delay between residual effect creation and implementation of the restoration or offset measure, seedling height at time of planting, species to be planted, species' growth rates (if known), local or regional site/growing conditions, and expected time to achieve target tree height and density (i.e., free to grow).

Table 5-2 Spatial Risk Multiplier

Notation	Offset Location	Spatial Risk Multiplier
A	Within the Chinchaga caribou range	1.0
B	Within 15 km of the Chinchaga caribou herd range (i.e., where the expected value of the offset measure would contribute to reducing predator density and access and apparent competition with primary prey)	1.5
C	Within another boreal caribou range in Alberta	2.0
D	Within another boreal caribou range in British Columbia	2.5
E	Outside boreal caribou range in Alberta or British Columbia	3.0

NOTE:

Adapted from DEFRA (2011, 2012)

Offset multipliers address the effectiveness, time lag, and spatial relevance of habitat restoration measures in relation to the residual effect they are intended to offset. In the case of delivery multipliers, risks are associated with the effectiveness and achievability of each measure. Where there is greater uncertainty regarding the effectiveness or achievability of offset measures, higher multipliers are applied to accommodate for potential loss or failure of measures. These may include challenges relating to site specific conditions or restoration methods.

Temporal multipliers are used to account for the delay between residual effect creation and restoration or offset measure achieving the objective. In the case of tree planting for future forested state, for example, the temporal risk multiplier considers seedling height at time of planting, species to be planted, species' growth rates (if known), and local or regional site/growing conditions.

NGTL uses spatial multipliers in its offset calculations as a way of accounting for the spatial relevance of the offset measure relative to where the project effect being offset occurs. In general, the greater the distance from the affected caribou range the offset is applied, the higher the spatial multiplier. Spatial multipliers are not applicable to on-site (on-ROW) habitat restoration measures because those restoration measures are directly applicable to the location where the project effect (direct and indirect) is created.

5.3 CALCULATING THE INITIAL OFFSET VALUE

The IOV is the area required to be offset after habitat restoration measures are implemented on the project footprint and accounting to unrestored and remaining direct and indirect effects. The IOV accounts for residual effects associated with on-ROW restoration measures (i.e., temporal delay and effectiveness), and for residual effects associated with unrestored area (i.e., the operational ROW).

Determining an offset for the Project is calculated in two stages:

1. **Initial Offset Value (IOV):** based on the planned project footprint and the areas and measures planned for on-site (on-ROW) habitat restoration. An 'Updated IOV' is used once the as-built footprint is known and planned on-site habitat restoration measures have been implemented.

2. **Final Offset Value (FOV):** based on the as-built project footprint and actual areas and measures used for on-site (on-ROW) habitat restoration (i.e., updated IOV), and on the selection of offset locations and measures and accounting for delivery, temporal, and spatial risks.

To calculate the IOV, the following steps are completed:

1. Along the length of the route, the project footprint is considered either new cut alignment (i.e., the ROW will create a new linear feature) or contiguous alignment (i.e., the ROW is immediately adjacent to, and shares the space of, an existing ROW). Contiguous alignment is assumed to have a lesser effect on caribou habitat compared to new cut alignment, both from a functional (i.e., predator and human access) and ecological (i.e., less forest cover is removed on contiguous alignment) perspective. The contiguous alignment approach is also consistent with the mitigation hierarchy, whereby the contiguous alignment

avoids (i.e., no new linear feature) and reduces (i.e., less forest cover removal) project effects to the extent feasible. An inherent effect multiplier is applied in the following way (Northern Resource Analysts 2014):

a. Areas of the project footprint that are classed as contiguous alignment are assigned a 20% inherent effect (0.2 multiplier)

b. Areas of the project footprint that are classed as new cut alignment are not afforded a reduction and assigned a 100% inherent effect (1.0 multiplier)

c. Alignment class and the inherent effect multiplier are not applicable to indirect effects

For each footprint element and alignment class (i.e., new cut or contiguous) combination, identify the planned habitat restoration measures and applications (see Table 5-1) and assign the appropriate delivery and temporal risk multipliers.

Calculate the following IOV formula components:

- **Residual Direct Disturbance Value (RDDV):** total area classed as new cut or contiguous alignment, accounting for the inherent effect multiplier of contiguous alignment (Northern Resource Analysts 2014).
- **Residual Indirect Disturbance Value (RIDV):** total area represented by a 500-m permanent disturbance buffer applied to the unrestored project footprint (i.e., operational ROW), less any areas of existing direct or indirect permanent anthropogenic disturbance.
- **Residual Post-Restoration Value (RPRV):** the area to be restored, accounting for the RDDV and delivery and temporal risk multipliers as applicable. The RPRV is calculated for each restoration unit.

The IOV and associated components (RDDV, RIDV, and RPRV) are calculated as follows:

Calculation 4-1:

$$\mathbf{IOV}\ (\mathbf{ha}) = \sum (\mathbf{RDDV}(\mathbf{operational\ access}) + \mathbf{RIDV} + \mathbf{RPRV})$$

$$\text{RDDV} = \sum \text{(parallel (ha) x inherent effect) + (new cut (ha) x inherent effect)}$$

$$\text{RIDV} = \text{(500 m buffer (ha) – all other indirect buffers (ha))}$$

$$\text{RPRV} = \sum \text{RDDV x (1 – (1 ÷ (delivery multiplier x temporal multiplier x spatial risk multiplier))}$$

The IOV is an estimate of the area to be offset and accounts for direct and indirect effects and the planned implementation of on-ROW habitat restoration measures. Table 5-3 summarizes the restoration units, residual effects (for restored and unrestored footprint elements), risk multipliers, and the IOV. The actual area to be offset is the FOV, which is discussed in Section 5.5.

For ease of updating and interpretation, restoration units are comprised of three categories of information: 1) Footprint Element, 2) Planned Habitat Restoration Measure, and 3) ROW Alignment. The IOV calculation is completed for each restoration unit, and individual IOV values are summed to arrive at the total IOV. For areas planned for on-ROW habitat restoration, appropriate multipliers for inherent effect and risk (delivery and temporal) are applied. The inherent effect multiplier is included in the IOV determination for the contiguous portion of the operational ROW but is not applied to the ROW when calculating the IOV associated with indirect effects. Risk multipliers are not applied to the operational ROW area, or to areas affected by indirect effects, because these areas are not included in on-ROW habitat restoration measures. These areas will, however, include risk multipliers (including the spatial risk multiplier) in the FOV calculation once offset locations and measures are identified.

The corresponding areas related to footprint element, planned habitat restoration measures, and ROW alignment described in Table 5-3 are illustrated in a series of maps in Appendix F[7]. All areas of the project footprint that are directly affected and are planned for on-ROW habitat restoration measures are subject to risk multipliers (Table 5-3). The area of planned habitat restoration is 28.88 ha, and after accounting for inherent effects, and delivery and temporal risk, the RPRV for this area is 3.73 ha. The operational ROW is 20.21 ha, and after accounting for existing maintained disturbance and inherent effects the RPRV for this area is 4.23 ha. Incremental indirect effects associated with the Project are 25.49 ha. There are 25.07 ha of temporary workspace and unmaintained ROW that remains unrestored and left for natural regeneration, which results in an RPRV of 5.44 ha after accounting for inherent effects. There is no RPRV associated with 8.99 ha of the project footprint that will remain unrestored as an existing maintained disturbance. The total IOV for direct and indirect Project effects is 38.89 ha (Table 5-3).

[7] Indirect Project effects are illustrated in Appendix B.

Table 5-3 Quantification of the Initial Offset Value for Residual Project Effects[1]

Restoration Unit (Project ROW)			RPRV = (RDDV x Inherent Effect) x (1-(1÷(Delivery x Temporal)))				
Footprint Element	**Planned Habitat Restoration Measure[1]**	**ROW Alignment**	**RDDV (ha)**	**Inherent Effect**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Residual Effect (RPRV & RIDV) (ha)**
Temporary Workspace or Unmaintained ROW	Barrier Segments (rollback/mounding)	Contiguous	5.22	0.2	3.3	1.0	0.73
Temporary Workspace or Unmaintained ROW – Upland or Transitional Forest	Tree Planting to Accelerate Reforested State	Contiguous	13.16	0.2	1.25	1.7	1.39
Temporary Workspace or Unmaintained ROW – Lowland Forest	Tree Planting to Accelerate Reforested State	Contiguous	9.97	0.2	1.25	3.3	1.51
Temporary Workspace or Unmaintained ROW – Shrub Community	Seeding and Left for Natural Revegetation, or; Shrub Planting and Left for Natural Revegetation	Contiguous	0.53	0.2	2.5	4.0	0.10
Planned Habitat Restoration Area (ha)			**28.88**	**Subtotal RPRV (ha)**			**3.73**
Temporary Workspace and Unmaintained ROW	Unrestored; left for natural regeneration	Contiguous	24.54	0.2	n/a	n/a	4.91
		New	0.53	1.0	n/a	n/a	0.53
Temporary Workspace, Unmaintained ROW, and Operational ROW[2]	Unrestored; existing maintained disturbance	n/a	8.99	n/a	n/a	n/a	n/a
Operational ROW[2] (10 m centered on ditch line)	Seeded and maintained	Contiguous	19.97	0.2	n/a	n/a	3.99
		New	0.24	1.0	n/a	n/a	0.24
Maintained Operational Access (ha)			**54.27**	**Subtotal RPRV (ha)**			**9.67**
Total RPRV (ha)							**13.40**
Total RIDV (ha)							**25.49**
Initial Offset Value (ha) (RPRV + RIDV)							**38.89**

Restoration Unit (Project ROW)			RPRV = (RDDV x Inherent Effect) x (1-(1÷(Delivery x Temporal)))				
Footprint Element	**Planned Habitat Restoration Measure[1]**	**ROW Alignment**	**RDDV (ha)**	**Inherent Effect**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Residual Effect (RPRV & RIDV) (ha)**

NOTE:

[1] These measures are planned, and not final. Final restoration measures and corresponding updates to area and IOV calculations will be provided in the Caribou Habitat Restoration Implementation Report and Status Update (see Section 6.1).

[2] The Operational ROW is 23.04 ha and is comprised of 21.78 ha of new permanent disturbance and 1.26 ha of existing permanent disturbance.

5.4 OFFSET DECISION PLANNING AND FRAMEWORK

NGTL's offset decision planning criteria are consistent with the approach outlined in the Business and Biodiversity Offsets Programme (2012a), where the preferred approach to implementing offsets considers the regulatory policies and frameworks under which offsets might be structured. The following challenges to using this approach were identified for this Project:

- Absence of an established offset policy or other regulatory mechanism for developing offsets for caribou and caribou habitat
- Limited availability of provincial range plans, directives, or preliminary guidance for priority caribou management/conservation areas in Alberta

Considering these challenges, NGTL anticipates implementing direct measures that are consistent with priorities identified in the proposed amended federal Recovery Strategy (ECCC 2019). For past NGTL projects in caribou ranges, NGTL has located its offsets in parks for permanency. However, as a result of ongoing consultation with AEP and ECCC, NGTL is investigating options to locate offsets for the Project within the Chinchaga caribou range; this includes exploring opportunities to implement the offset on existing, non-project, NGTL ROWs. Discussions with AEP and ECCC indicated that both regulators would be amenable to on-ROW offsets on existing, non-project, NGTL ROWs, provided there are mechanisms in place for NGTL to maintain vegetation for ongoing operations (i.e., integrity monitoring) and maintenance (i.e., access) (see Section 3.1).

Information from engagement activities with Aboriginal groups, stakeholders, and AEP are used in combination with the methods described below to finalize offset measures in the Final CHR&OMP. The final selection of offset locations will be completed at two scales: (i) landscape (or regional) scale, and (ii) site-specific scale. Considerations for the selection of offset locations at the landscape scale include risks associated with offset permanence, caribou conservation benefits, and spatial context. These risks can be mitigated through the following:

- Regulatory mechanisms for protection of an area result in a higher degree of certainty in the permanence of the offsets
- Selecting offset locations that provide incremental conservation benefits, (adding to existing programs, land-use plans or funding)
- Selecting locations in the same woodland caribou range to provide ecological benefit to the affected herd

At the site-specific scale, permanence considerations relate to operational access requirements and minimal active use, including recreational, industrial, and traditional access needs. These considerations are intended to increase success rates for offset measures in areas where re-disturbance is less likely. Lease holder or disposition agreements that permit application of offset measures and restrict further access are also site-specific considerations that might affect the permanence of offsets.

As on past projects, NGTL will continue to work collaboratively with AEP to identify, prioritize, and select candidate caribou habitat restoration areas in priority caribou ranges for projects in caribou range in Alberta. Selection criteria considered AEP's priority caribou restoration areas, degree of existing disturbance, opportunities for collaborative partnerships and ease of access. A range plan for the Chinchaga caribou range has not yet been released. NGTL anticipates ongoing cooperation with AEP as range plans become available. Through ongoing consultation with AEP, NGTL is confident that offset planning will align with anticipated provincial range plans.

Conceptually, early implementation of offset measures is a desirable outcome. However, the information necessary to calculate an IOV or FOV is not typically available until after construction and planned on-ROW restoration measures have been selected and spatial extents are known. Once this information is known, the IOV can be calculated and subsequently be used to estimate the FOV from a range of potential offset measures and locations that could be implemented. While speculative spatial estimates may be of some value for initial planning purposes, NGTL prefers to have the necessary regulatory approvals and reasonably precise estimates of residual effects on caribou for a project before calculating final values and selecting final offset measures.

In offset planning, landscape level offset location selection criteria will include the following:

- Range planning considerations specific to boreal caribou recovery efforts and management
- Discussions and consultation with provincial and federal regulators
- Available caribou location data
- Areas with reduced or limited active traditional, recreational, or industrial use needs
- Areas adjacent, or near monitoring programs or other wildlife/landscape management objectives (e.g., Algar Restoration Project and LiDea Project [see Fuse Consulting 2014])
- Areas that fall in provincial parks or other locations afforded long-term protection from future development (these sites will be prioritized with the Province to determine overlaps in provincial planning priorities and caribou restoration priorities)

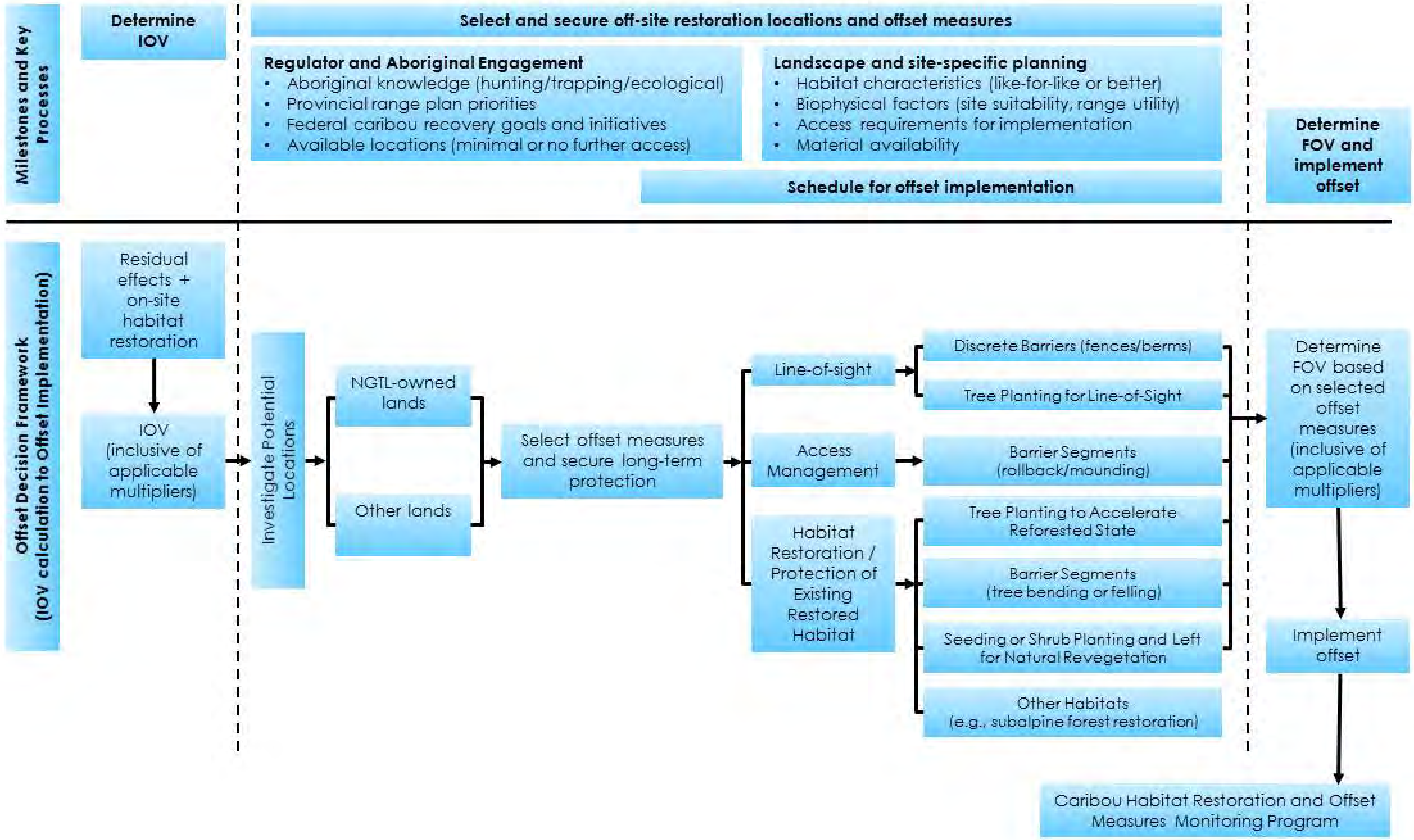
NGTL gives preference to locating offsets within the affected caribou range. However, final offset placement will result from consideration of both the priorities of the provincial regulators, and/or the availability and appropriateness of offset areas. After identifying a candidate offset area that could be secured at the landscape scale, the site-specific scale is evaluated for restoration potential. Once this area has been investigated and caribou habitat considerations such as connectivity of caribou habitat and overall patch size have been considered, restoration units are identified and characterized. After restoration units have been characterized, appropriate restoration measures are then implemented.

As introduced in Section 4.3, Appendix C provides a toolkit of potential habitat restoration and offset measures. Similar to habitat restoration planning for the Project ROW, offset measures will be selected based on expected effectiveness, site conditions, availability of appropriate materials, and NGTL’s habitat restoration and offset experience from other projects.

After the implementation of caribou habitat restoration measures on the ROW and the calculation of the IOV, the Offset Decision Framework (Figure 5-1) will be used for determining and implementing caribou habitat offset measures to allow for the calculation of the Final Offset Value (FOV) (Section 5.5). As illustrated in Figure 5-1, the Offset Decision Framework is divided into two main components:

1. The upper component relates to milestones and key processes
2. The lower component relates to specific decision options and pathways

While the Offset Decision Framework illustrates the offset selection process and the determination of the IOV and FOV as discrete steps, NGTL anticipates using an iterative process to balance constraints, make good use of opportunities, and achieve a high offset value relative to the cost of implementation.



Section 5.0 Offsetting Decision Framework

5.5 CALCULATING THE FINAL OFFSET VALUE

The FOV is dependent on the IOV, and on the selection of offset locations and offset measures. Therefore, before the FOV can be calculated, it is first necessary to know what the spatial boundaries of the as-built project footprint are, and to what extent the planned habitat restoration measures are implemented (i.e., area treated and type of restoration measure). In the case of this Project, the as-built project footprint is known, but the planned habitat restoration has not been implemented yet. The IOV will be updated in a future filing, the Caribou Habitat Restoration Implementation Report and Status Update (see Section 6.1).

The FOV is calculated once offset locations and offset measures have been identified. Risk multipliers specific to the habitat and habitat restoration measures are applied to account for uncertainty in effectiveness and time lag. The inherent effect multiplier is included in the FOV if off-site restoration measures are located on an existing linear feature, but the offset measure does not span the full width of that linear feature (e.g., Northern Resource Analysts 2014).

The FOV is calculated in a manner similar to the IOV. Identified offset locations are categorized by habitat type and habitat restoration measures, identified as restoration units. Multipliers are applied to the IOV for delivery, spatial, and temporal risks specific to the proposed offset habitat and habitat restoration measures, and the inherent effect multiplier is included as needed. The resulting offset area for each restoration unit is then summed to calculate the FOV, using the equation in Calculation 4-2.

Calculation 4-2:

$$FOV\ (ha) = \sum [Restoration\ unit\ (ha)\ \times (Delivery\ Risk\ \times\ Spatial\ Risk\ \times\ Temporal\ Risk)] \times\ [Inherent\ Effect\ Multiplier]$$

A hypothetical FOV is quantified and provided as an example in Table 5-4. The actual FOV for the Project will be provided in subsequent filings with the CER (i.e., Conditions 10 and 11 of Order XG-N081-021-2018); the actual FOV will reflect on-ROW habitat restoration measures implemented and the selection and location of offset measures to be implemented.

Table 5-4 Hypothetical Quantification of a Final Offset Value

Restoration Unit Description			FOV = Updated IOV x (Inherent Effect x Delivery Risk x Temporal Risk x Spatial Risk)					
Habitat Type	**Restoration Measure**	**Offset Location [1]**	**Updated IOV [2,3] (ha)**	**Inherent Effect [4]**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Spatial Risk Multiplier [1]**	**FOV [3] (ha)**
Upland/Transitional	Tree Planting to Accelerate Reforested State	A	25.0	1.0	1.25	1.7	1.0	53.1
Lowland	Tree Planting to Accelerate Reforested State	A	13.9	1.0	1.25	3.3	1.0	57.3
							Final Offset Value (ha)	**110.4**

NOTES
[1] Offset location corresponds with the offset location notation descriptions in Table 5-2 and the associated spatial risk multiplier
[2] In this hypothetical quantification, the 'Updated IOV' is the same as the calculated IOV provided in Table 5-3
[3] IOV and FOV are rounded to one decimal place
[4] If offset is applied on an existing ROW but it does not span the full width, there is a 5.0 multiplier; if offset is applied on an existing ROW and does span the full width, there is a 1.0 multiplier (i.e., neutral)

6.0 FUTURE FILINGS ON CARIBOU HABITAT RESTORATION AND OFFSET MEASURES

The following sections identify NGTL's future filings to the CER on caribou habitat restoration and offset measures for the Project based on the Conditions in Order XG-N081-021-2018.

6.1 CARIBOU HABITAT RESTORATION IMPLEMENTATION REPORT AND STATUS UPDATE

Per Condition 10 of Order XG-N081-021-2018 NGTL will make a separate filing pertaining to the implementation of habitat restoration offset measures, as follows:

> *10. Caribou Habitat Restoration Implementation Report and Status Update*
>
> *NGTL must file with the Board for approval, a Caribou Habitat Restoration Implementation Report and Status Update on the implementation and status of caribou habitat restoration measures undertaken on the Project right-of-way in areas of the Project within caribou habitat. This report must be filed on or before 1 November after the implementation of the restoration measures and must include, at a minimum:*
>
> > *a) a table of caribou habitat restoration measures implemented including, their location on the right-of-way, their distance or spatial extent, the site specific method applied at each location, a description of the adjacent off-right-of-way habitat, as well as any site specific challenges;*
> >
> > *b) updated Environmental Alignment Sheets showing the types of measures implemented and at what locations;*
> >
> > *c) a quantitative assessment and populated tables of the total remaining disturbance (direct and indirect) that was carried into the initial offset value calculation, including the disturbance before restoration, the restored footprint and the total remaining disturbance;*
> >
> > *d) updates to consultation logs;*
> >
> > *e) offset measures planning status; and*
> >
> > *f) updates or considerations, if any, from relevant provincial range or action plans.*
>
> *NGTL must provide a copy of the filing to DTFN and any other Aboriginal communities who express an interest in the filing, as well as Environment and Climate Change Canada, and the appropriate provincial authorities.*

6.2 CARIBOU HABITAT OFFSET MEASURES IMPLEMENTATION REPORT

Per Condition 11 of Order XG-N081-021-2018 NGTL will make a separate filing pertaining to the implementation of habitat restoration offset measures, as follows:

11. Caribou Habitat Offset Measures Implementation Report

NGTL must file with the Board for approval, a Caribou Habitat Offset Measures Implementation Report demonstrating how all Project related residual effects from directly and indirectly disturbed caribou habitat have been offset. This implementation report must be filed on or before 31 March after the implementation of offset measures and must include:

a) an inventory of what measures were implemented, at what map locations, for what distance or spatial area, and on what type of previous disturbance (e.g., type, width, age, condition);

b) a description of factors considered when determining the location for offset measures, including consideration of both site-specific factors, landscape-level factors and how the selected locations optimized landscape restoration or preservation;

c) how the measures at those locations met the Offset Measures Plan criteria for offsets;

d) a quantitative assessment of the final offset value calculations, based on the revised Caribou Habitat Restoration and Offset Measures Plan (CHR&OMP) and inventory of measures implemented from a), and demonstrating how the offset measures have offset the previously calculated residual effects; and

e) evidence of how consultation feedback was integrated into the implementation of offsets, including:

e. i) any feedback from provincial authorities; and

e. ii) any potentially affected Aboriginal peoples whose traditional territory is located where the offset measures may be implemented.

NGTL must provide a copy of the filing to DTFN and any other Aboriginal communities who express an interest in the filing, as well as Environment and Climate Change Canada, and the appropriate provincial authorities.

6.3 CARIBOU HABITAT RESTORATION AND OFFSET MEASURES MONITORING PROGRAM

Per Condition 12 of Order XG-N081-021-2018 NGTL will file the following:

12. Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP)

NGTL must file with the Board for approval, on or before 31 March after the second complete growing season after commencing operation of the Project, a final Caribou Habitat Restoration and Offset Measures Monitoring Program for monitoring and verifying the effectiveness of the caribou habitat restoration and offset measures implemented as part of the CHR&OMP. This CHROMMP must include, but not be limited to:

a) the scientific methodology and protocols for short-term and long-term monitoring of the restoration and offset measures, including the appropriate duration of monitoring for each type of measure implemented;

b) sufficient sampling and control locations to provide statistical validity for each measure, accounting for ecological conditions;

c) protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from either this Program or other NGTL Caribou Habitat Restoration and Offset Measures Monitoring Plans or Programs;

d) a quantitative assessment that demonstrates how the previously calculated residual effects have been offset by the measures implemented, to be updated in each report based on monitoring results; and

e) a schedule for filing reports of monitoring results and the adaptive management responses, to the Board, Environment and Climate Change Canada and provincial authorities to be contained in the CHROMMP as well as at the beginning of each report filed.

NGTL must provide a copy of the filing to DTFN and any other Aboriginal communities who express an interest in the filing, as well as Environment and Climate Change Canada, and the appropriate provincial authorities.

6.4 CARIBOU MONITORING REPORTS

Per Condition 13 of Order XG-N081-021-2018 NGTL will file the following:

> *13. Caribou Monitoring Reports*
>
> *NGTL must file with the Board for approval, based on the schedule referred to in the CHROMMP, Caribou Monitoring Report(s) outlining the results of the CHROMMP. NGTL must also notify DTFN, and any other Aboriginal communities who have expressed an interest in this filing to NGTL, when the filing(s) are available.*

7.0 SCHEDULE

Table 7-1 presents a proposed schedule for construction, habitat restoration, offset measures implementation, and related future filings. NGTL has considered the seasonal sensitivity of caribou and has developed the final clean-up and habitat restoration implementation schedule for the Project with this timing in mind. Final clean-up is proposed to be completed before the start of the caribou restricted activity period (i.e., by February 15, 2020). Habitat restoration is proposed to start in summer 2020 after the end of the caribou restricted activity period (i.e., after July 15, 2020) and continue into November 2020. The schedule for future filings has been updated to reflect the relevant conditions in Order XG-N081-021-2018 (see Section 6.0).

Table 7-1 Proposed Schedule for Construction, Habitat Restoration, Offset Measures Implementation and Related Future Filings

Project Milestones	Timeline
Construction	
Clearing	November to December 2018
Pipeline (Mainline) Construction	November 2018 to March 2019
Machine Cleanup/Validation Testing/Tie-ins	February 2019 to March 2019
Final Cleanup	December 2019 to mid-February 2020
Caribou Restoration and Offset Planning	
Filing of Preliminary CHR&OMP to the NEB	December 2017
Filing of Final CHR&OMP to the CER	January 2020
Implementation of on-ROW Caribou Habitat Restoration	Mid-July to November 2020
Implementation of Offset Measures	August 2020 to November 2021
Filing of Caribou Habitat Restoration Implementation Report and Status Update (Condition 10)	On or before November 1 after the implementation of the restoration measures
Filing of Caribou Habitat Offset Measures Implementation Report (Condition 11)	On or before March 31 after the implementation of offset measures
Filing of Caribou Habitat Restoration and Offset Measures Monitoring Program (Condition 12)	On or before March 31 after the second complete growing season after commencing operation of the Project
Filing of Caribou Monitoring Reports (Condition 13)	Detailed schedule will be defined within the Caribou Habitat Restoration and Offset Implementation Report and Monitoring Plan

8.0 PERFORMANCE INDICATORS

After implementation of the caribou habitat restoration and offset measures, NGTL will undertake monitoring to determine whether the objective, goals, and targets outlined in Section 2.0 of this Final CHR&OMP are achieved. The success of the restoration and offset measures will be quantified by the performance indicators outlined in Table 8-1 and Table 8-2. The primary measures in these tables are taken from Table 4-3; the measures may also have a secondary function. The performance indicators are based on NGTL's experience with restoration measures generally and will be presented in detail in the CHROMMP.

Table 8-1 Performance Indicators to Measure CHR&OMP Goals and Targets (G1)

Goal	Target	Primary Measures	Performance Indicator	Applicability to the Project
(G1) NGTL's caribou habitat restoration and offset measures are ecologically relevant, practically located, and reasonably protected to minimize potential for re-disturbance by human activity	• (T1) Access is lower on managed segments compared with unmanaged segments	• Implement access management • Woody debris rollback • Mounding • Vegetation screens	• <20% increase in access (e.g., rate, proportion, count) from the baseline assessment as measured by remote cameras • Access (rate, proportion, count) on managed segments is lower than on non-managed segments	• Not applicable on the project ROW since the Project is 99% parallel to existing disturbance • Access management is applicable on the offset area to limit access
	• (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 and offset measures	• Applicable to the Project

Table 8-2 Performance Indicators to Measure CHR&OMP Goals and Targets (G2)

Goal	Target	Primary Measures	Performance Indicator	Applicability to the Project

(G2) NGTL's caribou habitat restoration and offset measures establish 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
		• Minimal surface disturbance
		• Seedling planting
		• Shrub staking
			Upland and Transitional Forest Habitat Types:
			• Achieve ≥80% survival rate for planted seedlings within 10 years following implementation of restoration measures
			• Demonstrate sustained growth trends across ≥80% of restoration locations within 10 years following implementation of restoration measures
			Treed Wetland/Lowland Habitat Types:
			• Where tree seedlings are planted (e.g., mounded sites), achieve ≥50% survival rate for seedlings/ transplants within 10 years following planting
			• Demonstrate sustained growth trends across ≥50% of restoration locations within 10 years following implementation of restoration measures
			Shrub/Graminoid Wetland Habitat Types:
			• Within 10 years following implementation of restoration measures:
			  ◦ ≥50% cover of native vegetation species in the project footprint
			  ◦ no restricted weeds
				• Applicable to both the project ROW and offset location

As outlined in Table 8-1, the performance indicators for Goal 1 include measurable parameters to define success of access management. Access management may be implemented on a specific project as a habitat restoration technique or as an offset measure on an existing NGTL ROW. NGTL considers a performance indicator for Target (T1) of no increase (0%) in access after construction to be unrealistic. Recognizing this, but needing to establish an acceptable increase in access, NGTL established an increase in access of < 20%. This performance indicator is intended to address a range of access changes between 0 to < 20%. If it is found that access has increased beyond 20% in areas where caribou habitat restoration measures have been applied, adaptive management will be used to evaluate why the measures are not meeting the intended target and whether remedial measures could address the concern.

As outlined in Table 8-2, 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 lowland locations, and the potential for site specific influences and factors, tree height was not chosen as a monitoring metric.

9.0 MONITORING, ADAPTIVE MANAGEMENT, AND REPORTING

Monitoring, adaptive management, and reporting are important elements to inform whether restoration investments (i.e., on-ROW habitat restoration and offset measures) are contributing meaningfully to the desired strategic outcome of the conservation and recovery of woodland caribou. To this end, NGTL will develop a CHROMMP for the Project to monitor the effectiveness of the habitat restoration and offset measures implemented. The CHROMMP will be designed to identify and manage issues requiring supplemental or remedial action to achieve habitat restoration and offsetting 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.

9.1 MONITORING

NGTL will develop a CHROMMP for the Project consistent with the requirements of Condition 12 of Order XG-N081-021-2018 (see Section 6.3).

9.2 ADAPTIVE MANAGEMENT

Adaptive management is the systematic process of monitoring and assessing outcomes and modifying habitat restoration measures or offset measures if necessary. NGTL will implement adaptive management by supplementing offset measures or taking other 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 and offset measures are considered successful when monitoring results indicate restoration has achieved, or is on trajectory to achieve, the performance indicators and, thereby, the monitoring plan targets. No additional measures or monitoring will be considered necessary at that point. If performance measures indicate that 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; additional offsets) and monitoring will continue until the targets are met.

9.3 REPORTING

In accordance with Condition 13 of Order XG-N081-021-2018 (see Section 6.4), NGTL will file with the CER, based on a schedule to be provided in the CHROMMP, reports outlining the results of the monitoring program.

10.0 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 communities
- Adaptive management practices in the field

10.1 CARIBOU HABITAT RESTORATION RESEARCH

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 and offset measure toolkit (Appendix C) and decision frameworks. Similarly, habitat restoration measures that are determined to be ineffective will be removed from NGTL's toolkit and decision frameworks. Section 10.3 provides examples of lessons learned to date by NGTL regarding habitat restoration measures.

In addition to the continual evaluation and improvement of habitat restoration and offsetting tools over time, other aspects of restoration and offsetting are also routinely evaluated. For example, results from ongoing caribou habitat monitoring activities, and new information from peer-reviewed literature, as it relates to the magnitude of the delivery and temporal risk multipliers, may cause those multipliers to be adjusted to more accurately reflect expected outcomes. In this Final CHR&OMP, the delivery and temporal risk multipliers have been updated to be consistent with other recently filed caribou habitat restoration and offset measures plans (e.g., Stantec 2018a; Stantec 2018c; NGTL 2019).

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.

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10.2 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 km^2.
- 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, conduct 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 and other multi-stakeholder working groups to engage provincial regulators on caribou recovery in Alberta and British Columbia (BC). NGTL is participating, through the Canadian Energy Pipeline Association, on three caribou sub-regional task forces created by the Province of Alberta. These multi-stakeholder task forces are responsible for advising 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).

10.3 LESSONS FROM NGTL HABITAT RESTORATION

Preliminary and final caribou habitat restoration plans were completed for NGTL's Northwest Mainline Expansion Project, Leismer to Kettle River Crossover Project (Leismer), and Chinchaga Lateral Loop No. 3 Project. , , Preliminary plans were also completed for Liege Lateral Loop No. 2 – Thornbury Section and the 2017 NGTL System Expansion Project. , First year monitoring results are available from on-ROW and offset area restoration. Based on NGTL's experience with these projects, the following lessons learned were incorporated into this Final CHR&OMP:

- 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 (NGTL 2019). Unless there is 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 parallels existing infrastructure due to decreased effectiveness (see Appendix D, 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 parallel 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.
- NGTL has implemented 'lattice style' access management in areas where sufficient and appropriately sized timber is available (see Appendix D, 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.

11.0 LITERATURE REVIEW

A literature review was completed to provide regulatory and ecological context relevant to boreal caribou and specifically to the Chinchaga caribou range, 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 and offset 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 4-3). This summary was used to provide the foundation for the toolbox of habitat restoration and offset 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 11.14. Based on the results of the literature review, the habitat restoration and offset measures best suited for caribou range are identified.

This literature review was prepared for the Preliminary CHR&OMP and is, therefore, current to December 2017. Content was updated for this Final CHR&OMP primarily as it pertains to regulatory context, recovery objectives, and guidelines for boreal caribou (i.e., Section 11.2), and offset risk and uncertainty (Section 11.13).

11.1 LITERATURE REVIEW METHODS

The literature review incorporates regulatory and ecological context relevant to the Chinchaga caribou range to inform the selection of appropriate habitat restoration and offset 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 Final CHR&OMP.

A literature review of primary literature, 'grey literature'[8], and guidance documents was completed specific to offsets and referenced in the development of this plan to offset residual project-related effects to caribou habitat. The following presents further details on the approach, rationale, and methods used for the literature review to inform NGTL offset measures planning decisions including scientifically-based definitions, mitigation hierarchy, offset measures, design elements, and risk multipliers.

The literature review of habitat restoration and offset measures was completed using a systematic approach and standard research techniques, which enabled NGTL to consider recent knowledge of caribou habitat restoration in the this Final

[8] That is, literature not produced through commercial publishing.

CHR&OMP. Literature reviewed included federal and provincial recovery strategies and management plans, peer-reviewed primary scientific articles, previously submitted NGTL caribou habitat restoration and offset filings to the CER, caribou habitat restoration and offset filings to the CER from other proponents, publicly available government reports, in-house reference material, guidance documents from expert individuals/agencies, and established offset policies and emerging offset policies from provincial, state, and federal agencies in Canada and internationally.

The literature review for this Final CHR&OMP 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
- Provincial, state, and federal government agency websites for established or emerging offset policies and frameworks (countries included: Australia, Brazil, Canada, New Zealand, the United Kingdom, and the United States)
- Expert agency websites that provide scientific review and best-practice guidance and frameworks for established and emerging offset programs (organizations included: Alberta Conservation Association, Business Biodiversity Offset Programme, Commonwealth Scientific and Industrial Research Organization, International Union for Conservation of Nature, Pembina Institute, the United Nations Convention on Biological Diversity, and Alberta Association for Conservation Offsets)
- 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
- Offset and associated modifiers, such as environmental, conservation, biodiversity, allowance, compensatory, mitigation, bio-banking, direct, indirect, in-kind, out-of-kind, like for like, multiplier and ratio

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.

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

NGTL began consultation and working collaboratively with provincial regulators, Indigenous communities, 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 CHR&OMP 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 Canad*a (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 CHR&OMP 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).[9]

The Final CHR&OMP 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.

In addition to the recovery planning and policy documents described above, NGTL considered 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

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

Two other documents considered by NGTL in the development of this Final CHR&OMP 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.

11.3 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 approximately 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).

11.4 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).

11.5 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 CHR&OMP habitat restoration measures. Earlier NGTL Caribou Habitat Restoration 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 the CHR&OMP 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 the Project and, therefore, some of the thresholds and indicators were used to guide the development of targets and performance indicators for the CHR&OMP.

In particular, the quantifiable targets associated with treed lowland and shrubby/graminoid lowland habitat types incorporated 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 trees 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.

11.6 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.

11.6.1 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 approximately 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 provides 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).

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.

11.6.2 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).

11.7 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 and also creates 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).

11.8 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.

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).

11.9 OFFSET DEFINITIONS

Conservation and biodiversity offsets are generally defined as measurable conservation outcomes or environmental values resulting from actions designed to compensate for residual adverse effects arising from a development after appropriate habitat restoration measures are applied. Conservation offsets generally refer to an increased quantity, quality, or security of specific environmental values outside the project footprint to compensate for residual adverse effects arising from the development activity (Croft et al. 2011; DSEWPC 2012a; Environment Canada 2012). Conservation offsets are generally applied in circumstances where the environmental values are specific to either individual species or plant communities under threat. Parameters can range from numbers of individuals of a threatened species or characteristics of its habitat, to the area and quality of threatened communities or ecotypes (Gibbons and Lindenmayer 2007; DSEWPC 2012a; Bull et al. 2013a).

Some literature suggests that the potential overlapping benefit of conservation offsets might be the indirect conservation of localized biodiversity values where offsets are implemented (Croft et al. 2011; DSEWPC 2012a; Bull et al. 2013b). However, biodiversity offsets are discussed primarily in the context of no net loss, or a net gain, of biodiversity value compared to more generalized environmental values associated with conservation offsets (Department of Conservation 2010; McKenney and Kiesecker 2010; TEEB 2010; BBOP 2012c; Doswald et al. 2012; Maron et al. 2012; Pilgrim and Ekstrom 2014; Sustainable Prosperity 2014; ten Kate and Crowe 2014; Calvet et al. 2015). Habitat offsets aimed at achieving and detecting no net loss can only be successful where the offset ratio is relatively large, monitoring is long-term, robust and precise, and funding is available to substantially increase the amount of habitat if monitoring indicates that this is necessary (Pickett et al. 2013). Biodiversity offsets imply broader considerations of a landscape's ability to maintain biodiversity, while still acknowledging the application might be focused on specific objectives (McKenney 2005; Kiesecker et al. 2009; BBOP 2012c; Poulton 2014).

This Final CHR&OMP follows an approach consistent with the adopted design elements for the development of conservation offsets (offsets) recognizing that the environmental values of concern are specific to the threats and unique conservation needs of caribou and their habitat. Literature reviewed suggests a strong preference for equivalency between the nature of the residual effects and the value added by an offset measure (i.e., like for like or better) (Bull et al. 2013a; Habib et al. 2013; Poulton 2013). This approach is particularly relevant when offsets target specific environmental values rather than a more general mandate that might suit higher-level biodiversity management objectives (Gibbons and Lindenmayer 2007; Bull et al. 2013b).

11.10 MITIGATION HIERARCHY

The sequence of actions to identify the need, availability, and suitability of offsets is outlined in the Standard on Biodiversity Offsets (BBOP 2012c). Under this accepted standard, potential effects of a proposed development activity are assessed in context of a mitigation hierarchy. The mitigation hierarchy includes four steps: avoid, minimize, restoration/rehabilitation, and offset (BBOP 2012c).

Maximizing the degree to which each step is pursued before continuing to the next is the recommended practice to reduce residual effects and the potential need for offsets (BBOP 2012c; DSEWPC 2012a; Environment Canada 2012; Madill and Darling 2017). Offsets are a measure of last resort within the mitigation hierarchy, as their ability to counterbalance ecological losses outside the project footprint is more uncertain and of greater risk than habitat restoration measures applied to the project footprint (Morris et al. 2006; Gibbons and Lindenmayer 2007; Bull et al. 2013a). Offsets counterbalance residual effects by replacing equivalent ecological mechanisms.

In the context of caribou habitat restoration measures that will be applied to the project footprint, the first three steps of the mitigation hierarchy can be described as:

1. **Avoid**: measures taken during project planning stages to avoid potential effects (i.e., route selection, locating temporary workspaces and facilities outside of caribou range).
2. **Minimize**: measures taken to reduce the intensity, extent and/or duration of potential effects (including direct, indirect and cumulative effects, as appropriate) that cannot be completely avoided, as far as is practically feasible (i.e., reduction of footprint size, minimum ground disturbance construction methods, activity scheduling, using existing access and minimizing vegetation clearing).
3. **Restore**: measures taken to rehabilitate or restore equivalent ecological mechanisms following construction.

In the context of the mitigation hierarchy, this Final CHR&OMP reflects the final measures taken to address the residual project effects on caribou habitat.

11.11 OFFSET MEASURES

In referenced literature, including Environment Canada (2012) guidance, existing offset programs commonly use the design elements and frameworks recommended by BBOP (2012c) as the standard best practice, and therefore, this approach was applied to this Final CHR&OMP. Under BBOP, initial planning stages first consider the legal framework and/or policy requirement for an offset. Currently, there is little guidance or policy specific to caribou recovery or offsets in general in Alberta (Poulton 2014; Way 2017). In the absence of caribou range plans, and where disturbance exceeds

35%, ECCC considers all existing habitat to be critical habitat (Corcoran and Eyre 2017). Offsets may be relevant, if, after applying avoidance and mitigation measures, the project will have residual effects. In considering proposed offsets, ECCC will assess whether the offset is consistent with the range plan (Corcoran and Eyre 2017). Notwithstanding, offset criteria, guidelines, and frameworks referenced in the development of this Final CHR&OMP include examples and applications presented in the primary literature, as well as currently available but emerging science to address the unique conservation needs of caribou and their habitat.

11.11.1 Direct and Indirect Offsets

According to BBOP (2012c), as well as ten Kate et al. (2004), McKenney (2005), Croft et al. (2011), Schneider (2011), Weber (2011), DSEWPC (2012a), Environment Canada (2012a), BC MOE (2014b), Sustainable Prosperity (2014), Calvet et al. (2015), and Poulton (2015), offset measures can be categorized as 'direct offset' and 'indirect offset'. A habitat-based rationale specifies that direct offsets are distinct from indirect offsets based on whether habitat is, or will be, directly modified (BBOP 2012a; Bull et al. 2013a). The terms 'direct offset' and 'indirect offset' are not to be confused with, or considered directly related to, the terms 'direct effects' and 'indirect effects'. A direct or indirect offset can be applied to either a direct or indirect effect.

Direct offsets include like-for-like habitat restoration, land securement such as rezoning or transfer of development rights for land protection, or population management such as caribou population enhancement or predator and other ungulate control programs. Equivalency between the environmental value affected by a project and the value added by a direct offset measure (i.e., like-for-like) is recommended (BBOP 2012c; Environment Canada 2012; Bull et al. 2013a; BC MOE 2013; Northern Resource Analysts 2014, 2016; NGTL 2015). Land securement is typically limited to proponents with tenure or development rights within caribou habitats that meet the objectives of like-for-like quantity and quality. Population management is problematic for a single proponent to implement effectively and requires continuous investment (Northern Resource Analysts 2016).

Indirect offsets are typically comprised of financial contributions (i.e., offset funding) that would be transferred from a proponent to a trust fund or the government, or to research and monitoring programs, in advance of development (i.e., financial offsets). The effectiveness of offset funding for caribou habitat in Alberta is currently untested. However, with respect to no net loss of biodiversity, studies show that, in most cases, offset funding programs do not provide sufficient guarantees that this can be achieved (Calvet et al. 2015). Offset banking, by which individual proponents contribute funds to a large restoration project ahead of impacts, can yield better ecological and effectiveness outcomes than offset funding (Calvet et al. 2015). However, Calvet et al. (2015) notes limitations of the offset banking approach which include incomplete and imprecise scientific knowledge regarding biodiversity and conservation issues, and conceptual limitations stemming from the inherent difficulty of applying the most recent advances in ecology and conservation biology.

NGTL's approach to offsetting will be to use on-the-ground restoration measures, and to avoid using financial offsets (i.e., funding or banking) as a mechanism for compensating for loss of caribou habitat.

11.11.2 Canadian Examples

In Canada, compensating for lost fish habitat was first introduced by Fisheries and Oceans Canada (DFO) as a policy objective to achieve net gain of habitat within its 1986 Policy for the Management of Fish Habitat (DFO 1986). In 2013, DFO amended the *Fisheries Act*, embedding a modernized approach to offsetting into regulation. *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013a), requires proponents of projects that cause serious harm to fish and fish habitat to offset that harm to maintain and enhance the ongoing productivity of important fisheries serving the public interest.

Offset measures include habitat restoration and enhancement, habitat creation, chemical or biological manipulations (stocking of fish or control of aquatic invasive species), complementary measures (contributions to scientific research to maintain or enhance productivity of fisheries) and habitat banking in advance of the project's impact.

Provincial requirements for compensation of the permanent loss of wetlands are discussed in Alberta's Wetland Policy (Government of Alberta 2013). Where permanent losses occur, the policy employs restorative and non-restorative replacement objectives where offset ratios consider the value of wetland lost versus the value of wetland replaced. Wetland evaluation criteria include biodiversity, water quality improvement, flood reduction, human value, and relative abundance (current versus historical). Offsets for wetlands in Alberta are reviewed on a case-by-case basis and follow guidance documents and frameworks for other wetland compensation programs in Canada (Cox and Grose 2000). A proponent is offered the option of reducing their own impact, implementing restorative treatment (which could take the form of the developer's own restoration), enhancement or construction of another wetland, or paying an in-lieu fee into a government-authorized fund (Poulton 2015).

The *Alberta Land Stewardship Act* has provisions that endorse in general terms the research and development of new legal and policy tools to pursue objectives and regional plans (Poulton 2015). Among these are offsets.

Conservation offset policy is very much in early development in Alberta. However, the Government of Alberta has committed to interested stakeholders to examine several regulatory instrument options, including a regulation-based biodiversity offset policy, available under the *Alberta Land Stewardship Act*. In Canada, both federally and provincially, there is a general lack of frameworks that enable best practices on offsets (Sustainable Prosperity (2014). Alberta is focusing its policy development upon adapting a model of conservation offsetting which was developed in Alberta originally for greenhouse gases and wetlands (Poulton 2015). NGTL will continue its participation in this and other stakeholder consultation opportunities provided by the Government of Alberta into the future.

The *British Columbia Ministry of Environment Policy for Mitigating Impacts on Environmental Values* ('Environmental Mitigation Procedures') (BC MOE 2014a) consider design elements in terms of environmental value and ecological equivalency (BC MOE 2014a). These Environmental Mitigation Procedures recognize the importance of the best available data and information to be used for developing procedures for specific environmental values, associated components, and risks (BC MOE 2014b). Environmental values and risks are reviewed in the context of the mitigation hierarchy; offsets are judged on a case-by-case basis in consideration of the residual effects (Madill and Darling 2017).

BC MOE (BC MOE 2014b) introduce the concept of environmental indicators as the metrics to trend and report on the processes affecting environmental components. Environmental risks are considered in terms of probability of occurrence and consequence to the environmental value and graded using a qualitative matrix (BC MOE 2014b).

Ontario's *Endangered Species Act* allows for a form of offsetting using overall benefit permits. An overall benefit permit authorizes a person, company, or organization to perform a harmful activity so long as they provide an overall benefit to the species or environmental resource through impact monitoring, effectiveness monitoring, and supplementary actions to achieve the overall benefit (i.e., offset measures). Examples such as these demonstrate how several provinces have regulatory and policy regimes incorporating the mitigation hierarchy and the concepts of habitat offsets or compensation.

Although offset mechanisms can be found in various policies and pieces of legislation in Canada, implementation is in the early stages and policy-makers and program operators are still interpreting what the policies mean for how best to implement offsets in practice. While many are cautiously optimistic that offsets will achieve positive outcomes, it remains too early to say conclusively if they are indeed being applied in ways that support conservation goals and protect biodiversity and habitat (Sustainable Prosperity 2014).

11.11.3 International Examples

In the United States, early examples of offset policies include the *Clean Water Act* (1972) and the *Endangered Species Act* (1973). Compensatory mechanisms under these legislative acts (as they evolved) generally consider the type, degree, and scale of habitat disturbance, where compensation ranges from habitat restoration activities through financial contributions to trusts or other conservation programs. Previously, the United States Department of the Interior had an Instruction Memorandum, which outlined offsite mitigations where project effects could not be mitigated to an acceptable level onsite (1740/1790 [310/230] P, Instruction Memorandum No. 2008-204). The United States wetland and stream mitigation policies are well-established offset programs. Conservation banks for wetlands, stream mitigations, and threatened species management have seen modest increases at both state and federal jurisdictions in the Unites States (Environmental Law Institute 2002). Some of these programs follow no net loss design elements within environmental impact assessment criteria, while others provide indirect contributions to specific conservation programs. Similar offset models are observed in Africa, the European Union and South America, which are either emerging policies or voluntary contributions (Madsen et al. 2011).

Madsen et al. (2011) documented at least 45 existing compensatory mitigation programs, ranging from banking of biodiversity credits through allocation of development fees, to policies that drive one-time offsets. At the time of publication of Madsen et al. (2011), another 27 programs were in various stages of development. Countries with offset policies enabled through legislation include Australia, Brazil, Canada, New Zealand, Sweden and the United States (Bovarnick et al. 2010; Government of Western Australia 2011; Madsen et al. 2011; DSEWPC 2012a; DEFRA 2013; NSW Government 2014; Queensland Government 2014).

Offset policies in Australia and New Zealand generally follow the mitigation hierarchy with no net loss objectives (Department of Conservation 2010; Government of Western Australia 2011; DSEWPC 2012a; NSW Government 2014; Queensland Government 2014). With established policies dating back nearly 20 years, offset programs are relatively diversified with established bio-banking trust funds (or conservation banks) and other offset mechanisms under the *Environmental Protection and Biodiversity Conservation Act* (Australia) and *The Conservation Act* (New Zealand). Bio-banking trust funds have provided flexibility to align offsets toward the priority conservation objectives. A prominent example is The Reef Trust, with the strategic objective of improving water quality, habitat, managing invasive species, and protecting threatened species in The Great Barrier Reef World Heritage Area (Commonwealth of Australia 2015).

11.11.4 Offset Challenges

Where offset policies are established, some have been acknowledged as imperfect, uncertain, or ineffective in maintaining environmental values (Morris et al. 2006; Gibbons and Lindenmayer 2007; Madsen et al. 2011; Bull et al. 2013a; DEFRA 2013). One of the most common criticisms levelled at offsets is that they exchange certain and almost immediate losses for uncertain future gains. In the case of restoration offsets, gains might be realized after a time delay of decades, and with considerable uncertainty (Laitila et al. 2014). Offsets are perceived as more remote and uncertain than actions directly applied to prevent, reduce, or repair a development's effects. Offsets cannot make unacceptable development acceptable; they simply provide an additional tool that can be used during the environmental impact assessment process (Department of Conservation 2010; BBOP 2012c; DSEWPC 2012a; DEFRA 2013).

Bull et al. (2013a) provides a review of the theoretical and practical challenges of offset guidelines, frameworks, and policies, and identifies the importance of an established policy or legal framework to direct, protect, and sustain offset programs. Additional recommendations for offset criteria include that the objectives (i.e., equivalency, permanency and uncertainty) and the degree of financial investment necessary to achieve gains (i.e., multipliers) be based on scientific research, rather than a priori assumption of offset effectiveness (Bull et al. 2013a).

Despite the complex and inter-relating challenges associated with offset design, objectives, implementation, and compliance, they are not considered sufficiently flawed to be dismissed as a policy instrument. In the absence of conclusive scientific research to provide guidance, adaptive management is suggested to provide an opportunity to reduce uncertainty risk for specific circumstances where offset response cannot be adequately predicted or does not achieve gains (Gibbons and Lindenmayer 2007).

An evaluation of offset opportunities for caribou in Alberta and practical impediments for implementation was completed by Robichaud and Knopf (2014). The authors concluded that several actions to offset impacts of development and achieve no net loss or net positive impact for caribou are theoretically feasible (i.e., if implemented they should work), including habitat restoration and manipulations of the large mammal predator-prey system. However, implementation challenges are substantial and include a lack of mechanisms for setting aside some resources for long periods of time, public opposition to predator control, and uncertainty associated with loss-gain calculations. A framework and related policy for offsets is currently lacking in Alberta, but its development would undoubtedly provide important guidance on the successful design and implementation of offsets for caribou.

11.12 OFFSET DESIGN ELEMENTS

Design elements are offset selection factors chosen in consideration of the potential environmental effects of a project, as well as the unique conservation needs, including equivalency, additionality, location, timing, duration, and accountability. Design elements consider the environmental values, available offset measures, their effectiveness, and the achievability of objectives (McKenney 2005; McKenney and Kiesecker 2010; BBOP 2012c; DSEWPC 2012b; Bull et al. 2013a).

Proponents advocate offsets as an effective and operationally efficient mechanism for enhancing environmental values and achieving important conservation objectives (McKenney 2005; Dyer et al. 2008; Bovarnick et al. 2010; McKenney and Kiesecker 2010; Croft et al. 2011; BBOP 2013; Pickett et al. 2013; Sustainable Prosperity 2014). Offsets in their various forms (e.g., like for like mitigation, banking or trading programs, land securement) provide flexibility for stakeholders, industry, and regulatory authorities to exercise several measures where legislative frameworks and policy exist. However, a large amount of effort is required for successful outcomes (Pickett et al. 2013).

The reasons why offsets are undertaken vary. Offsets can be undertaken voluntarily or can be a regulatory requirement imposed as a condition of approval before receiving a permit for a specific project (Doswald et al. 2012; Sustainable Prosperity 2014; Calvet et al. 2015; Poulton 2015). A key benefit of offsets is that they allow both offset purchasers and offset creators flexibility. Under ideal circumstances, developers will look at the cost of complying with offset requirements and factor the associated cost into the overall project cost to decide ultimately whether or not to proceed with the proposed project or whether to redesign the project to lessen impacts on environmental values (Sustainable Prosperity 2014). However, there are potentially dozens of ecological, cultural, social, economic, and resource location factors that could affect project design and costs, and only a few reasonable options might be considered. Conversely, offsets may come into force under policy or as a condition of project approval after most project design considerations have been finalized, which can contribute to investment uncertainty.

International best practices suggest that offset design elements should be considered on a case-by-case basis and be reflective of the legislative framework governing the offset requirement. Furthermore, offset design elements should address residual effects of the development and provide benefit to environmental values or equivalent ecological mechanisms affected (ten Kate et al. 2004; BBOP 2012c; 2013; DSEWPC 2012a; Environment Canada 2012; DEFRA 2013).

Monitoring of habitat offset projects is generally recommended pre- and post-development to determine success, and long-term monitoring should be undertaken to evaluate sustainability and achievement of objectives (Quintero and Mathur 2011; Pickett et al. 2013).

The following design elements are identified as a starting point for the development of conservation allowances or conservation offsets (Doswald et al. 2012; Environment Canada 2012; Pilgrim and Ekstrom 2014; Sustainable Prosperity 2014):

- **Effectiveness**: the likelihood that the objective of the offset will be achieved, and that the chance of failure is minimized.
- **Equivalency**: offsets should compensate for adverse impacts by protecting, enhancing or restoring equivalent ecological mechanisms at another site.
- **Additionality**: offsets should provide ecological protection beyond what would be provided under a business-as-usual scenario.
- **Location**: the location of offsets should have comparable ecosystem values, such as species composition and habitat structure, and should be determined based on an assessment of the relevant species and habitat/ecosystem context.
- **Timing**: the preference is for offsets that can be implemented before the adverse impacts of proposed development occur.
- **Permanence**: the positive effects of offsets should last an appropriate amount of time (ideally, in perpetuity) to compensate for the duration of the ecological loss resulting from the project.
- **Accountability**: offsets should be formalized through written documentation, or, where possible, formalized through permitting or other conditions.

Additional offset design elements described by Environment Canada (2012a) include:

- Providing an operational framework relevant to the jurisdiction within which the project is located.
- Adherence to the mitigation hierarchy and international best practice suggested by BBOP (2012c, 2013) and other offset policies (Department of Conservation 2010; Government of Western Australia 2011; DSEWPC 2012a; NSW Government 2014).
- Alignment of environmental values with the unique conservation needs of caribou and federal recovery strategy objectives (e.g., (ECCC 2019) and provincial guidelines (Government of Alberta 2011).
- Providing consistency with current federal and provincial position statements and expert agency recommendations concerning offsets (Dyer et al. 2008; Croft et al. 2011; DEFRA 2011; Poulton 2014; Schneider 2011; Weber 2011).

11.13 OFFSET RISK AND UNCERTAINTY

Multipliers are used to address the risks and uncertainties associated with different types of offset measures (Dyer et al. 2008; Moilanen et al. 2009; McKenney and Kiesecker 2010; Croft et al. 2011; Australian Government 2012; BBOP 2012c; DEFRA 2012). Within the literature, multipliers vary considerably between regulatory jurisdictions and agencies, including the methods used to calculate an appropriate multiplier (Department of Environmental Affairs and Development Planning 2007; Moilanen et al. 2009; Cole 2010; Croft et al. 2011; Australian Government 2012; BBOP 2012b; Government of Alberta 2013; Queensland Government 2014; Barker 2017). Offset measures based on scientific knowledge or proven techniques reduce the need for higher multipliers as uncertainty and risk concerning offset effectiveness are predictable (Cox and Grose 2000; Moilanen et al. 2009; Croft et al. 2011; DSEWPC 2012a; BBOP 2013). Higher multipliers are employed to discourage development activities where the permanent loss of environmental values or ecological mechanisms may occur, or in areas that are considered more at risk or of higher value (Cox and Grose 2000; Moilanen et al. 2009; Croft et al. 2011; DSEWPC 2012a; Government of Alberta 2013). Indirect offsets (e.g., research programs) generally incur higher multipliers where equivalency to the environmental values or ecological mechanisms could not be achieved (Cox and Grose 2000; Moilanen et al. 2009; DSEWPC 2012a; Government of Alberta 2013).

While multipliers are a common feature in offset policy, and are typically expected by regulatory agencies, there is little in the way of established practices or scientific rationale describing how to calculate an appropriate offset multiplier, or whether the proponent alone should bear the risk of the offset if it fails (BBOP 2012c). For example, in BC there is policy guidance for implementing a 4:1 offset ratio for effects on high elevation winter range (BC MOE 2013), but a rationale for the ratio is not provided. Environment Canada (2012a) states that the ratio of offset to adverse effect should be greater than 1:1 in all cases, often at least 2:1, and in some cases much higher. As an example, ECCC recommended a 4:1 ratio for the 2017 NGTL System Expansion Project (NGTL 2015), but a rationale for the recommended ratio was not provided.

A method for defining and including multipliers for determining an offset has been developed for NEB-regulated projects that affect caribou habitat. Northern Resource Analysts (2014; 2016) developed the method by undertaking an expert-based survey and integrating principles and best practices for determining biodiversity offsets (e.g., DEFRA 2011, 2012; BBOP 2012c). The method has been applied to NEB-regulated projects on multiple NGTL projects, including the Northwest Mainline Expansion Project (NGTL 2013; Northern Resource Analysts 2014), the Chinchaga Lateral Loop No.3 Project (Northern Resource Analysts 2016), the 2017 NGTL System Expansion Project (NGTL 2015), the Smoky River Lateral Loop

Project (NGTL 2017c), and the North Montney Mainline (NGTL 2019). The method has also been reviewed and used on other NEB-regulated projects, including the High Pine Expansion Project (Stantec 2018), the Pine River Aerial Crossing and 2BL Crossover Projects (Stantec 2017b), the Wyndwood Pipeline Expansion Project (Stantec 2018c), and the Spruce Ridge Program (Stantec 2018b).

The method used by Northern Resource Analysts (2014, 2016) to calculate an offset uses the concept of applying risk multipliers to different kinds of habitat restoration actions to account for uncertainty and time lags. To gain a current understanding of caribou habitat restoration measures and effectiveness, Northern Resource Analysts undertook a survey of 36 caribou experts representing government, industry, academia, and consulting professionals. The survey asked 45 questions pertaining to range utility (i.e., predator/prey use of a landscape altered anthropogenic disturbance and fire [Northern Resource Analysts 2014]), mitigation effectiveness, and uncertainty, and asked survey participants what value they would consider appropriate for delay factors or mitigation effectiveness. For example, if discrete barriers were to be implemented at a high intensity, survey respondents indicated that there would be no delay factor following implementation, and that the measure would be effective about 50% of the time. Details of the questionnaire, and survey responses, are provided in the Final Offset Measures Plan (OMP) for the Chinchaga Lateral Loop No.3 (Northern Resource Analysts 2016).

While the Northern Resource Analysts (2014) method was based on the expert opinions of those surveyed at the time, NGTL acknowledges that as part of continual improvement, risk multipliers should be reviewed and updated as necessary based on new information and feedback. This includes new information from peer-reviewed scientific literature, ongoing and new monitoring programs, and policy updates, and from feedback received during consultation with regulatory agencies on project-specific offset plans. Feedback from regulatory agencies is considered an important component in defining multipliers and project-specific offset amounts (BBOP 2012c; Environment Canada 2012).

Where uncertainty and time lags exist, the Department of Environment, Food and Rural Affairs (DEFRA) in the United Kingdom (DEFRA 2012) proposed multipliers for discrepancies or risks based on a model developed by Moilanen et al. (2009). This same approach was used by Northern Resource Analysts (2014; 2016) in developing an offset calculator and associated risk multipliers for impacts to caribou habitat. The risk multipliers, which are adopted for this Final CHR&OMP, are defined as:

- **Delivery Risk**: Pertains to the challenges and uncertainty of the habitat restoration technique and whether it can be effective or achievable. The key factors that contribute to delivery risk include effectiveness (i.e., probability of failure or underperformance), additionality (i.e., is the offset contributing to habitat above and beyond what is required or already in place), and permanence (i.e., protection from future disturbance). There is an inverse relationship between these categories and the delivery risk ratings (e.g., as effectiveness improves, delivery risk declines).

- **Temporal Risk**: Pertains to when each habitat restoration measure would be expected to be achieved. Temporal risk is associated with delay factors, such as the time required for habitat restoration measures to achieve the offset objective and goals. In this Final CHR&OMP, temporal risk accounts for the period of time between when the effect commences (i.e., vegetation is cleared) and when habitat becomes suitable for caribou and/or not suitable for wolves and alternate prey. Suitability depends on site and growing conditions, and restoration prescription (e.g., species and height of seedlings).
- **Spatial Risk**: Pertains to the spatial relevance of the habitat restoration measure in relation to caribou habitat affected. The key factors that contribute to spatial risk include proximity to the affected population, and equivalence of the habitat (i.e., critical habitat range type and biophysical attributes) disturbed by the Project and the offset habitats. Spatial risk increases as the proximity of offset habitat to disturbance habitat increases.

11.13.1 Delivery Risk

For a given mitigation or restoration measure that is implemented, there is likely to be an associated delivery risk (i.e., uncertainty) that the measure will not achieve the intended objective either partially or at all (Moilanen et al. 2009; DEFRA 2012). Those measures that are not expected to achieve the objective should be avoided, as they can lead to exceptionally high offset ratios with little chance of being effective (Moilanen et al. 2009; BBOP 2012c; DEFRA 2012). Generally, delivery risk tends to be greater for novel or untested restoration measures, for restoration measures that require specific applications or specialized implementation techniques that are not easily achieved, or for 'one-size-fits-all' restoration treatments intended for multiple species (Moilanen et al. 2009; DEFRA 2012). Conversely, delivery risk tends to be lower for habitat restoration measures that are well-defined, widely utilized, known to work, are relatively easy to create and implement, and are specific to an intended species or habitat objective. An example of a restoration measure that would have a low delivery risk multiplier in British Columbia would be tree-planting and associated silviculture practices that are based on sustainable forest management goals, objectives, and standards, and are supported by a long history of success.

A theoretical analysis of offset multipliers that used a probabilistic model to account for delivery risk was developed by Moilanen et al. (2009). The model predicted that offset multipliers could be as low as 2, or greater than 100 when the predicted probability was greater than 50% and the degree of uncertainty of the habitat restoration measure was moderate to high (Moilanen et al. 2009). DEFRA (2012) based its offsetting program on the principles of Moilanen et al. (2009), and so too did Northern Resource Analysts (2016) when developing a caribou OMP. Both DEFRA (2012) and Northern Resource Analysts (2016) acknowledged that as offset delivery risk multipliers became excessively large for a given restoration measure that there was likely little value in pursuing the measure at all. For example, partial blocking of access across a ROW is unlikely to deliver on the intended function and therefore is not included in the restoration or offset toolbox (see Section 4.3).

The delivery risk multipliers used by DEFRA (2012) are provided in Table 11-1. DEFRA (2012) asked experts to assign a delivery risk category to several broad habitat types (i.e., exclusive of knowledge of site-specific habitat substrates, nutrient levels, and existing state) throughout England as a starting point. Values assigned to the recreation of habitats ranged from ‘low’ to ‘impossible’, and values assigned to restoration of habitats ranged from ‘low’ (1.0 multiplier) to ‘high’ (3.0 multiplier).

Table 11-1 Delivery Risk Multipliers used by DEFRA (2012)

Category of Difficulty for Recreating or Restoring Habitat	Delivery Risk Multiplier
Impossible	-
Very High	10.0
High	3.0
Moderate	1.5
Low	1.0

Northern Resource Analysts (2016) used the results of its questionnaire to support assigning delivery risk multipliers to a suite of caribou habitat restoration measures (Table 11-2). These values were based on respondents’ answers to specific questions[10]. Discontinuous measures such as fences, berms, rollback, mounding, and tree planting that did not span the full width of a project ROW (or the full width of a project ROW and an existing contiguous ROW) were viewed as having less value (i.e., higher uncertainty) than the same measure when applied continuously across the full width of a ROW. Among access management measures, 60% of respondents indicated that continuous application of rollback would have the lowest delivery risk; rollback is also identified as effective in other literature when applied at specific volumes and lengths (e.g., CLMA and FPAC 2007; EOS 2009; AER 2013). For tree planting, 54% of survey respondents indicated that continuous application of this measure would result in 100% reduction of an effect in the long term, whereas 38% of survey respondents indicated that discontinuous application would result in a 50% reduction of effect in the long term.

[10] Questions 27-45 in the survey (see Northern Resource Analysts 2016).

Table 11-2 Delivery Risk Multipliers used by Northern Resource Analysts (2016)

Habitat Restoration Measure[1]	Delivery Risk Multiplier[2]
Discrete Barriers (fences/berms)	2.0–3.3
Barrier Segments (rollback/mounding)	1.6–3.3
Tree Planting for Line-of-Sight	1.25–2.5
Tree Planting to Accelerate Reforested State	1.25

NOTES

[1] Some potential restoration measures, such as seeding, were not included in Northern Resource Analysts (2016).

[2] Delivery risk multiplier values vary depending on the application of the habitat restoration measure and the intensity of the application.

11.13.2 Temporal Risk

Temporal risk (i.e., delay) multipliers are used to account for the elapsed time between an adverse effect occurring, and a planned restoration or offset measure (e.g., tree planting) achieving a specified goal such as a net neutral or positive effect (Quétier and Lavorel 2011; Environment Canada 2012). Generally, temporal multipliers are smaller when the duration is relatively short, and larger when the delay is relatively long.

For ecological restoration of caribou habitat in boreal ecosystems, literature suggests that forested stands at 40 years post-fire have recovered sufficiently to function as caribou habitat (Coxson and Marsh 2001; BC MOFR 2010; Environment Canada 2014). This is further supported by a review of literature by Ray (2014), which suggests that boreal caribou generally switch from avoidance of, to selection for, forested habitats when the forest is more than 40 years old. Additionally, forage biomass for primary prey (e.g., deer and moose) and habitat use by wolves gradually decreases following the forest initiation stage (i.e., 0–10 years) and through the forest establishment stage (i.e., 11–25 years) (Ray 2014; BC MOE and BC MFLNRORD 2017).

One target for achieving functional restoration of forested stands in boreal caribou ranges in BC is to achieve an average tree height of at least 3 m (BC MOE and BC MFLNRORD 2017). This vegetation target height is within the range of values reported elsewhere, whereby vegetation height ranging from 1.2 to 5 m tall have been shown to reduce wolf, grizzly bear, and human use and movement rates along linear features (Finnegan et al. 2014; Dickie et al. 2017). In northern Alberta, Dickie et al. (2017) compared wolf movement rates in relation to vegetation height on linear features with wolf movement rates in forests without linear features. They found that wolf movement rates were similar in summer when vegetation height was 4.1 m tall, and similar in winter when vegetation height was 2.4 m. They also noted that wolf movement rates on linear features began to drop substantially when vegetation height exceeded 0.5 m and when at least 30% of a linear feature had vegetation that exceeding 4.1 m. In this context, temporal risk can in part be linked to functional restoration of caribou habitat by identifying vegetation height and cover targets that reduce predator movement and relating them to differential growth rates among vegetative species and ecosites.

The number of years to achieve effective functional height (i.e., 2.5–5.0 m across seasons) will vary with site conditions and tree species but could be less than 20 years (BC MOE and BC MFLNRORD 2017). Where restoration measures such as access management and line-of-sight are implemented, the timeframe for functional habitat restoration may be reduced further, and in some instances, be effective immediately. For example, planting older trees (1.2–1.5 m tall) over a sufficient area and at a sufficient density could greatly reduce temporal lag for measures aimed at achieving line-of-sight objectives, such as concealing 90% of an adult caribou at 60 m distance (BC MFLNRO 2016).

DEFRA (2011; 2012) developed a range of temporal multiplier values based on the theoretical work of Moilanen et al. (2009). The multiplier values range from 1.2 to 3.0 for 5 year to 32 year time periods (Table 11-3), which were applicable to the recovery of a variety of broad habitat types (excluding those classed as impossible to recreate or restore). Northern Resource Analysts (2016) adopted the temporal risk multipliers developed by DEFRA (2011)[11], but applied generally the lower (1.2) and upper (2.8) values based on respondent's answers to questions[12] relating to temporal delay and different restoration measures (Table 11-4). Measures that were considered effective immediately were assigned a temporal risk multiplier of 1.0.

Table 11-3 Temporal Risk Multipliers used by DEFRA (2012)

Years to Target Condition	Temporal Risk Multiplier
5	1.2
10	1.4
15	1.7
20	2.0
25	2.4
30	2.8
32	3.0

[11] In DEFRA (2012), a 3.0 target multiplier was used for 32 years; this was not included in DEFRA (2011).
[12] Questions 27-45 in the survey (see Northern Resource Analysts 2016).

Table 11-4 Temporal Risk Multipliers used by Northern Resource Analysts (2016)

Habitat Restoration Measure[1]	Temporal Risk Multiplier[2]
Discrete Barriers (fences/berms)	1.0
Barrier Segments (rollback/mounding)	1.0
Tree Planting for Line-of-Sight	1.2-2.8
Tree Planting to Accelerate Reforested State	1.2-2.8

NOTES
[1] Some potential restoration measures, such as seeding or shrub planting, were not included in Northern Resource Analysts (2016).
[2] Temporal risk multiplier values vary depending on the application of the habitat restoration measure and the intensity of the application.

Regionally, tree height-growth curves can be informative for determining an appropriate temporal risk multiplier when planting tree seedlings as a habitat restoration measure. For example, in BC, for interior spruce on moderately productive sites, a model developed by Hu and García (2010) estimated that an average tree height of 2.5 to 5.0 m would be achieved in 6 to 11 years. Also, for lodgepole pine on moderately productive sites, a model developed by Batho and García (2014) estimated that an average tree height of 2.5 to 5.0 m will be achieved in 5 to 9 years.

11.13.3 Spatial Risk

Spatial risk is directly linked to the ‘equivalency’ and ‘location’ elements of offsetting. Generally, offset measures that are implemented in like-for-like or better areas would have a low spatial risk multiplier, and offsets located in areas that would have little value in relation to the impact area would have a high spatial risk multiplier. A spatial risk multiplier of 1.0 is commonly used when the offset links directly to the value being affected and is expected to directly contribute to the goal of no net loss or net benefit (e.g., DEFRA 2012; Noga and Adamowicz 2014).

Spatial risk multipliers in the context of offsetting for wetland losses are relatively well-developed. For permanent wetland losses in Canada, Cox and Grose (2000) found that spatial risk multipliers for replacement wetlands ranged from 1.0 to 4.5. More recently however, in Alberta, spatial risk multipliers for wetlands can range from 1.0 to 8.0, with the multiplier value depending on the value of the wetland lost versus the value of the wetland replaced (Alberta Government 2013). In the United States, the average multiplier for wetlands was 1.36 when a banking scheme was used, and 1.41 when a trading scheme of spatial wetland area was used (Brown and Lant 1999). In Ohio and Michigan, a 1.0 multiplier is used when the offset meets like-for-like criteria, whereas in New Jersey a 2.0 multiplier is used for like-for-like offsets (Environmental Law Institute 2002). In Australia, land-based offset risk multipliers range from 1.0 to 4.0, and take into consideration offset area, area of impact, and ecological equivalency (Queensland Government 2017).

The approach used by DEFRA (2012) to identify spatial risk multipliers is summarized in Table 11-5. In this approach, location parameters are tied to specific offsetting strategies that identify the preferred area(s) for an offset, such as within a specific ecosystem type, species' range, or management area. When an offset is planned for implementation in a location identified within the offsetting strategy, no spatial multiplier is required. If the location identified for offsetting buffers, links, restores, or expands a habitat area outside of an area identified in the offsetting strategy, a spatial risk multiplier of 2.0 is used. Lastly, if the offset is not expected to contribute to the offsetting strategy, a spatial risk multiplier of 3.0 is used.

Table 11-5 Spatial Risk Multipliers used by DEFRA (2012)

Location Parameter	Spatial Risk Multiplier
Offset is in a location identified in the offsetting strategy	No multiplier required
Offset is buffering, linking, restoring or expanding a habitat outside an area identified in the offsetting strategy	2
Offset is not making a contribution to the offsetting strategy	3

A modified version of the spatial risk multipliers used by DEFRA (2012) was used recently in a caribou OMP for the Chinchaga Lateral Loop 3 Project in Alberta (Table 11-6) (Northern Resource Analysts 2016). A spatial risk multiplier of 1.0 was used for offsets that would be located within an area accessible to the affected species' population, and a multiplier of 3.0 was used if the location of the offset was not expected to contribute toward the objective of no net loss or net gain of caribou habitat.

Table 11-6 Spatial Risk Multipliers used by Northern Resource Analysts (2016)

Location Parameter	Spatial Risk Multiplier
Offset is located so that it is accessible to the species population affected	1.0
Offset is directly contributing to a spatially identified area, corridor or stepping-stone or restoration area where accessibility by a population is not required	1.5
Offset buffering, linking, restoring or expanding a habitat outside an area outside of the offset area in question	2.0
Offset does not contribute to any of the above	3.0

11.13.4 Inherent Effect

Another multiplier, developed by Northern Resource Analysts (2016), is the 'inherent effect' multiplier. The inherent effect multiplier is a discount factor that allows for a potential project effect (and the resulting offset value) to take into account similar existing effects (see below), and potentially incentivize developers to use existing disturbance to the extent possible (i.e., to utilize the avoid and reduce levels of the mitigation hierarchy as much as possible). In Alberta, respondents to a questionnaire on caribou and caribou habitat indicated that developers who utilized existing linear disturbances and minimized the amount of new cut would reduce project effects considerably and was thus viewed as a high value measure (CLMA and FPAC 2007). An inherent effect multiplier could also reduce the potential for unintended outcomes (i.e., perverse effects), which might arise from aligning a linear feature in an undisturbed area that is less expensive to develop but has potentially greater adverse effects. Discounts in the context of offsetting for effects on caribou habitat are relatively new, but they have been in use in other fields, such as carbon offsetting (e.g., Kollmuss et al. 2010).

For caribou habitat offsetting, the inherent effect concept, and its associated multiplicative value, was derived from respondents' answers to the questionnaire conducted by Northern Resource Analysts (2016). Specifically, responses to a subset of questions[13] that pertained to range utility, linear disturbance, and line width were the context for identifying the inherent effect's multiplicative value. The inherent effect's multiplicative value is specific to linear features and the contiguous alignment (or lack thereof) with other existing linear features. The survey revealed that 89% of respondents did not consider all linear features to be created equally, and that 66% and 70% of respondents, respectively, thought that a project effect should be discounted for width of cut (greater than 15 m) or when paralleling an existing linear feature. Among the survey respondents, 80% thought that the full manifestation of a range utility effect (i.e., 100% full effect) was likely reached when line width was 15 m or more, and when vegetation was maintained in an herbaceous or low shrub state (such as along a maintained pipeline or transmission ROW). Thus, a 0.2 (20%) inherent effect multiplier was identified from the survey by taking the 100% full effect minus the 80% average respondent response that the full effect would already be present in the case of parallel/contiguous alignment with a linear feature that is already at least 15 m wide and maintained in a low herbaceous or shrubby state (Northern Resource Analysts 2016). For new cut alignments of linear features, or for non-linear developments (e.g., compressor stations, well pads), the inherent effect multiplier is 1.0 (i.e., no credit). The inherent effect multiplier is applied to the full area of the project footprint (i.e., restored and unrestored) where it is contiguous with another linear feature.

11.14 KNOWLEDGE GAPS AND LIMITATIONS OF THE LITERATURE REVIEW

The literature review included in this Final CHR&OMP 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.

[13] Questions 13 to 26 in the survey (see Northern Resource Analysts 2016).

- 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.
- Uncertainty in risk of specific circumstances where offset response cannot be adequately predicted or does not achieve gains

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Appendix A

Consultation

Table A-1: Summary of Consultation Related to Caribou with Alberta Environment and Parks and Environment and Climate Change Canada

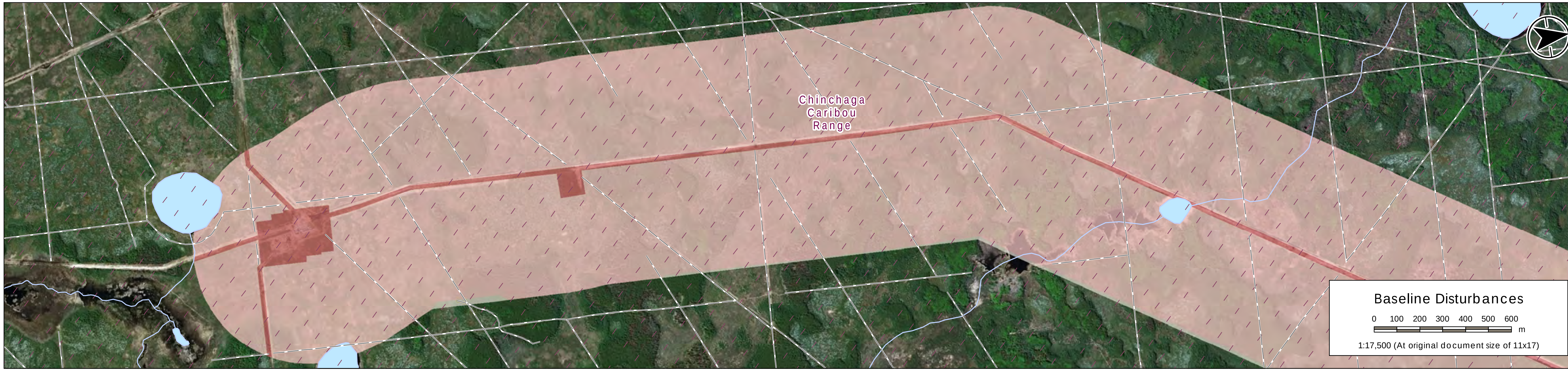
Name and Title	Date and Method	Consultation Related to Caribou
Paul Gregoire Wildlife Biologist, ECCC	May 19, 2017 Email	NGTL provided summary of discussion with ECCC. The summary included: ECCC would be amendable for NGTL to put offsets on existing ROWs. ECCC is not necessarily in agreement with the offsetting calculations put forth on previous NGTL project. Important to limit access where the linear feature intersects other linear features. Access management will be included in the plan.
George Duffy, Caribou Range Planning Lead, AEP Dave Hervieux, Regional Resource Manager, AEP Robin Steenweg, Species at Risk Wildlife Biologist, AEP Monica Dahl, Planner, AEP Paul Gregoire Wildlife Biologist, ECCC	June 30, 2017 Meeting	NGTL met with ECCC and members of AEP to discuss use of existing ROWs for offset measures. ECCC supported this approach and locating offsets within existing ranges.
AEP Caribou Range Planning Team	October 18, 2017 Meeting	NGTL and AEP discussed on-ROW habitat restoration methods and priority areas for offset efforts across the province to ensure NGTL is in alignment with upcoming policies. AEP encourages the restoration of existing pipeline ROWs as offsets where possible.
Courtney Hughes Land Management and Biodiversity Specialist, AEP Natalka Melnycky Wildlife Biologist, AEP Chris Briggs Regional Fisheries Biologist, AEP Don Williams Operations Unit Head Regional Integrated Approvals, AEP	November 8, 2017 WebEx Meeting	NGTL met with AEP for an initial discussion about the Northwest Mainline Loop (Boundary Lake North Section) project. NGTL provided AEP with an overview of the Project, construction schedule, caribou mitigation and CHR&OMP.

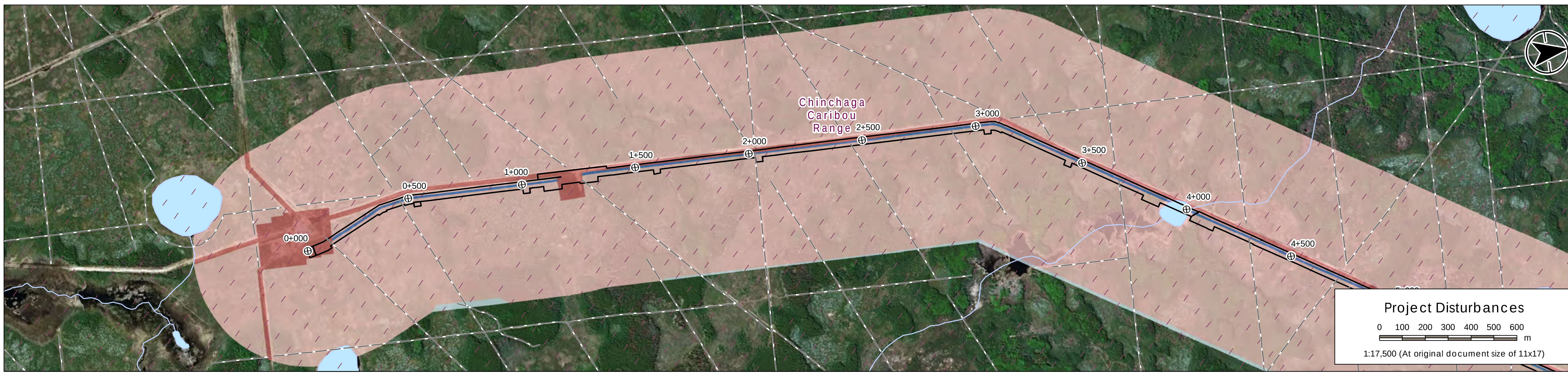
Courtney Hughes Land Management and Biodiversity Specialist, AEP Natalka MeInycky Wildlife Biologist, AEP Erin Flory, Senior Environmental Planner, TC Energy Robert Morin, Senior Construction Coordinator, TC Energy Barb Taylor, Senior Environmental Planner, TC Energy Peter Andre, Project Manager, TC Energy Catherine Watson, Senior Environmental Planner, Caribou SME, TC Energy Shawna Adams, Senior Environmental Planner, TC Energy	November 28, 2018 Meeting	NGTL provided AEP with updates for NGTL Projects falling within the Chinchaga Caribou Range. This included updates on the different project construction schedules, wildlife matters, caribou habitat mitigation and the CHR&OMPs. In addition, a project general overview was provided by NGTL for the North Corridor Expansion (NCE) 2022.
Courtney Hughes Land Management and Biodiversity Specialist, AEP Natalka MeInycky Wildlife Biologist, AEP Jeff Poeckens, Land Management Specialist, Regional Integrated Approvals, AEP Rick Goy, Lands Team Lead, AEP Jones Yu, Project Manager, TC Energy Erin Flory, Senior Environmental Planner, TC Energy Barb Taylor, Senior Environmental Planner, TC Energy Catherine Watson Senior Environmental Planner and Caribou SME, TC Energy Matt Jobin, EIT, TC Energy	July 30, 2019 Meeting	The focus of the meeting was to discuss the draft NGTL Chinchaga Caribou Range Offset Plan that NGTL had provided to AEP. NGTL requested that AEP provide guidance as to their preferred options for the implementation of caribou habitat restoration given that they have access to provincial caribou data. Project updates for those NGTL projects falling within the Chinchaga Caribou Range were also provided by NGTL.

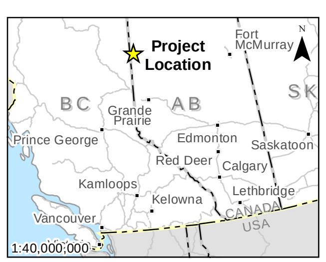
George Duffy, Caribou Range Planning Lead, AEP Cynthia Chand, Integrated Resource Planner, AEP Jennifer Renton, Integrated Resource Planner, AEP Brian West, Project Manager, TC Energy Wade Pruett, Manager Environment, TC Energy Steve Morck, Senior Environmental Planner, TC Energy Catherine Watson, Senior Environmental Planner and Caribou SME, TC Energy	December 9, 2019 Meeting	NGTL and ECCC discussed proposed caribou habitat restoration and access control measures for the 2021 NGTL System Expansion. A discussion around offset planning and caribou habitat restoration implementation, as well as the potential opportunities for greatest benefits from restoration and access management for caribou for NGTL projects was discussed. NGTL also provided updates for other NGTL projects falling within caribou range.
Paul Gregoire, A/Manager Regulatory Affairs Section, ECCC Brian West, Project Manager, TC Energy Wade Pruett, Manager Environment, TC Energy Steve Morck, Senior Environmental Planner, TC Energy Catherine Watson, Senior Environmental Planner and Caribou SME, TC Energy	December 9, 2019 Meeting	NGTL and ECCC reviewed the proposed caribou habitat restoration and access control measures for the 2021 NGTL System Expansion. There was a general discussion on the status of offset planning for these projects as well as the other NGTL projects falling within caribou range. ECCC also provided feedback on how the information is presented within the CHROMPs that are filed with the CER.

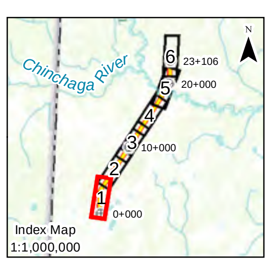
Appendix B

Extent of Baseline and Incremental Project Disturbance









Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Baseline Disturbances

- Permanent, Direct
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Project Disturbances

- Permanent, Direct (Residual Effect)
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada
3. Not all features may be present on each page and some features may not be visible because of the disturbance hierarchy (i.e., baseline temporary direct disturbance is not visible because it is hierarchically below baseline permanent direct and indirect disturbances).

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Stantec TC Energy

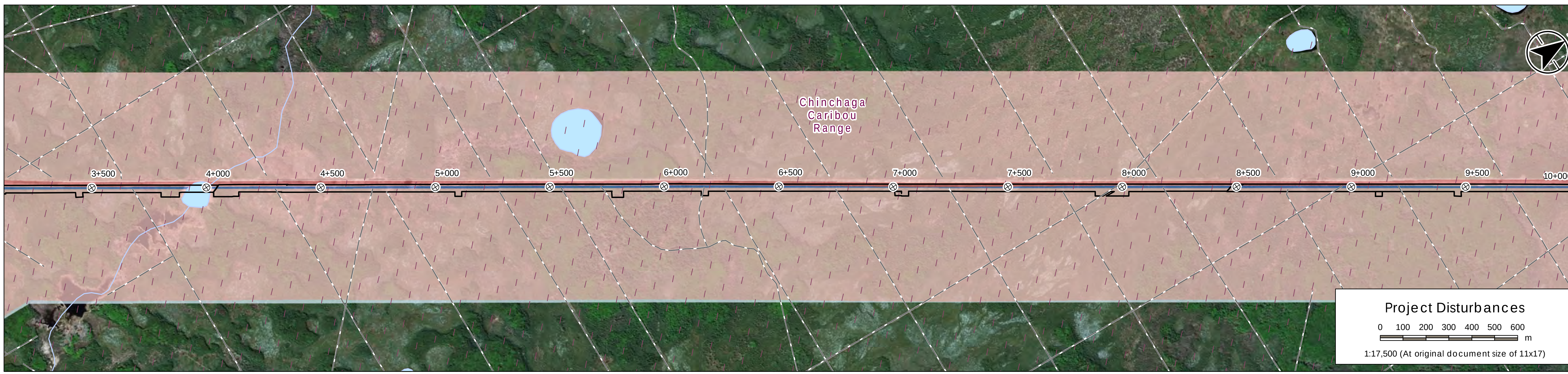
Project Location
North-Western
Alberta

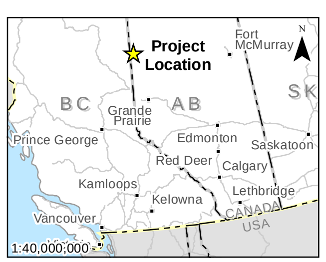
Project Number 123513301
Prepared by LTRUDELL on 20200129
Checked by CBRYDEN on 20200129
GIS Review by SPARKER on 20200129

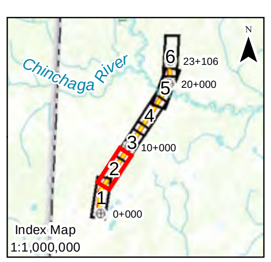
Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

Figure No.
Appendix B

Title
Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 1 of 6







Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Baseline Disturbances

Permanent, Direct

Permanent, Indirect

Temporary, Direct

Temporary, Indirect

Project Disturbances

Permanent, Direct (Residual Effect)

Permanent, Indirect

Temporary, Direct

Temporary, Indirect

Notes
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Project Location
North-Western
Alberta

Project Number 123513301
Prepared by LTRUDELL on 20200129
Checked by CBRYDEN on 20200129
GIS Review by SPARKER on 20200129

Client/Project/Report
TC Energy
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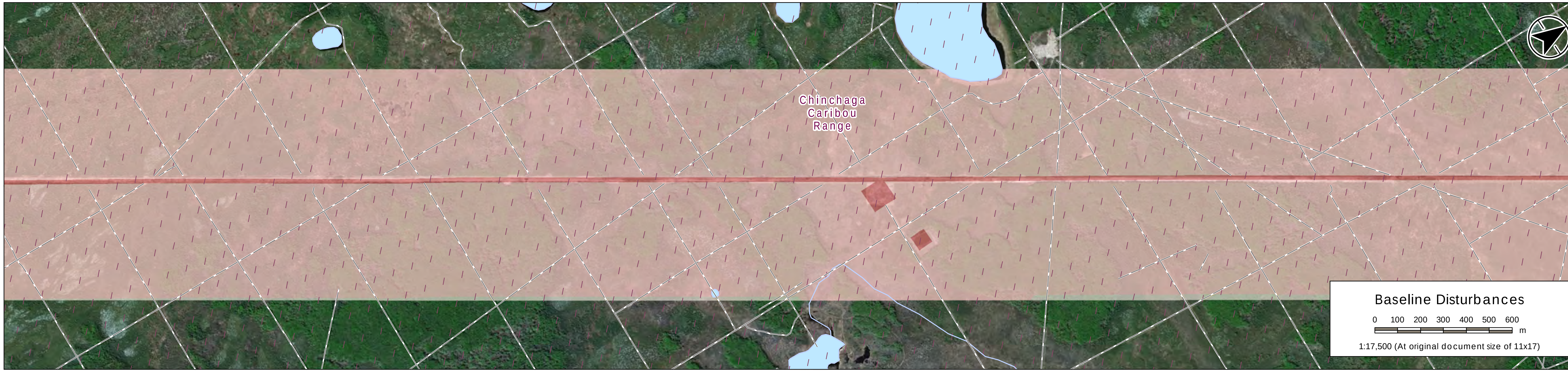
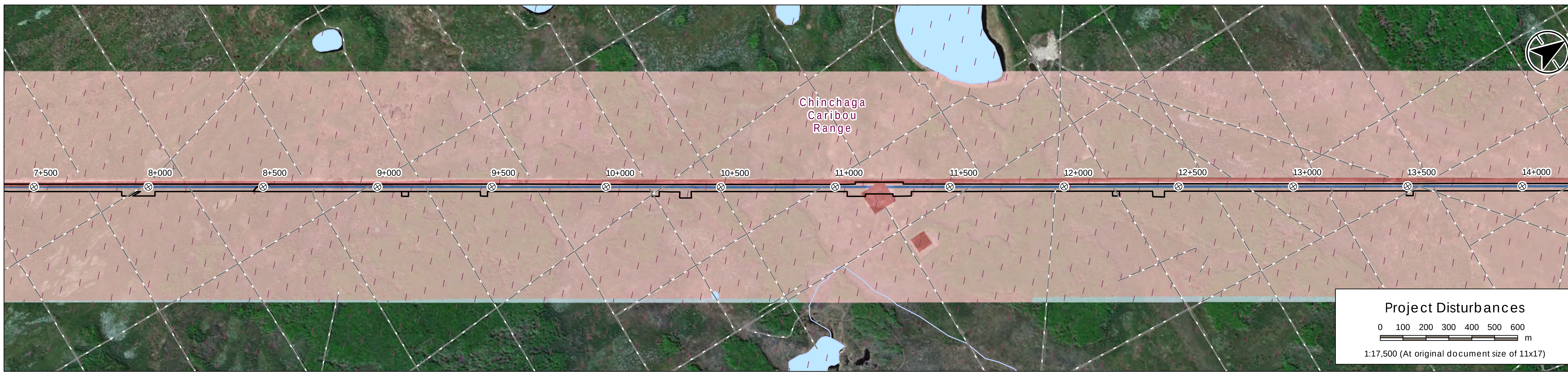
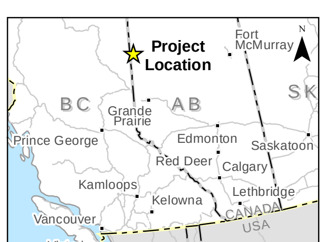
Final Caribou Habitat Restoration and Offset Measures Plan

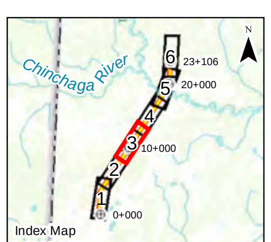
Figure No.
Appendix B

Title
Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 2 of 6









Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Baseline Disturbances

- Permanent, Direct
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Project Disturbances

- Permanent, Direct (Residual Effect)
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Notes

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Project Location
North-Western
Alberta

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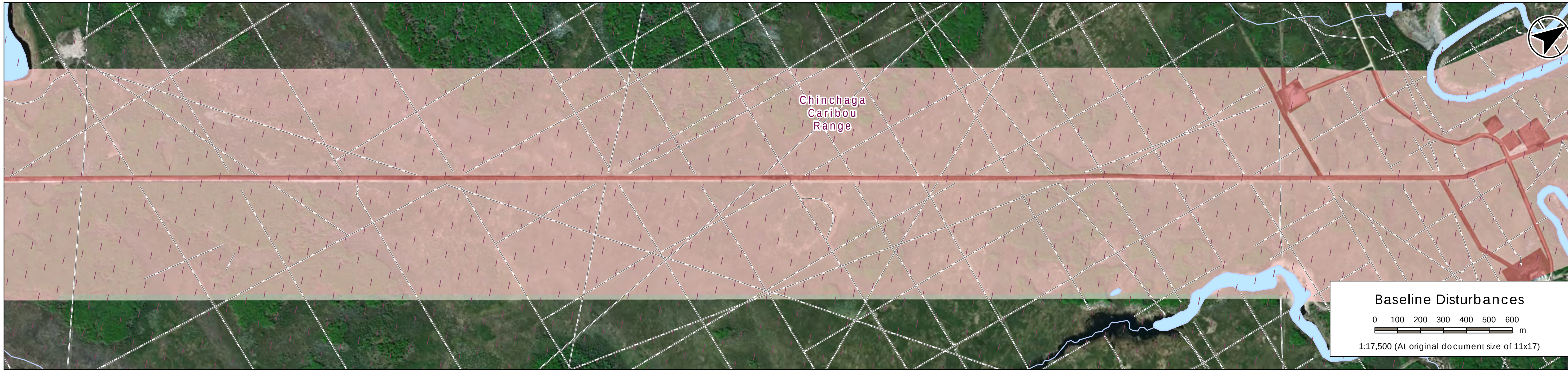
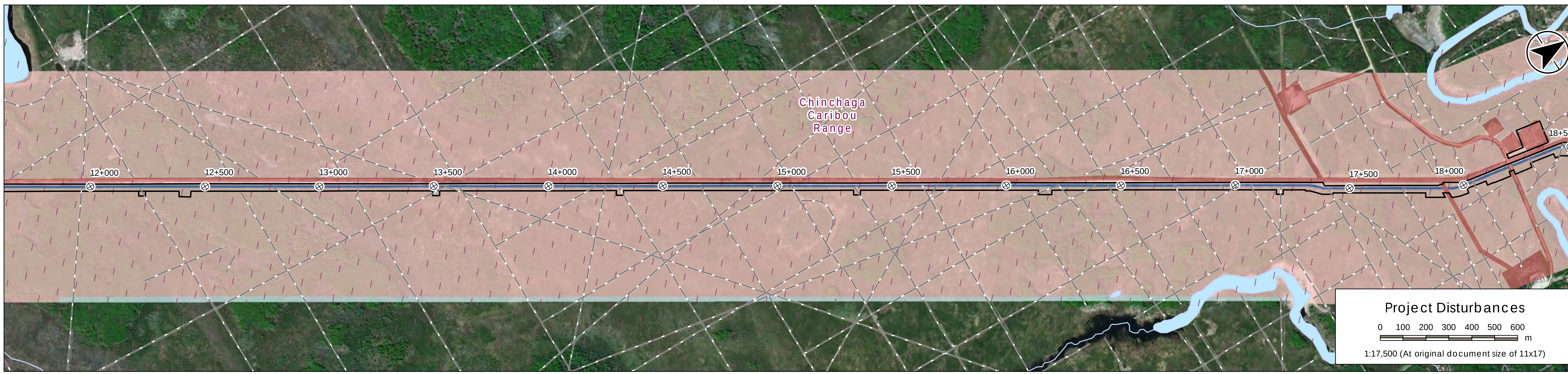
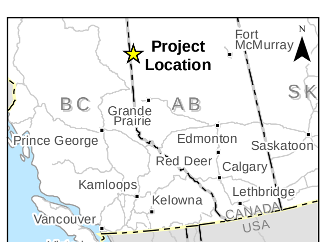
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

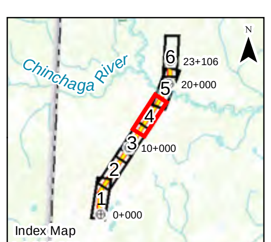
Figure No.
Appendix B

Title
Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 3 of 6









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Seismic Line
Hydrology
Watercourse
Waterbody
Chinchaga Caribou Range

Kilometre Post
Project Footprint

Baseline Disturbances
- Permanent, Direct
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Project Disturbances
- Permanent, Direct (Residual Effect)
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Stantec TC Energy

Project Location
North-Western
Alberta

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Prepared by LTRUDELL on 20200129
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Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
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Figure No.
Appendix B

Title
Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 4 of 6

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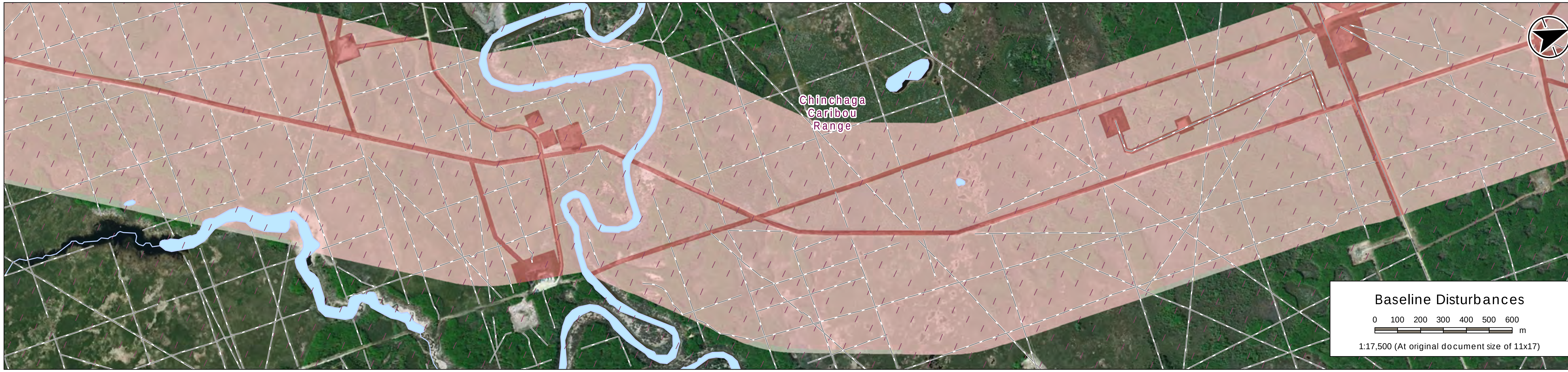

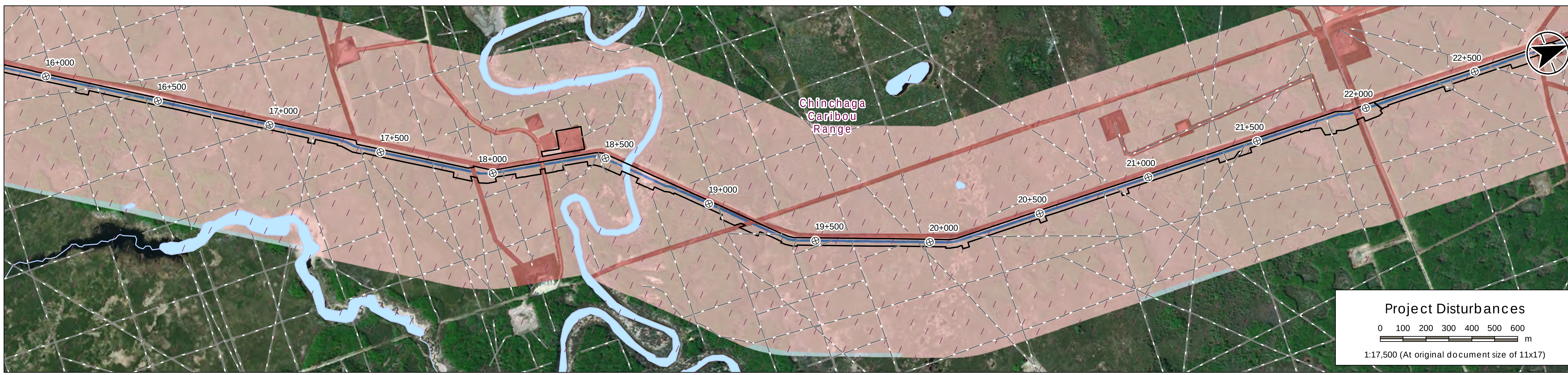

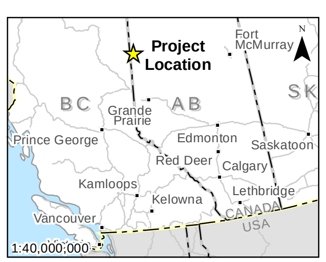

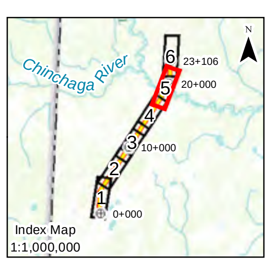

Seismic Line
Road

Hydrology

Watercourse
Waterbody
Chinchaga Caribou Range

Kilometre Post
Project Footprint

Baseline Disturbances

Permanent, Direct
Permanent, Indirect
Temporary, Direct
Temporary, Indirect

Project Disturbances

Permanent, Direct (Residual Effect)
Permanent, Indirect
Temporary, Direct
Temporary, Indirect

Notes

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Project Location
North-Western
Alberta

Project Number 123513301
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TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

Figure No.

Appendix B

Title

Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 5 of 6

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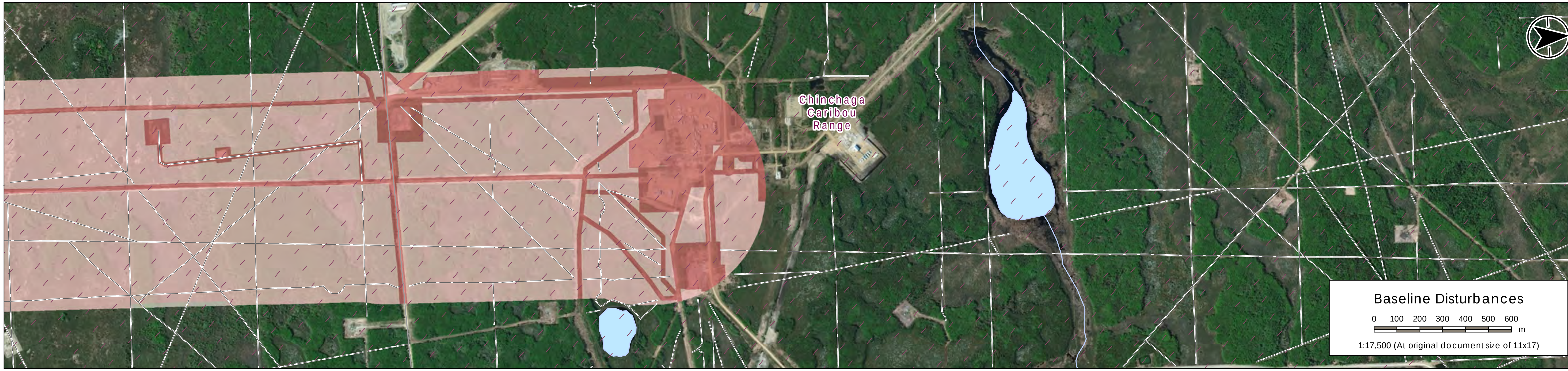

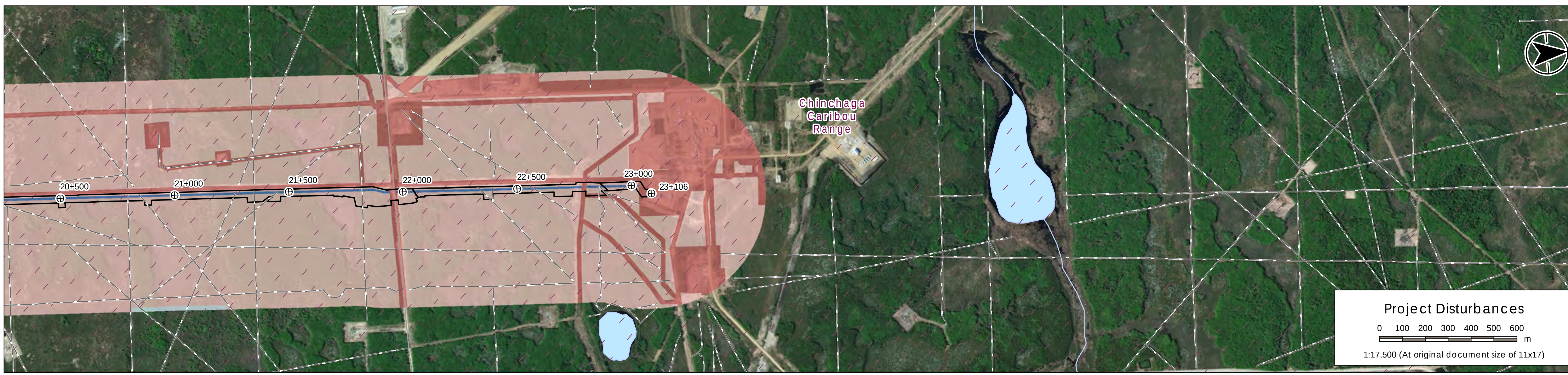

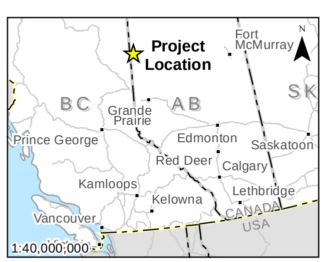

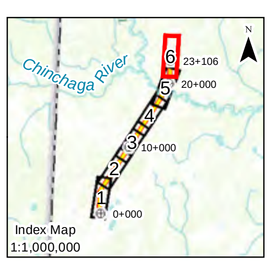

- Seismic Line
- Road

Hydrology

- Watercourse
- Waterbody
- Chinchaga Caribou Range
- Kilometre Post
- Project Footprint

Baseline Disturbances

- Permanent, Direct
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Project Disturbances

- Permanent, Direct (Residual Effect)
- Permanent, Indirect
- Temporary, Direct
- Temporary, Indirect

Notes
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Stantec TC Energy

Project Location
North-Western
Alberta

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Client/Project/Report
TC Energy
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Figure No.
Appendix B

Title
Boundary Lake North Section
Extent of Baseline and Incremental Project Disturbance - Sheet 6 of 6

Appendix C

Habitat Restoration and Offset 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 D

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.

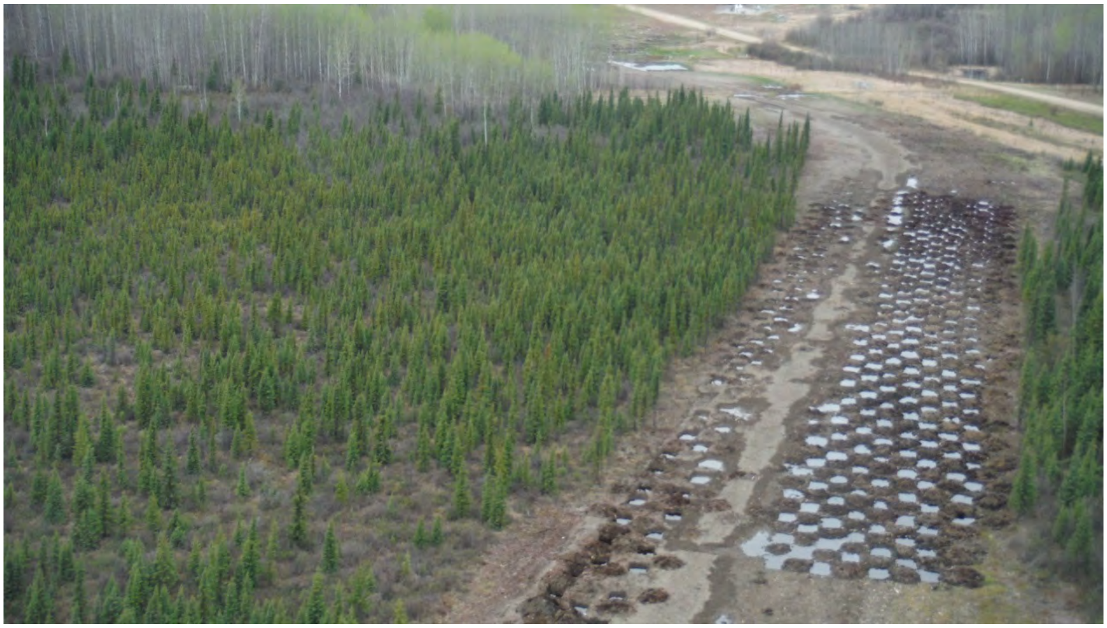


Plate 5: Aerial view of mounding in lowland on a non-parallel portion of the ROW. Photo source: NGTL.

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.

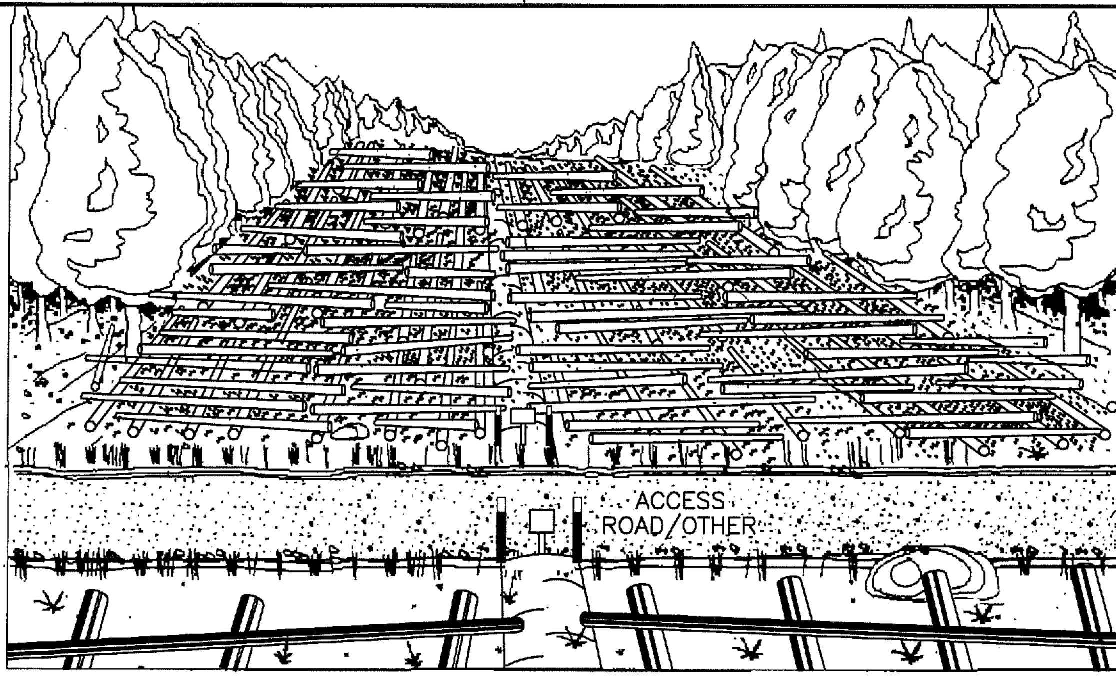
Plate 11: Example of mounding combined with conifer seedling planting on a ROW. The combination of measures is intended to manage access, and facilitate revegetation of conifers. Photo source: NGTL.

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

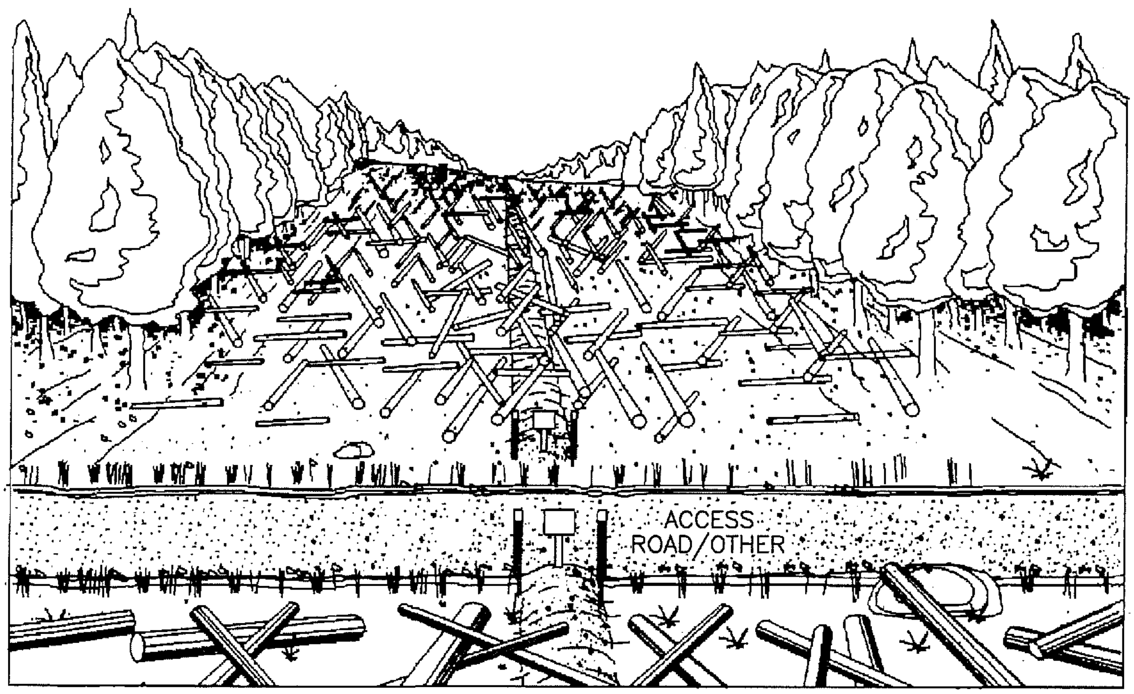
Plate 13: Example of lattice placement of rollback. Photo source: NGTL.

Appendix E

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.

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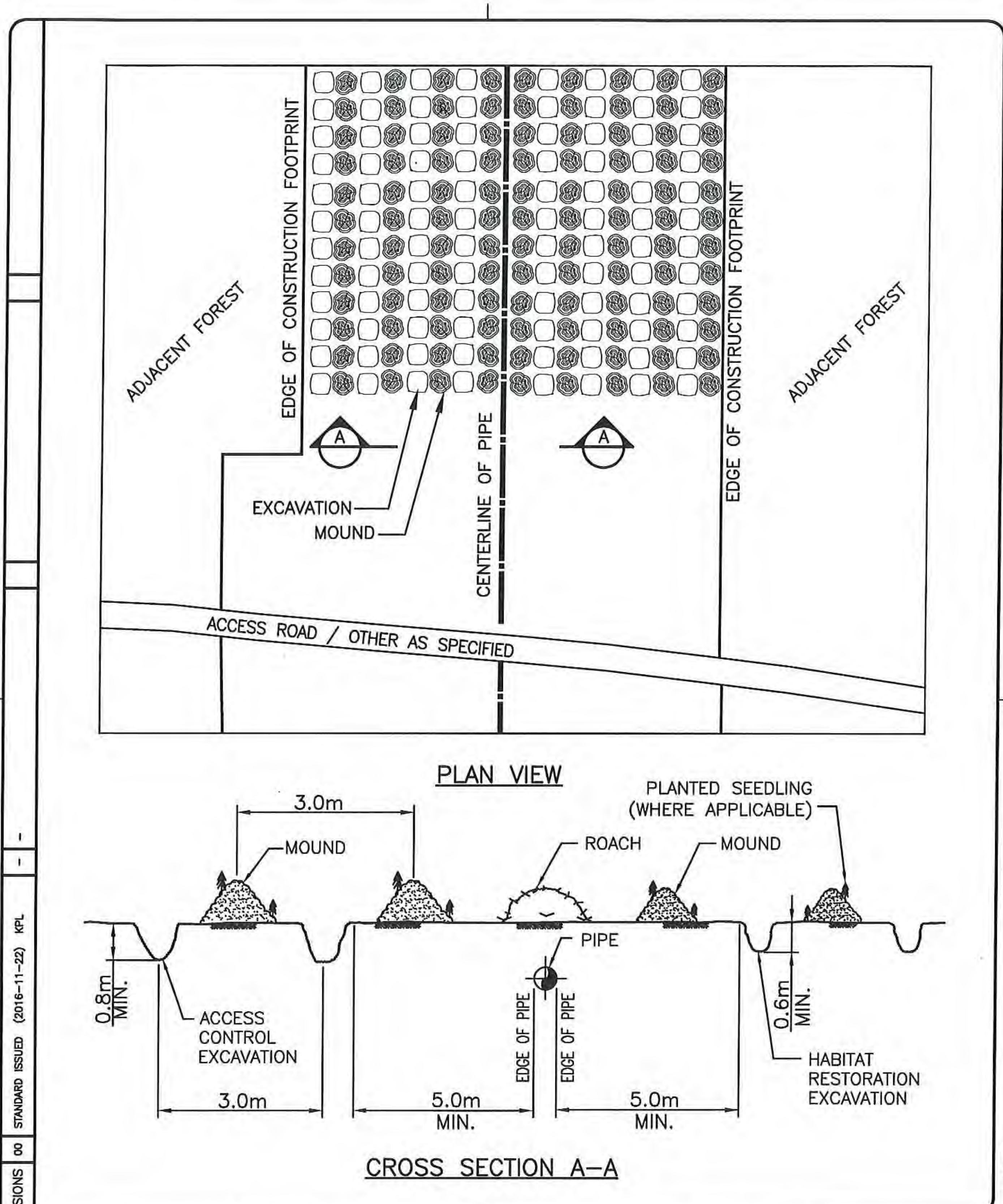

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NOTES:

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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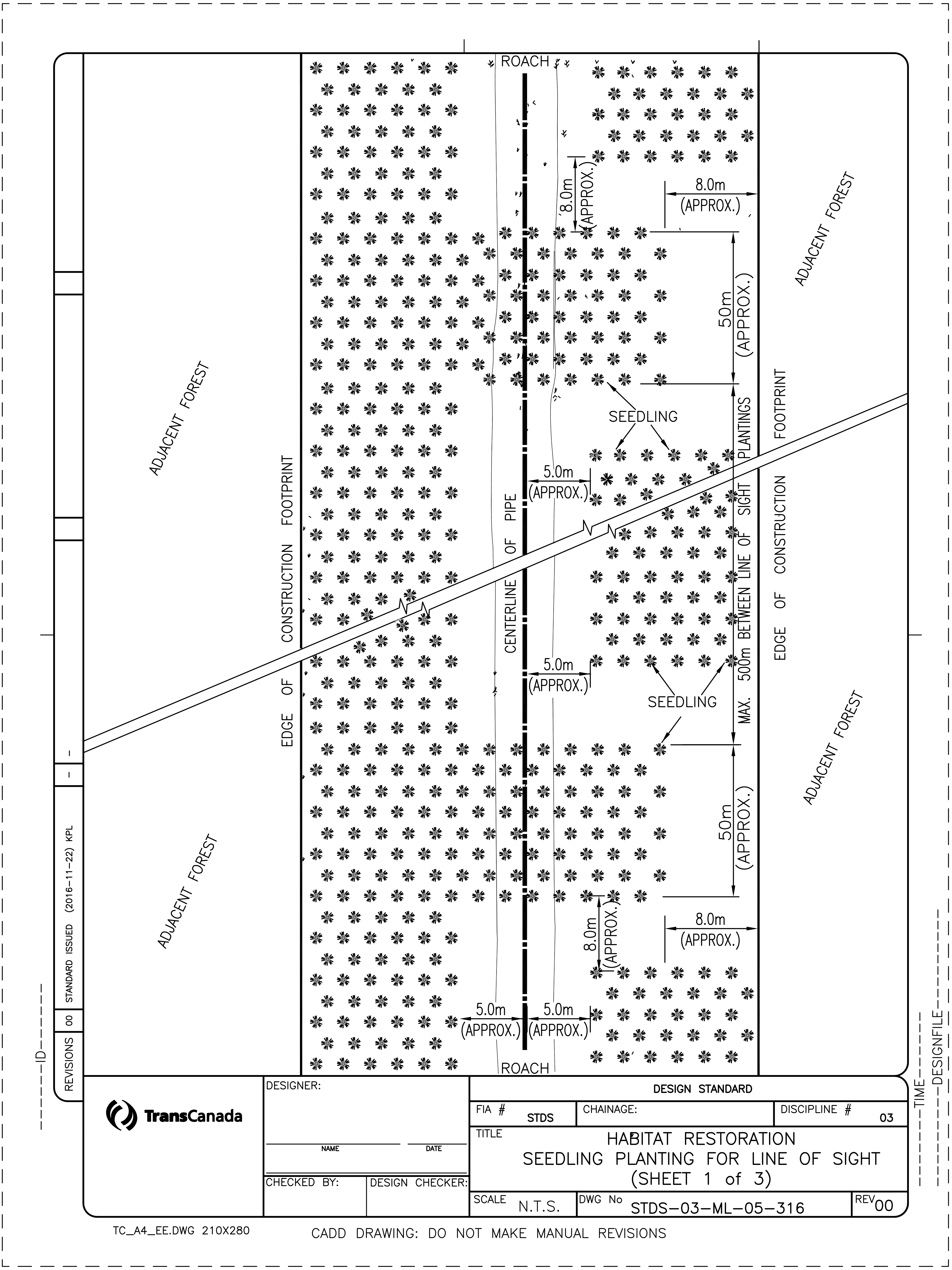
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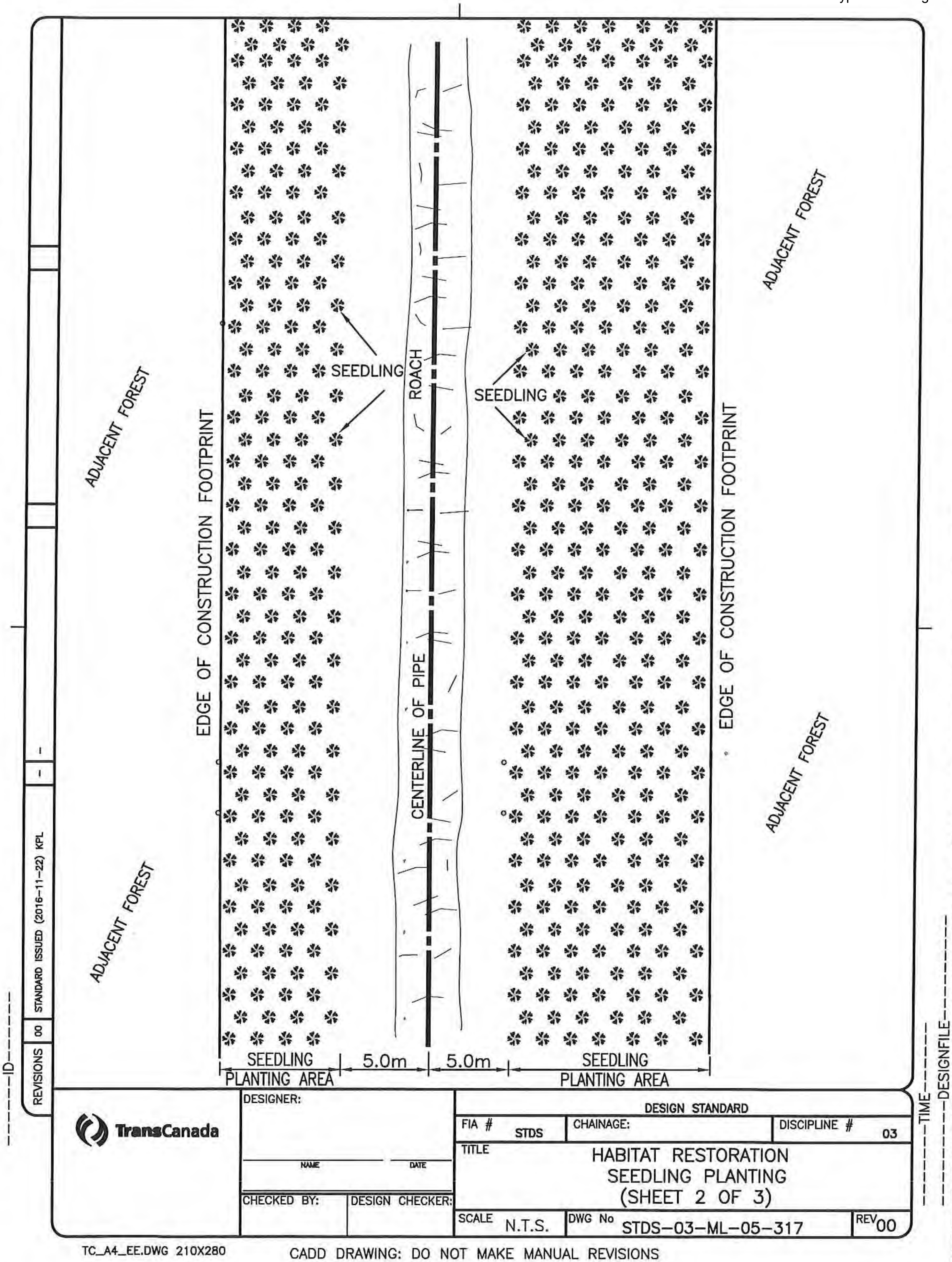
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NOTES:

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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NAME / DATE	FIA # STDS	CHAINAGE:	DISCIPLINE # 03
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	SCALE N.T.S.	DWG No STDS–03–ML–05–318	REV 00

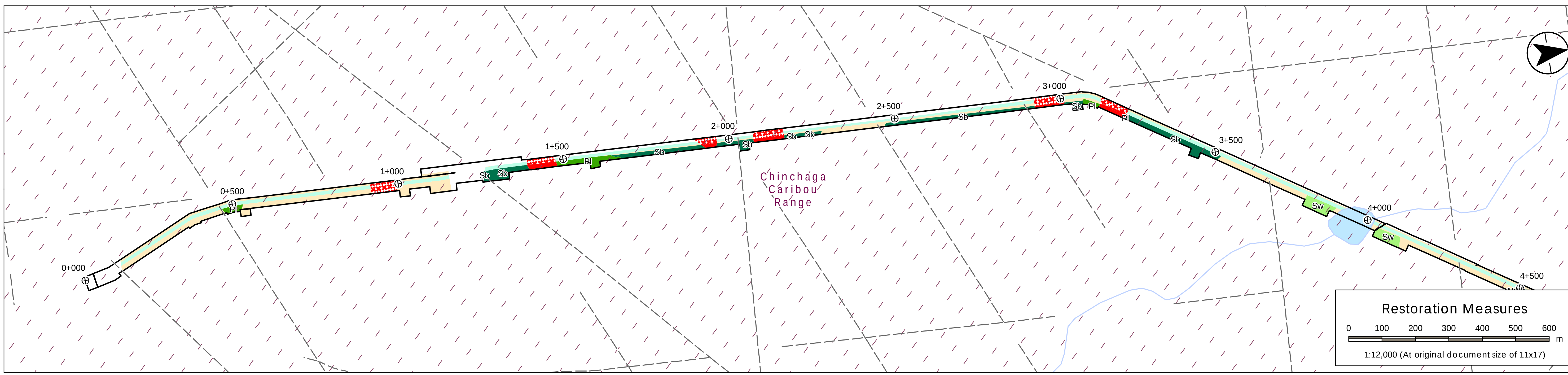
ID TIME DESIGNFILE

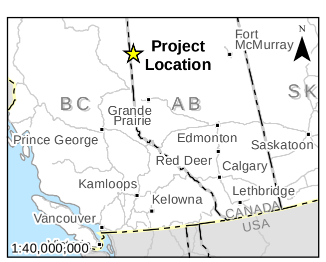
TC_A4_EE.DWG 210X280

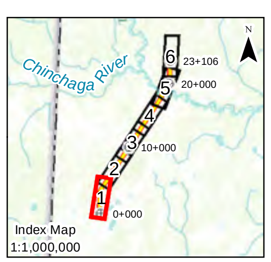
CADD DRAWING: DO NOT MAKE MANUAL REVISIONS

Appendix F

Footprint Elements and Planned Habitat Restoration Measures







Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Operational Access

Right Of Way and Temporary Workspace

Access Management

Rollback

Rollback, Planted

Restored

Plant Black Spruce (Sb)

Plant Lodgepole Pine (Pl)

Plant White Spruce (Sw)

Shrub Plant (Salix)

Unrestored

Natural Regeneration

Operational Access (10 m)

Unrestored

Other Disposition

Unrestored (existing maintained disturbance)

Notes

1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada
3. Not all features may be present on each page and some features may not be visible because of the disturbance hierarchy (i.e., baseline temporary direct disturbance is not visible because it is hierarchically below baseline permanent direct and indirect disturbances).

Project Location
North-Western
Alberta

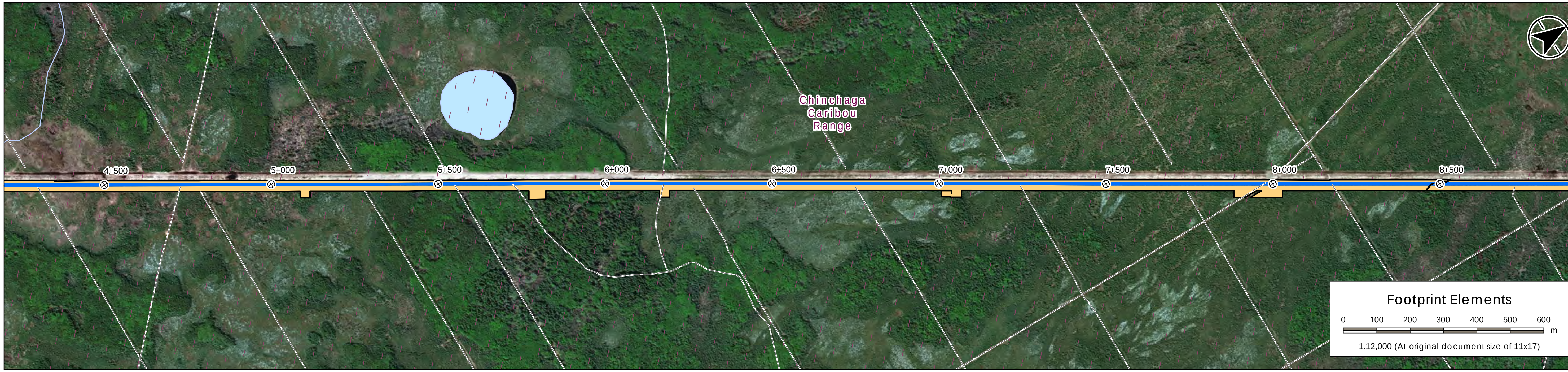
Project Number 123513301
Prepared by LTRUDELL on 20200129
Checked by CBRYDEN on 20200129
GIS Review by SPARKER on 20200129

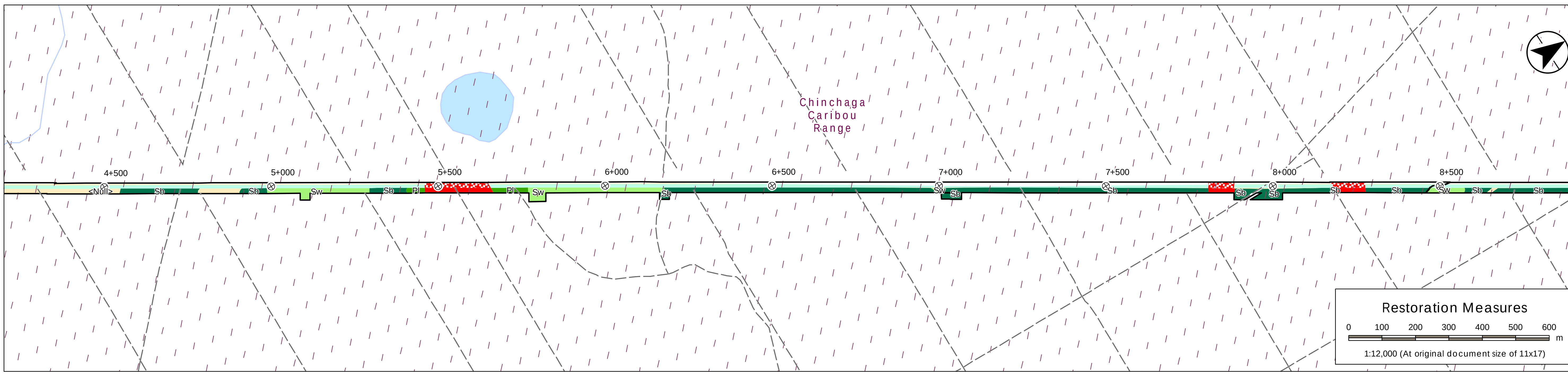
Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

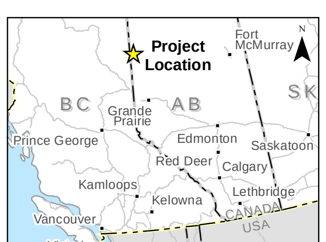
Figure No.
Appendix F

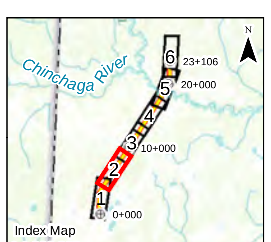
Title
Boundary Lake North Section
Footprint Elements and Planned Restoration Measures - Sheet 1 of 6

S:\1232\projects\123513301\figures\reports\CHR&OMP\fig_123513301_chromp_appF_boundary_footprint_elements_and_restoration_measures.mxd Revised: 2020-01-29 By: ltrudell









Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Operational Access

Right Of Way and Temporary Workspace

Access Management

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Figure No.
Appendix F

Title
Boundary Lake North Section
Footprint Elements and Planned Restoration Measures - Sheet 2 of 6

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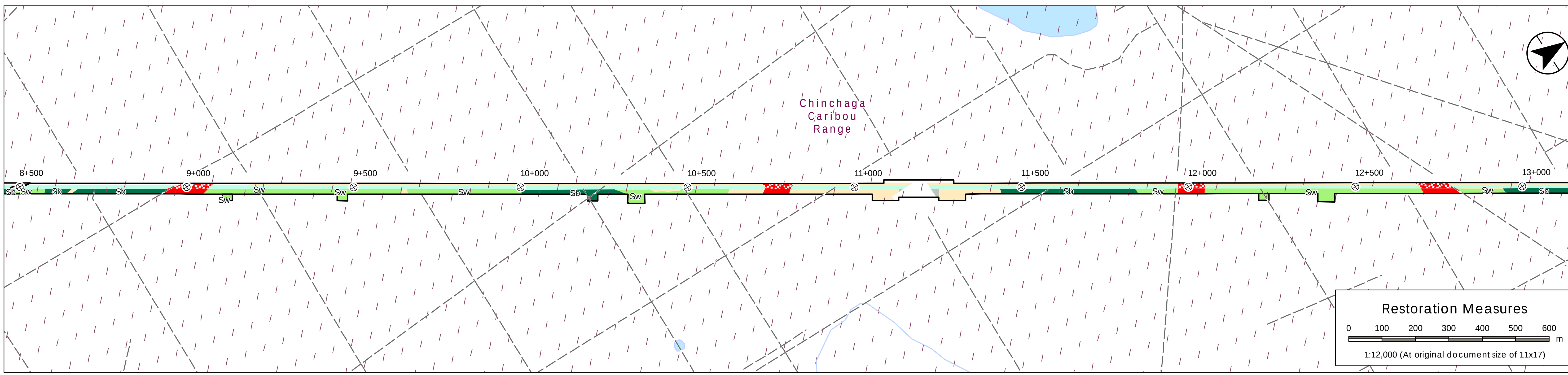

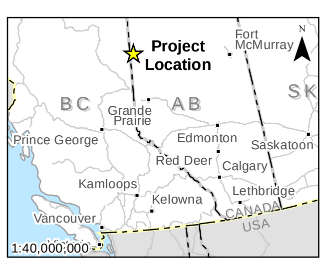

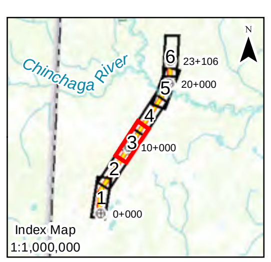

Seismic Line

Hydrology

Watercourse

Waterbody

Chinchaga Caribou Range

Kilometre Post

Project Footprint

Operational Access

Right Of Way and Temporary Workspace

Access Management

Rollback

Rollback, Planted

Restored

Plant Black Spruce (Sb)

Plant Lodgepole Pine (Pl)

Plant White Spruce (Sw)

Shrub Plant (Salix)

Unrestored

Natural Regeneration

Operational Access (10 m)

Unrestored

Other Disposition

Unrestored (existing maintained disturbance)

Notes
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Stantec TC Energy

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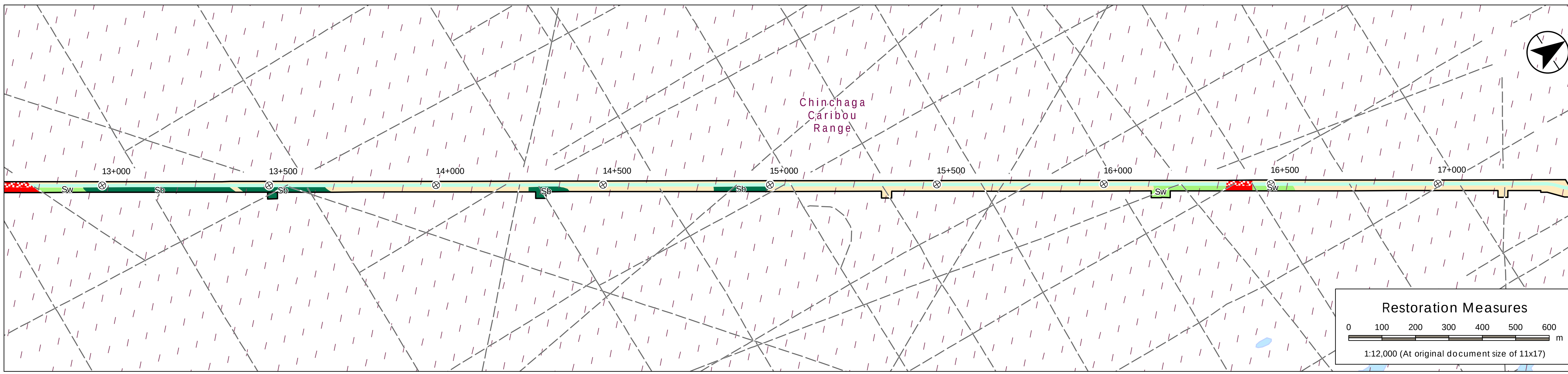
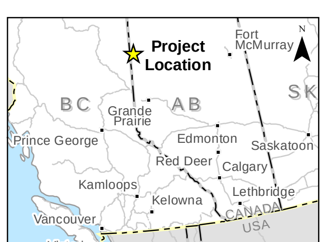
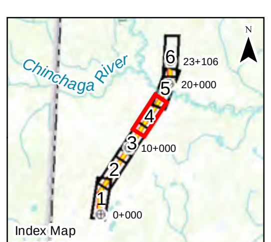
Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

Figure No.
Appendix F

Title
Boundary Lake North Section Footprint Elements and Planned Restoration Measures - Sheet 3 of 6







Seismic Line
Waterbody
Chinchaga Caribou Range

Kilometre Post
Project Footprint
Operational Access
Right Of Way and Temporary Workspace

Access Management
Rollback
Rollback, Planted

Restored
Plant Black Spruce (Sb)
Plant Lodgepole Pine (Pl)
Plant White Spruce (Sw)
Shrub Plant (Salix)

Unrestored
Natural Regeneration
Operational Access (10 m)
Unrestored
Other Disposition
Unrestored (existing maintained disturbance)

Notes
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Stantec TC Energy

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North-Western Alberta
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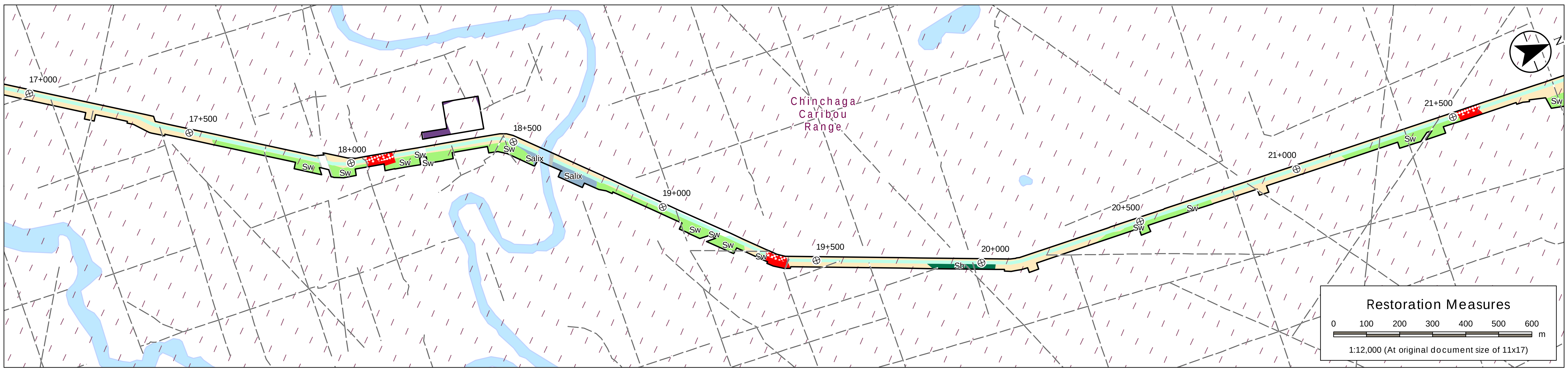
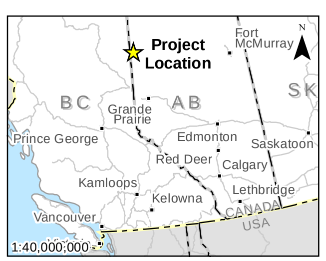
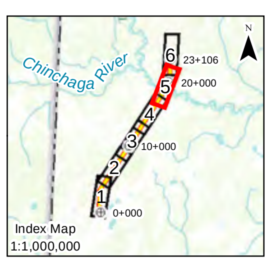
Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

Figure No.
Appendix F

Title
Boundary Lake North Section
Footprint Elements and Planned Restoration Measures - Sheet 4 of 6







- Seismic Line
- Waterbody
- Chinchaga Caribou Range
- Kilometre Post
- Project Footprint
- Operational Access
- Right Of Way and Temporary Workspace

Access Management

- Rollback
- Rollback, Planted

Restored

- Plant Black Spruce (Sb)
- Plant Lodgepole Pine (Pl)
- Plant White Spruce (Sw)
- Shrub Plant (Salix)

Unrestored

- Natural Regeneration
- Operational Access (10 m)
- Unrestored
- Other Disposition
- Unrestored (existing maintained disturbance)

Notes

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Stantec TC Energy

Project Location
North-Western
Alberta

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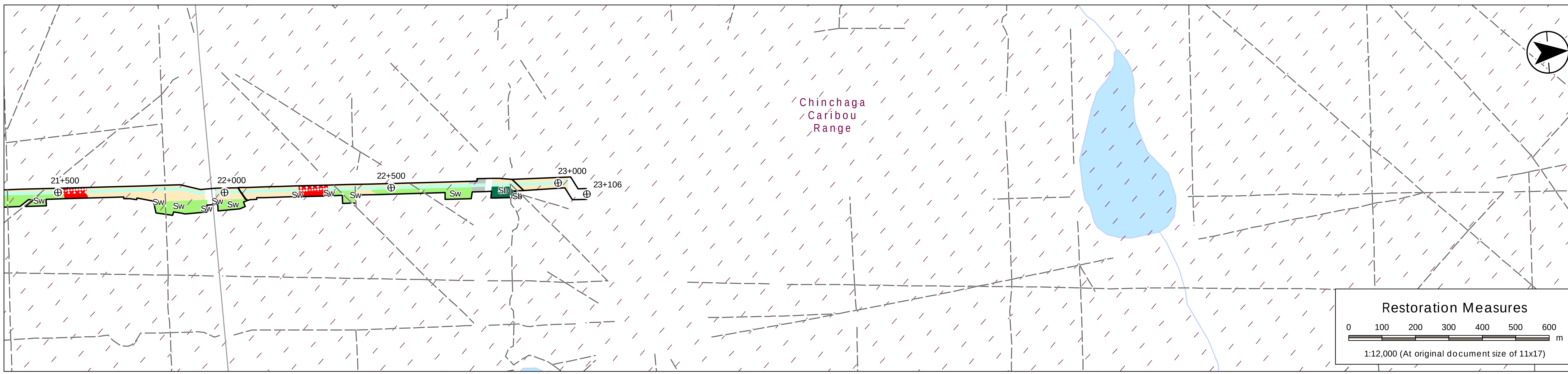
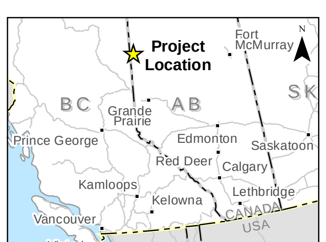
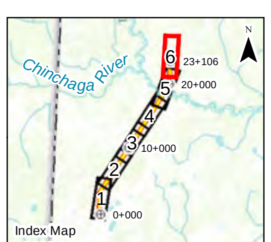
Client/Project/Report
TC Energy
Northwest Mainline Loop (Boundary Lake North Section)
Final Caribou Habitat Restoration and Offset Measures Plan

Figure No.
Appendix F

Title
Boundary Lake North Section
Footprint Elements and Planned Restoration Measures - Sheet 5 of 6







Seismic Line
Road

Hydrology

Watercourse
Waterbody
Chinchaga Caribou Range

Kilometre Post
Project Footprint
Operational Access
Right Of Way and Temporary Workspace

Access Management

Rollback
Rollback, Planted

Restored

Plant Black Spruce (Sb)
Plant Lodgepole Pine (Pl)
Plant White Spruce (Sw)
Shrub Plant (Salix)

Unrestored

Natural Regeneration
Operational Access (10 m)
Unrestored
Other Disposition
Unrestored (existing maintained disturbance)

Notes
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TC Energy
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Figure No.
Appendix F

Title
Boundary Lake North Section
Footprint Elements and Planned Restoration
Measures - Sheet 6 of 6

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