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February 28, 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)
Liege Lateral Loop 2 (Thornbury Section) and
Leismer East Compressor Station (Project)
Order XG-N081-003-2015 (Order)
Condition 9: Caribou Monitoring Report
File: OF-Fac-Gas-N081-2014-11 01

On November 11, 2019,[1] NGTL advised the Canada Energy Regulator (CER) of plans to file the Year One monitoring report for the Project, in accordance with Condition 9 of the Order, on or before March 1, 2020.

Enclosed, please see the Year One Caribou Monitoring Report for the Project.

If the CER requires additional information with respect to this filing, please contact me by phone at (403) 920-2174 or by e-mail at roselyn_chou@tcenergy.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Roselyn Chou
Regulatory Project Manager
Regulatory Facilities, Canadian Natural Gas Pipelines

Enclosure

cc: Heather Dodds, Canada Energy Regulator
Paul Gregoire, Environment and Climate Change Canada
Joann Skilnick, Alberta Environment and Parks
James Grier, Alberta Environment and Parks
Christa MacNevin, Alberta Environment and Parks

[1] CER Filing ID: C03076.

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1.0 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada Pipelines Limited (TCPL) and affiliate of TC Energy Corporation, applied under Section 58 of the National Energy Board Act (NEB Act) on September 19, 2014, to construct and operate the Liege Lateral Loop 2 Project, including the Thornbury Section and Leismer East Compressor Station (Thornbury). NGTL received approval from the National Energy Board (NEB), predecessor to the Canada Energy Regulator (CER). The NEB issued Order XG-N081-003-2015 and as amended by Amending Order AO-002-XG-N081-003-2015 issued on May 3, 2016 (collectively, the Order), approving Thornbury, subject to certain conditions. These include Condition 8, which defines the requirements for the filing of a Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP; Monitoring Program, the Program).[1]

NGTL developed the Monitoring Program to monitor and verify the effectiveness of caribou habitat restoration and offset measures[2] implemented as part of the development Caribou Habitat Restoration Plan (CHRP).[3] Pursuant to Condition 9 of the Order, NGTL committed to filing monitoring reports to the CER. This document reports the first-year results (Year 1) of the Project for the Monitoring Program. Details of the Monitoring Program are consistent with the primary principles and conditions used to guide other NGTL caribou habitat restoration and offset monitoring programs,[4] and reflect continual improvements based on lessons learned and the adaptive management approach utilized by NGTL. The Monitoring Program was also prepared with consideration for Operational Policy Statement and Follow-Up Programs under the *Canadian Environmental Assessment Act* (CEAA) (CEA Agency, 2011).

1.1 ORGANIZATION

This document reports Year 1 findings of this multi-year monitoring program and evaluates the results against the measurable targets (Appendix A Table 1, Appendix A Table 2). The report is divided into the following sections:

- Section 2: Monitoring Program Background and Goals
- Section 3: Ground-based Monitoring
- Section 4: Remote Camera Monitoring
- Section 5: Summary of Results

[1] NEB Filing ID: A89738-1.
[2] NEB Filing ID: A97781-1 Final Offset Measures Plan (OMP) filed on February 1, 2019
[3] NEB Filing ID: A87455 as well as subsequent errata filings to the CHRP (NEB Filing IDs: A88198, A89273).
[4] NEB Filing ID: A71613 filed with the NEB on August 4, 2015 to comply with Condition 24 (Certificate GC-119) for the Northwest Mainline Expansion Project, Condition 19 (Certificate GC-121) for the Chinchaga Lateral Loop No. 3 Project, and Condition 21 (Certificate GC-120) for the Leismer to Kettle River Crossover Project

- Section 6: Residual Effects, Restoration Trajectory and Offsets
- Section 7: Lessons Learned and Adaptive Management
- Section 8: References

2.0 MONITORING PROGRAM OBJECTIVES

NGTL's habitat restoraton efforts aim to achive self-sustaining forests capable of supporting boreal caribou. This Monitoring Program employs a methodology based on a framework of adaptive management informed by ground-based and remote camera surveys. Now at Year 1 of the Monitoring Program, the specific objectives of this report are to:

- Summarize Year 1 findings, and
- Evaluate the habitat restoration performance against the evaluation criteria and measurable targets, where feasible.

Appendix A shows the evaluation criteria and measurable targets (performance indicators) from the CHROMMP (NGTL, 2015).

This Monitoring Program is concurrent to Post Construction Reclamation Monitoring (PCRM). A primary objective of PCRM is to evaluate the success of mitigation measures implemented during construction. In PCRM, NGTL assesses environmental issues and as required, implements corrective measures to address issues. While distinct, the Monitoring Program and PCRM inform each other's activities and provide opportunities for joint procedural learnings and improvements.

2.1 PROJECT DESCRIPTION

The area considered by this Monitoring Program include two distinct locations sharing similar biogeoclimatic characteristics: The Liege Lateral Loop 2 right-of-way (ROW) and associated Leismer East Compressor Station footprint (Thornbury), and the offset locations calculated for the Project and sited in Dillon River Wildland Provincial Park (Dillon, Offsets). Collectively, these locations are referred to in this document as Project Areas. The Project Areas are within the Regional Municipality of Wood Buffalo, except for a small portion of the Offsets, which is located within Lakeland District. The nearest cities to the Project Areas are Fort McMurray to the northeast and Cold Lake to the south (Figure 2-1).

The Project Areas are located within the Central Mixedwood Natural Subregion and Lower Boreal Highlands Natural Subregion of the Boreal Forest Natural Region of Alberta (Natural Regions Committee 2006). Within this vast area, additional subregions occur[5]. Soils in the Program Area are predominantly Gray Luvisols and Dystric Brunisols; organic soils dominate poorly drained locations and wetlands. Typical vegetation communities in the program area consist of mixed forest with white spruce (*Piceau glauca*), black spruce (*Picea mariana*), aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*).

[5] These include Boreal Wetland Mixedwood, Peace River Lowlands and Boreal Subarctic.

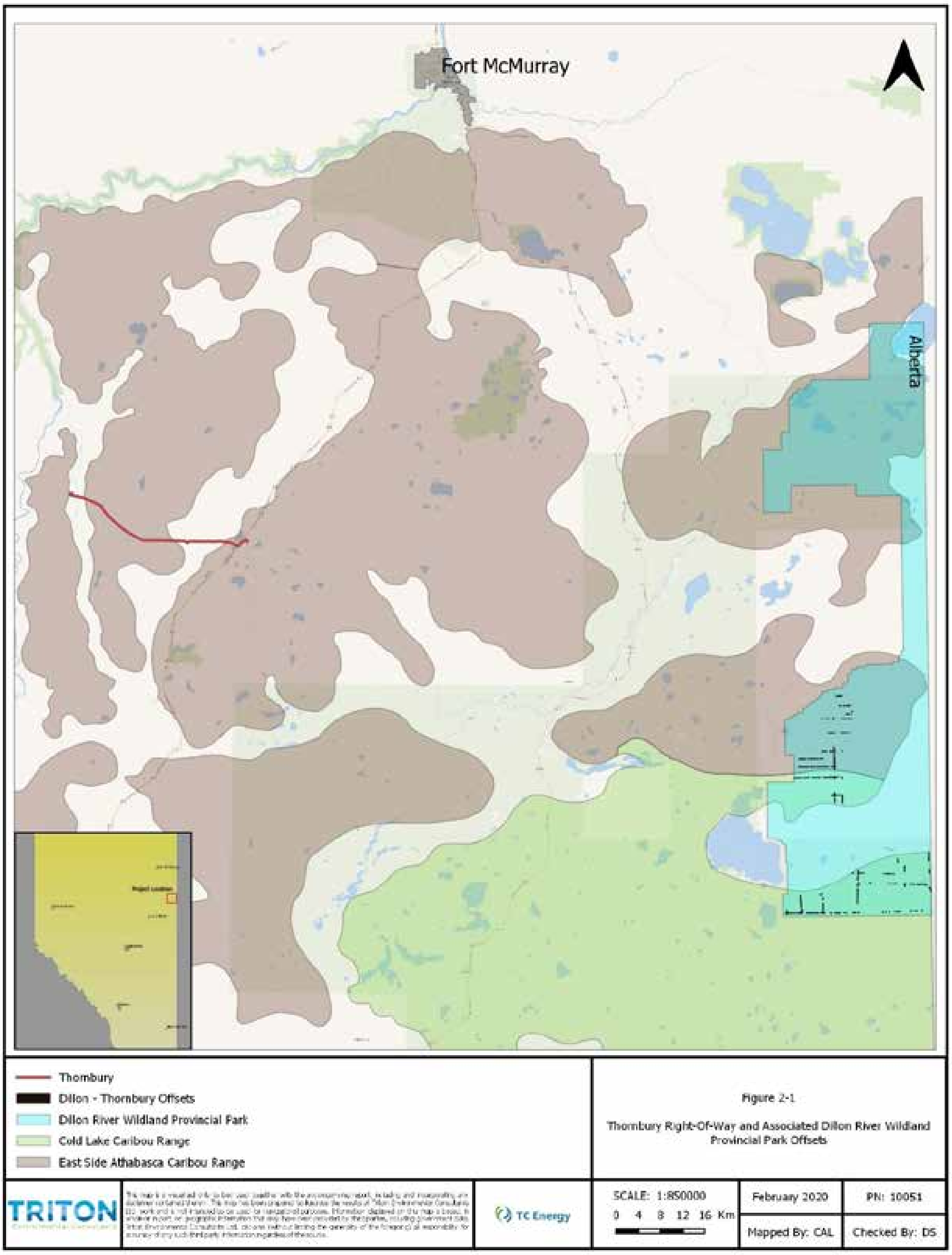

Figure 2-1: Thornbury ROW (in red) and Associated Dillon River Wildland Provincial Park Offsets.

Dry and sandy sites tend to be dominated by lodgepole pine (*Puinus contorta*) and jack pine (*Pinus banksiana*). Understory vegetation consists in an assortment of shrubs, forbs, and grasses. Common occurrences include but are not limited to dogwood (*Cornus stolonifera*), buffalo-berry (Sheperdia *canadensis*), dwarf birch (*Betula pumice*), willow species (*Salix spp.*), Labrador tea (*Rhododendron groenlandicum*), beaked hazelnut (*Corylus cornuta*), prickly rose (*Rosa acicularis*), low bush cranberry (*Viburnum edule*), green alder (*Alnus crispa*) as well as bunchberry (*Cornus canadensis*) common horsetail (*Equisetum arvense*), and cattail (*Typha latifolia*).

2.2 FOOTPRINT

2.2.1 Thornbury

Thornbury parallels the existing NGTL Liege Lateral and Liege Lateral Loop pipelines and is contiguous with existing disturbance for 93.3% of its length (Table 2-1). The development is in the East Side Athabasca River (ESAR) caribou range for 88% of its entire length (4.9 km of the ROW and the Compressor Station are within the Egg-Pony herd range, while 18.9 km are in the Algar herd range). The pipeline route crosses Environmentally Significant Areas (ESAs) 692 and 593, which contains large natural areas, intact riparian areas, important wildlife habitat, including habitat for woodland caribou, rare or unique landforms. The route also crosses four Aquatic ESAs, a Leading Edge Mountain Pine Beetle Management Zone, and a Key Wildlife and Biodiversity Zone (KWBZ) associated with the House River.

Construction activities for Thornbury first started in September 2015 and the pipeline went into service in November 2016. Final cleanup occurred between November 2016 and February 2017. In 2018-2019, NGTL vegetation specialists completed Year 1 of this Monitoring Program.

Table 2-1: Summary of Project and Caribou Habitat Information

Caribou Range	East Side Athabasca
Herd Range	Egg Pony and Algar
Disturbance	Existing disturbance: 93.3%
	Greenfield disturbance: 6.7%
% of Existing Disturbance in Overlapped Caribou Range[1]	81%

Note:

1. % of existing habitat disturbance in overlapped caribou range from the Federal Recovery Strategy for the Woodland Caribou (2012). The Draft Alberta Provincial Woodland Caribou Range Plan (2017) percentage for this same category is 88%.

2.2.2 Offset Areas

The Dillon River Wildland Provincial Park (Dillon) managed by Alberta Environment and Parks (AEP) situated within the ESAR (Christina herd) and Cold Lake (Cold lake herd) Caribou Ranges was chosen in consultation with AEP as the offset recipient due to its impacts from past seismic activities (Figure 2-2). Wildlands are one of the seven categories of protected natural areas in Alberta; this location was deemed fitting due to its importance as reservoir of integral habitat for boreal caribou and where offsets could be protected in perpetuity. Candidate sites for offsetting were first identified in 2014; at this time, NGTL conducted a comprehensive desktop review in collaboration with AEP and Alberta Pacific Forest Industry Inc. (Al-Pac) to identify suitable locations.

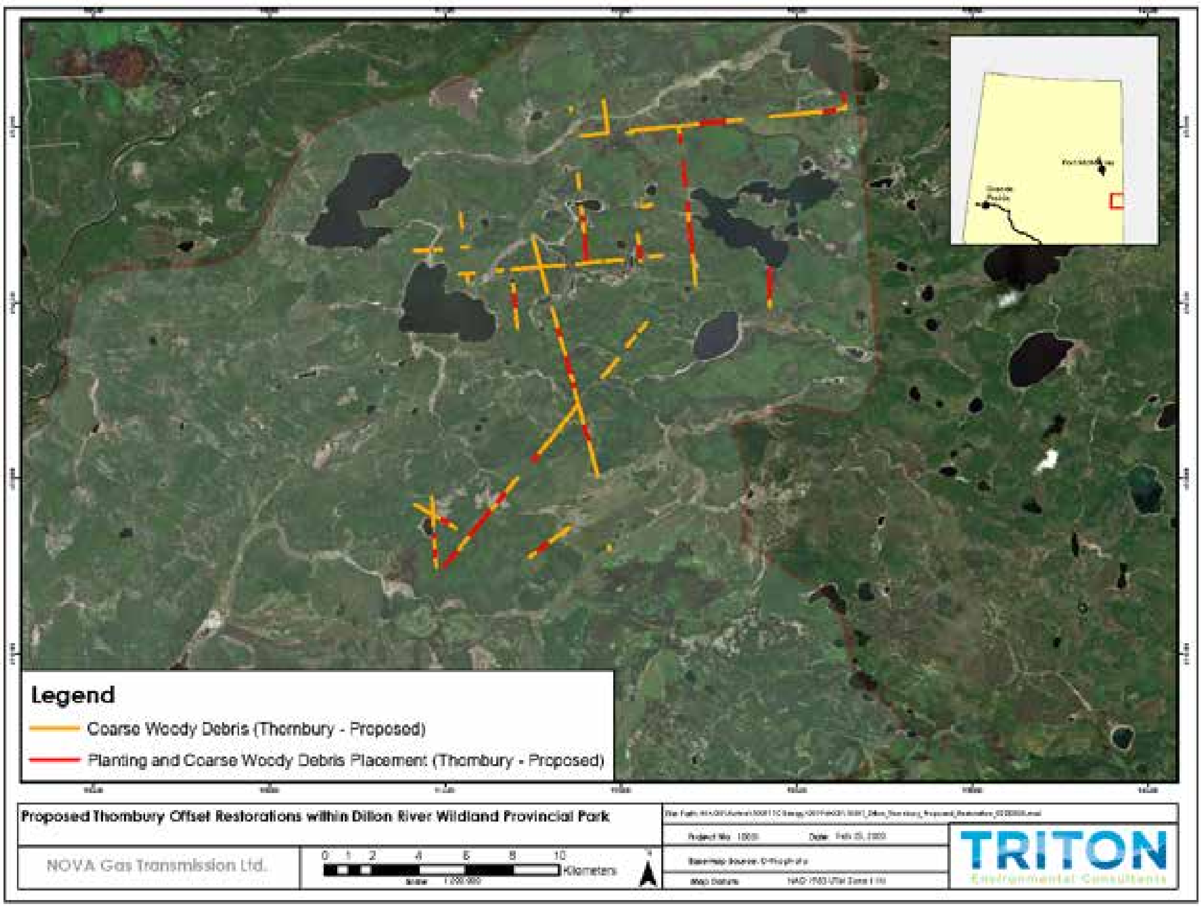

Figure 2-2: Proposed desktop offset plans for Dillon in 2014; these locations were subsequently revised following field verification and moved in the southern portion of the natural area (Figure 2-3 below)

In 2017, NGTL and AL-PAC initiated field visits to determine offset site suitability. Ground-truthing resulted in the discovery that some of the chosen recipient locations within the park were not appropriate for offsetting due to already well-established vegetation communities along seismic lines. NGTL identified alternative sites, tracking changes in locations and treatment areas, to ensure that the offset footprint remained equivalent (see Figure 2-3 below).

NGTL offset restoration measures implemented included the installation of discrete barriers (fences/berms), barrier segments (rollback, mounding), tree planting for line of sight blocking, tree planting to accelerate reforested state and augmentation of natural revegetation. Figures 2-2 and 2-3 provide preliminary and final offset locations, and their treatments in the Dillon River Wildland Park chosen for offsetting. A total of 51.4 ha was restored within the offset area of the 37.55 ha required.

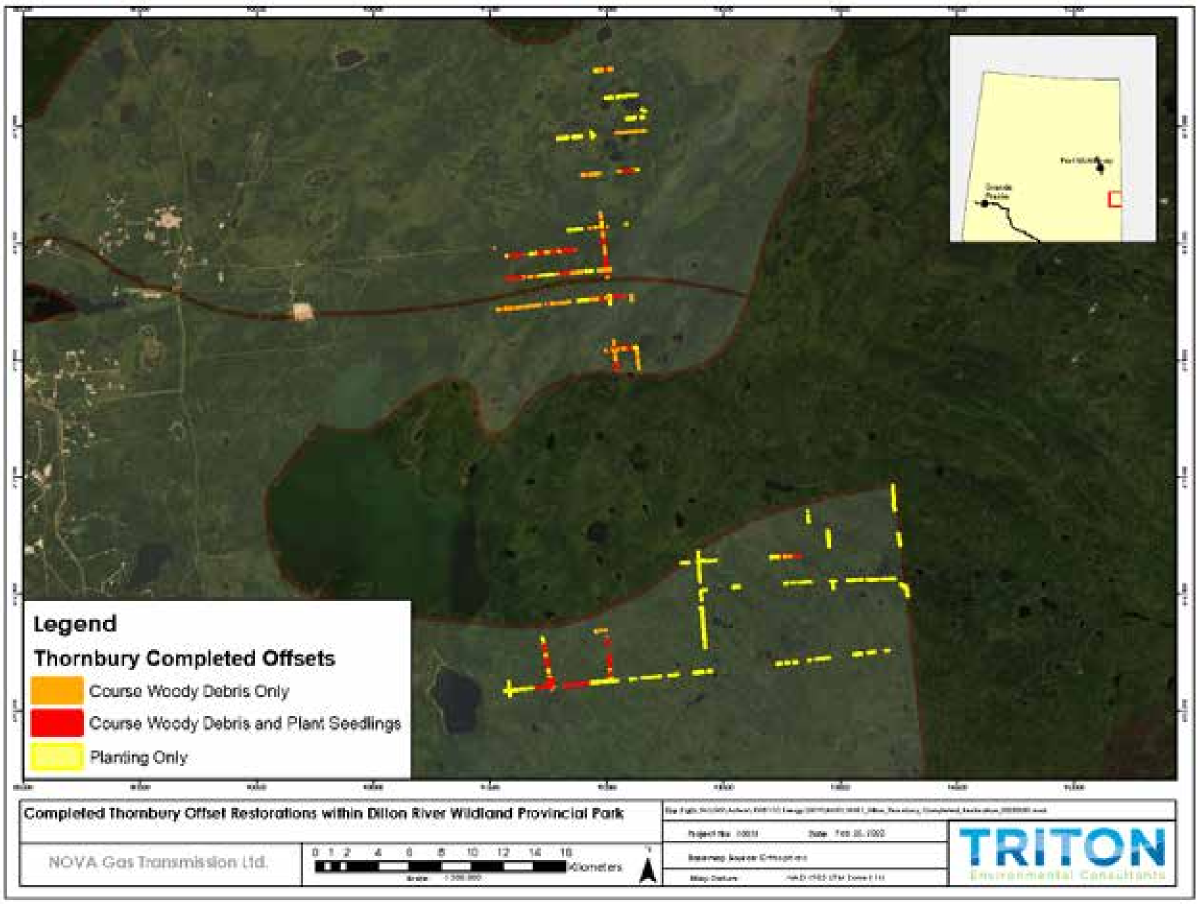

Figure 2-3: Dillon River Wildland Provincial Park Offsets following field verification in 2017.

NGTL offset restoration measures implemented included the installation of discrete barriers (fences/berms), barrier segments (rollback, mounding), tree planting for line of sight blocking, tree planting to accelerate reforested state and augmentation of natural revegetation. Figures 2-2 and 2-3 provide preliminary and final offset locations, and their treatments in the Dillon River Wildland Park chosen for

offsetting. A total of 51.4 ha was restored within the offset area of the 37.55 ha required

2.3 BOREAL CARIBOU

Boreal caribou (*Rangifer tarandus caribou*) are a distinct ecotype of woodland caribou inhabiting the boreal forests of Canada. In Alberta, there are 12 populations distributed over the northern half of the province. Boreal caribou are assessed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed as a threatened species under the federal Species at Risk Act (SARA). All herds in Alberta are deemed non-sustaining and require action to return 65% or more of their range to undisturbed conditions for the population to become viable once again (SARA, 2012).[6]

Boreal caribou are mostly sedentary and show high fidelity to home ranges. Lichens typically associated with old growth coniferous forests form an important part of their winter diet. In snow-free months caribou choice of forage is more varied, allowing herds to move across different habitats. The presence of old growth forests is, however, only one of the constraints influencing northern Alberta's caribou populations. Individuals or small herds find refuge from their main predators, wolves and bears, in mature coniferous stands with high canopy cover or in vast wetland complexes. Human disturbances affecting caribou habitat such as clearing and the construction of linear features (e.g., cutlines, roads, pipelines, etc.) result in cumulative effects to caribou through primary and secondary predation, return of the landscape to an earlier seral stage, loss of suitable habitat, and range fragmentation. These threats are compounded by natural fire cycles, insect harassment, disease, and climate change.

The direct correlation between habitat disturbance and sustaining woodland caribou populations underlines the importance of habitat restoration initiatives targeted to boreal caribou recovery. Restoration of disturbed habitat has become one of the key components for caribou conservation identified through the proposed amended federal Recovery Strategy (ECCC 2019). Preventing off-road and vehicular access, ensuring vegetation regrowth to a reclaimed and self-sustaining state, and blocking line-of-sight along the linear corridor are priority actions undertaken by this Monitoring Program; in alignment with provincial and federal policies, management plans and priorities (Alberta Woodland Caribou Recovery Team, 2005; Environment Canada, 2012, ECCC, 2019).

[6] Retrieved on December 16, 2019 from: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/woodland-caribou-boreal-population-2012.html

2.4 MONITORING PROGRAM METHODOLOGY FRAMEWORK

The restoration of caribou habitat requires unique consideration of species composition, ecological maturity, and of vegetation growth trajectories required to achieve suitable “caribou” forest conditions in as short time as possible. In this Monitoring Program, progression is informed by ground based and camera surveys. These surveys enable vegetation specialists to chart quantifiable performance indicators for treated sites (GOA, 2018). Monitoring has, therefore, the primary function of informing the adaptive management process. Based upon field observations over the course of time, decision makers can perform corrective actions and develop procedural learnings to inform current and future NGTL programs in caribou range. Habitat restoration and offset measures are considered successful when monitoring results indicate that restoration has achieved, or is on a trajectory to achieve, the Monitoring Program targets.

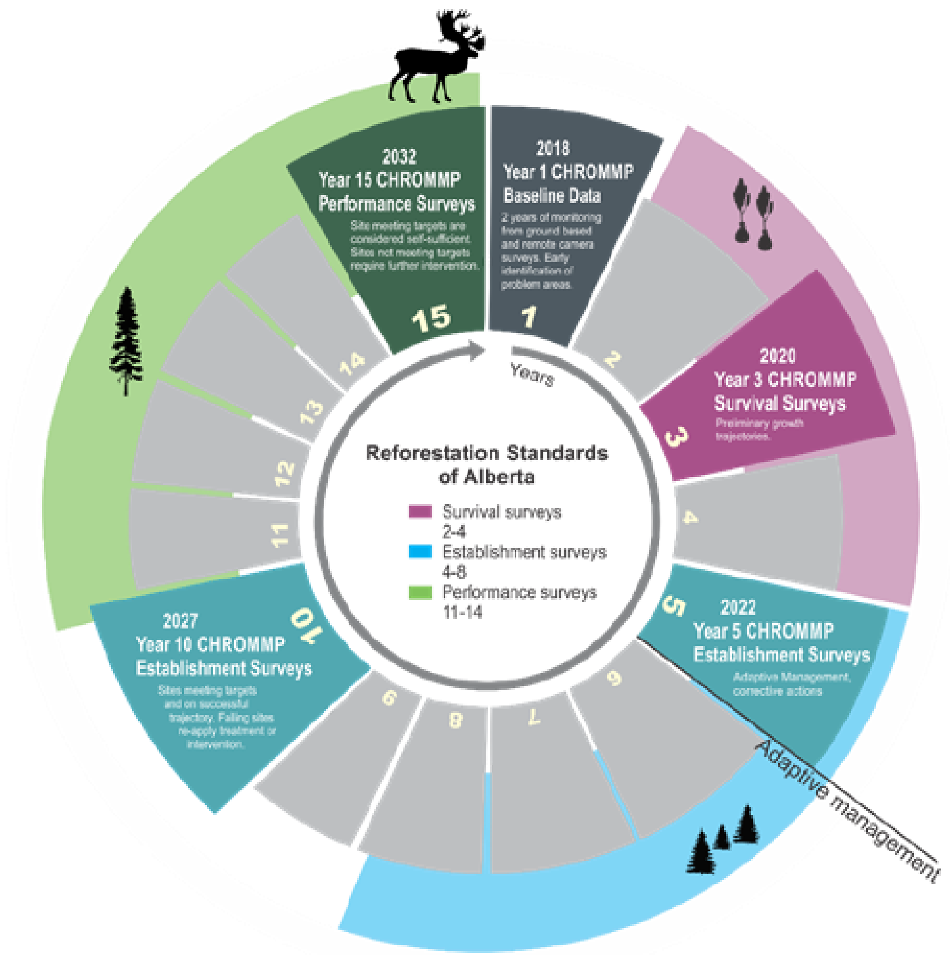

Figure 2-4: Monitoring Program wheel based on NGTL adaptive management’s framework. The Year 1 of the Monitoring Program started in 2018, was completed in 2019 and is reported in 2020. Next phases of the Program include Survival, Establishment and Performance surveys at Years 3, 5, 10 and 15. © TC Energy, 2020

This Monitoring Program was launched in Q3 of 2018 following the completion of habitat and offset restoration in February 2017. NGTL vegetation specialists established vegetation plots and installed remote cameras to monitor access controls and wildlife movements in the Project Areas. In Q3 of 2019, after a year of recording, remote camera and ground-based data was analyzed and compiled into this Year 1 CHROMMP. The process of data analysis and reporting started in 2019 and was completed in Q1 of 2020.

Having multiple data points in time and space is important to understand the long-term performance of treatment sites. The data collected in Year 1 of this Monitoring Program informed NGTL on the conditions of treated areas and allowed for the early identification of potential issues. A single year of data, however, is not yet sufficient to make inferences on the success of restoration activities. Survival surveys undertaken in the year 2020 (Year 3 of the Monitoring Program) will evaluate whether planted vegetation has successfully taken root with adequate density and vigor. In Year 5, seedlings are expected to have reached successful establishment and to be tall enough to be monitored from the air using LIDAR aerial surveys.

The 3 Types of Vegetation Surveys

Survival Survey: Survival surveys target plant mortality; in this Monitoring Program, they are used to identify areas that may require re-treatment due to immediate mortality, or augmentation of existing treatments required to ensure growth on the site and to meet the long-term goals.

Establishment Survey: establishment surveys determine if vegetation has established according to silviculture standards (Timber Management Regulation (122.1(1)a) and the performance indicators for years 5 and 10 of the Program. Sites meeting standards at this point are on trajectory to being restored. Any sites not meeting the measurable targets will require retreatment and possibly a re-quantification/re-calculation of offsets.

Performance Surveys: performance surveys are carried out to determine if forest stands have continued to grow according to performance indicators (Timber Management Regulation (122.1(1) a.1) and help quantify a full caribou habitat restoration timeline. If a site meets the measurable targets at Year 15, it is deemed self-sustaining and requiring no further intervention.

The amount temporal breadth granted by 5 years of monitoring will allow NGTL to identify sites requiring corrective actions (adaptive management), and to make more reliable predictions of performance indicators based upon the Program’s standards.

After this period, Year 10 and 15 will focus in gauging growth performance and the successful attainment of a firm trajectory towards functioning habitat for caribou.

2.3.1 The Role of Ground based and Remote Camera Surveys

The use of ground based and remote camera methods at interval years allows NGTL to make decisions in an ongoing fashion and shorten the habitat restoration timeline for problem sites requiring immediate corrective action, undertaken by PCRM crews. This approach goes beyond the goals of reclamation as intended in traditional silviculture practices, which focus to return the land to a productive state (Ray, 2014). NGTL's restoration framework guides a process of improvement of ecosystem functions for caribou without necessarily seeking to achieve a full return to pre-disturbance conditions. It is expected that at Year 15 of the Monitoring Program treated sites will be on a firm trajectory towards becoming functional boreal caribou habitat.

Ground based surveys methods employed in this Monitoring Program have been adapted from to the *Reforestation Standard of Alberta* (Alberta Agriculture and Forestry, 2017). Under these practices, survival surveys are typically conducted between Years 2 and 4, establishment surveys are performed between Years 4 and 8, and performance surveys are completed between Years 11 and 14. At the conclusion of the cycle, a site is considered successful if free-to-grow (Alberta Agriculture and Forestry, 2017). NGTL vegetation specialists modified the surveys cycle to include Years 1, 3, 5, 10, and 15. This alteration was made to account for linear corridor settings, specific treatment undertaken to improve caribou habitat (access controls and line-of-sight breaks) and to have additional data points during the Program.

The remote camera monitoring portion of the Monitoring Program will be used to evaluate human access at access control locations and assists in the identification of human effects within the Project Areas. Remote camera monitoring also will also be used to examine wildlife response to access controls at access control locations, and the presence and composition of species (Figure 2-5).

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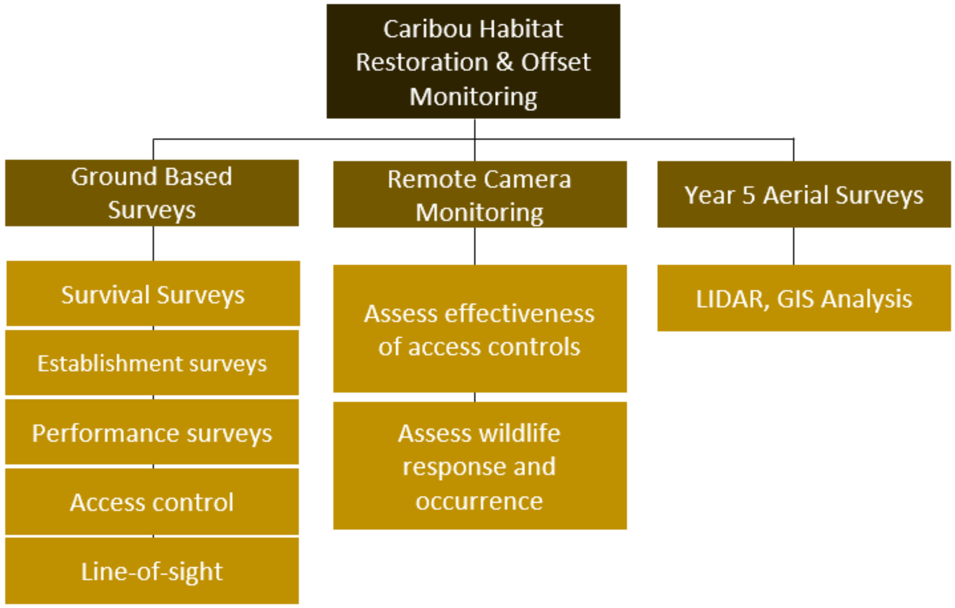


Figure 2-5: Overview of Monitoring Program methods. Aerial surveys using LIDAR will commence at Year 5 of this Monitoring Program

2.4.1 Offset Vs Pipeline Restoration Strategy

While subject to the same monitoring methodology, the restoration of the Thornbury linear corridor and of the seismic lines within Dillon are inherently different in terms of approach and of recovery performance. Restoration of past seismic footprint in Dillon is intended to provide a shorter timeframe for habitat rehabilitation within the ESAR and Cold Lake ranges and within Dillon, which due to its provincially designated status, protects the Dillon against future developments. The reader is encouraged to account for the different footprints of Thornbury and Dillon in the analysis of the Program's results.

3.0 GROUND BASED MONITORING

Ground-based monitoring involves physical access to a site to monitor the effectiveness of implemented habitat restoration and offset measures.[7] Specifically, the objectives of ground-based monitoring are to:

- evaluate vegetation communities' performance by collecting data on seedling density, vegetation height, percent cover and species composition;
- assess first-hand the effectiveness of access controls;
- evaluate the growth and effectiveness of and line-of-sight breaks; and
- gather information on the use of restored areas by wildlife through incidental observations.

The underlying methodology to monitoring is repeated measures experimental design, where measurements of restoration performance are repeated at each sample plot for each monitoring year using consistent standards.

3.1 METHODS

3.1.1 Timeline

The Program began in early 2018 with planning and site selection activities and fieldwork was completed in Q3 of 2018 during the vegetation growing season. Desktop site selection was refined on the ground based on local site conditions during a site visit and adjustments were made to plots to account for local topography and site suitability. As the Year 1 of this Monitoring Program includes remote camera monitoring for a period of 12 months, field crews revisited the Program Area in Q3 of 2019 to retrieve camera data and cameras. At this time, additional plots were selected to increase statistical representation for Thornbury.

3.1.2 Treatment Site Types

Treatment unit and plot type selection were chosen utilizing scientific data available for the Project Area and the Geographic Information System (GIS) ArcMap spatial analysis function. The strategy adopted by NGTL first involved delineation of treatment sites sharing similar characteristics (Table 3 1), followed by the creation of treatment units and plot types: restoration, natural regeneration, access control, and line of sight (Figures 1 and 2).

[7] NEB Filing IDs: A893697-1 (Revised Final CHRP), A87455 (Final CHRP), A88198, A89273 (errata filings).

Table 3-2: General definitions of treatment units, corresponding vegetation, and type of plots employed in the ground-based program

Plot Type	Treatment Unit Type	Description
Restoration Plots Plots selected in treatment units within the Project Areas to evaluate vegetation growth and restoration after planting. Natural Regeneration (Control) Plots Plots placed on sites disturbed by construction that are currently going through the process of natural regeneration (i.e., sites left to regenerate from the soil seed bank and natural ingress).	Treed Upland	Treed uplands (mixed wood, coniferous) are tracts of forest located in non-wetland areas on dry to moist soils. Typical upland vegetation include species such as white spruce, aspen, balsam poplar, jack and lodgepole pine, and balsam fir.
	Treed Lowland	Treed lowlands are tracts of forest typically located in soils with moist to wet regimes and within or adjacent to wetland complexes such as bogs, fens or waterbodies. Typical treed lowland species may include black spruce, tamarack, white birch, and cottonwood.
	Shrub Graminoid	Shrub Graminoid refers to areas characterized by the absence of trees and the prevalence of shrubs such as willows, dogwood and dwarf birch, forbs, and species that have grass-like morphology. These plots may occupy wetlands or naturally disturbed areas (e.g., burned bogs). Seedlings were not planted in these areas as coniferous trees were not dominant within the adjacent landscape.
Access Control Plots	Access management treatment locations monitored to determine ROW usage and effectiveness of controls.	
Line-of-Sight Plots	Monitoring locations used to determine the effectiveness of line-of-sight blockages installed to deter visual spotting of caribou by predators.	

3.1.3 Restoration plots

Restoration plots placed within treatment areas were used to measure the success of restoration activities based upon established metrics.[8] The treatment unit type for each was defined by similar ecological communities and biogeoclimatic influences (e.g., landscape, moisture, and nutrient regimes and corresponding uplands, lowlands, and shrubland habitat). Next, polygon plots were drawn using a stratified random site selection method. The number of plots (representation) for each habitat was accounted for to avoid bias.

3.1.4 Natural revegetation plots

Natural regeneration plots were selected using the same stratified random sampling methodology described above and in Appendix A.

3.1.5 Access Control Plots

Access controls utilized by NGTL in the Program Area include:

- Extended trenchless crossings
- Vegetation screens

[8] Appendix A.

- Rollback
- Fencing and signs
- Vegetation planting
- Mounding

The location of access management controls was first identified during the planning activities preceding pipeline construction using Thornbury construction alignment sheets. Proposed access management treatment locations were adjusted during the construction phase to consider site-specific conditions and to adapt to construction needs, where required. Criteria utilized for their initial appointment included: location within Caribou range, intersecting perpendicular access configuration, as well as evidence of existing human access. Access controls adjacent to other dispositions, including pipeline ROWs, roads, and facilities, access management measures rendered ineffective by accessible parallel dispositions were not considered.

Access controls were not defined for the Dillon offsets due to the different nature of the area, which is characterized by extensive regenerating seismic development and limited access due to its remoteness. However, felled trees (coarse woody debris) were combined or interspersed with planting treatments where required (see Photo 3 2 below in section 3.2.7) to limit access and, secondarily, to slow predators.

3.1.6 Line-of-Sight Plots

NGTL line of sight measures implemented in the Program Area include individual or combinations of vegetation screening, tree planting, rollback and mounding created during construction and final cleanup according to the Environmental Protection Plan (EPP). Line of sight mitigation included minimal disturbance construction techniques, where possible, that favor regeneration or preserve vegetation, conifer seedling plantings, snow ramping, bore extensions, and shrub staking. Fabricated screens and earth berms were not employed for line-of-sight blocking. The maximum line of sight mitigation applied that was applied within caribou range was deemed 500 m or less. Suitable locations for line of sight plots were identified using a random selection strategy using the Project Area construction alignment sheets and GIS data.

3.1.7 Restoration and Control Plot Establishment

A total of 99 plots were established within the restoration areas (Table 3 2, Figures 3-1 and 3-2). Circular plots (50 m2, i.e., 3.99 m radius) were created on operational dispositions 24 m wide or greater. Smaller plots (10 m2, i.e., 1.79 m radius) were utilized for non-operational Dillon Offset areas on seismic lines less than 24 m wide. The final monitoring plot locations were refined by ground crews in situ; plot locations were marginally changed where dictated by topography or access safety considerations. Plots deemed unsuitable during ground-truthing (i.e., treatment mismatch) were replaced at time of field establishment using pre-selected contingency plots necessary.

3.1.8 Field Program

Field work was conducted outside of the Restricted Activity Period for Caribou (i.e., after July 15) and within the vegetation growing season, by two teams of two qualified vegetation specialists. Monitoring sites were accessed via helicopter or on foot between August 17 to August 31 in 2018. Access control and line-of-sight monitoring plot data were collected simultaneously with the habitat restoration monitoring data. Where practical, restoration monitoring plots were selected in proximity to access control and line-of-sight plots.

NGTL conducted a site assessment at approximately KP 14+400 on August 8, 2019, as follow up to Information Requests pertaining to a NEB field inspection carried out on July 25, 2018. Results of the site assessment were included in a response (NEB 4.2) on August 23, 2019.[9]

Table 3-3: Distributions of monitoring plots established within each restoration treatment unit by Project Area

Location	Habitat Restoration Treatment Units *(Planted)*		Natural Regeneration Treatment Units *(Control)*		
	Upland	Lowland	Upland	Lowland	Shrub/ Graminoid
Thornbury	13	13	3	7	13
Dillon	13	13	8	5	11

[9] CV 1819-466.

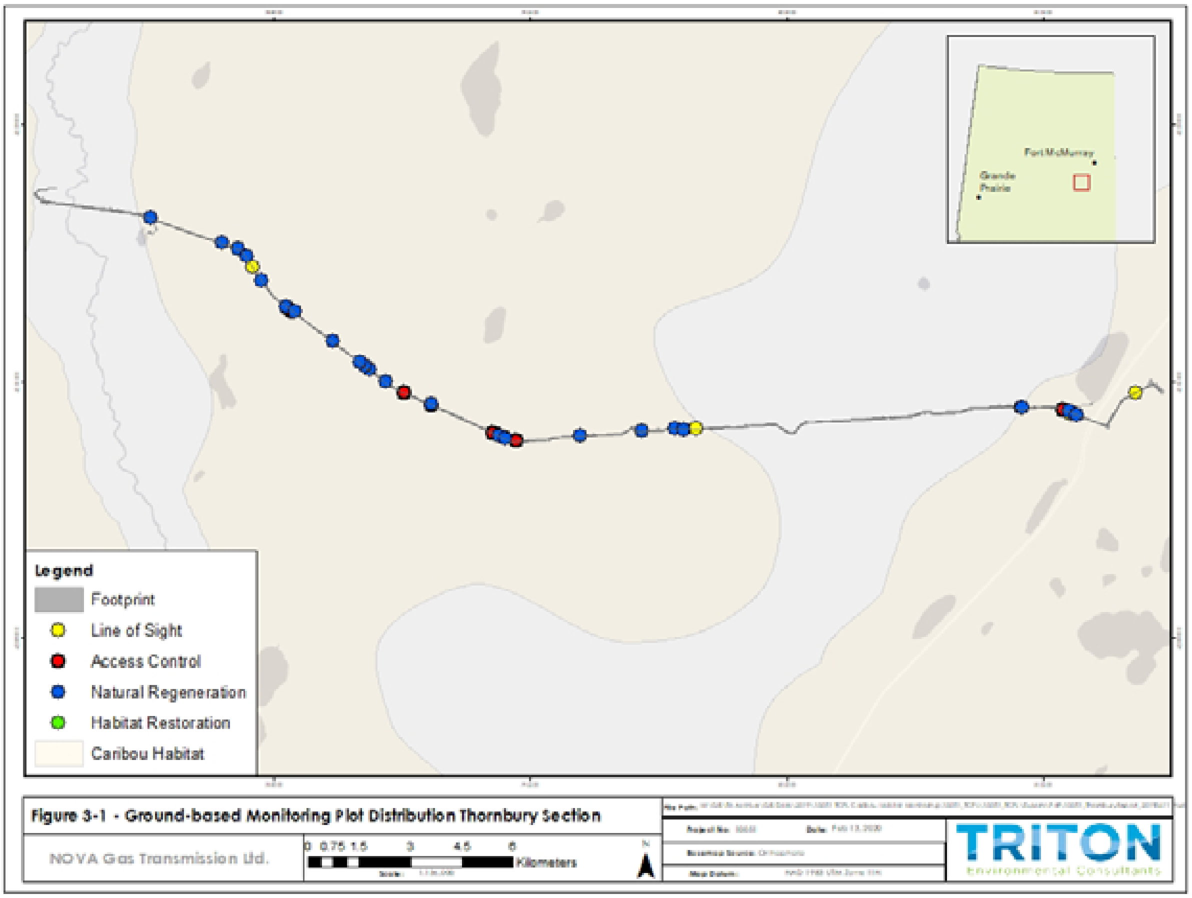


Figure 3-6: Ground-based Monitoring Plot Distribution Thornbury

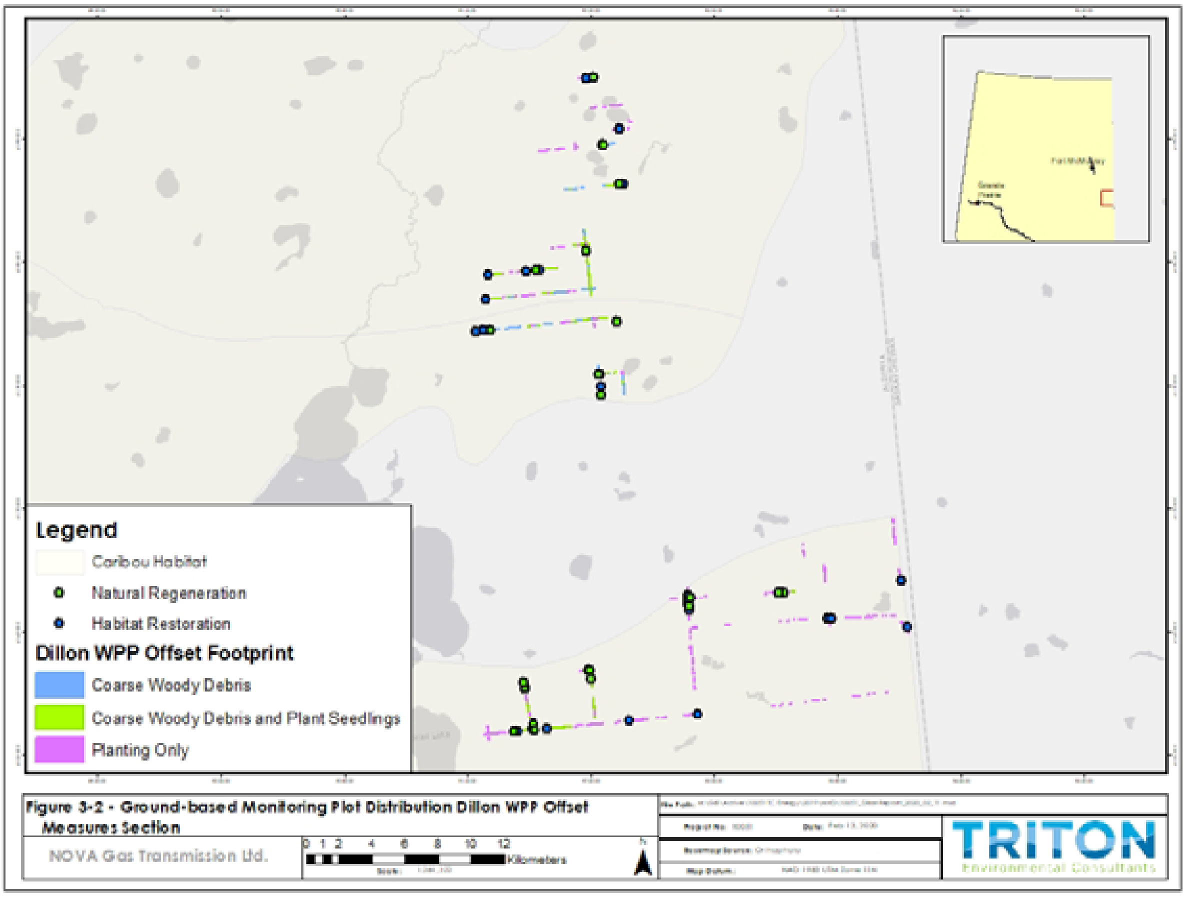


Figure 3-7: Ground-based Monitoring Plot Distribution for the Dillon River Wildland Provincial Park Offsets

3.1.9 Sampling Protocol

Information collected at each plot location was defined in Appendix B to ensure consistency and comprised the following:

- vegetation height, density, vigour and health of seedlings planted or naturally regenerating (tally of species by height class);
- vegetation community composition data, including vegetation strata height, species and percent cover information (e.g., trees, shrubs, forbs, grasses, nonvascular plants, indicator species and non-native, invasive or weed species). See Appendix C for a list of Characteristic Species;
- evidence of access (e.g., vehicle tracks, access type and level) and, where access-control measures are implemented, verification of their ongoing functionality as an adequate barrier or deterrent;
- line-of-sight measurements including functionality and seedling height, density, vigour and health (for vegetation line-of-sights);

- incidental wildlife signs (e.g., animal tracks, scat, browsing);
- cursorial soil information (e.g., percent cover of each surface substrate type to determine the percent covers of vegetated vs. non-vegetated ground, slope and aspect, drainage, moisture and nutrient regime, surface organic matter thickness; and
- any observed plot characteristics that might impact vegetation survival, establishment and/or growth (e.g., competition, vegetation damage).

3.1.10 Data Collection and Analysis

Habitat restoration, access control and line-of-sight data were collected by survey crews using a GPS-enabled field tablet. All field data was reviewed for accuracy and completeness following in-field and post-field quality assurance/quality control (QA/QC) protocols. Data processing and QA/QC was completed immediately after returning from the field and data was uploaded into a secured geodatabase.

Statistical testing was completed using R 3.5.3 software (R Core Team, 2018) and t-test inferential statistics. A t-test determines if there is a significant difference between two groups of data. In this program, t-tests were used to measure a range of different parameters such as the difference between native vegetation percent cover or seedling density and desired target values.

In restoration and control plots, one-sided t-tests were used to evaluate vegetation performance against habitat restoration thresholds, and paired t-tests assessed differences between treatment units. Each individual habitat restoration unit was evaluated separately because of the inherent differences associated with their biophysical characteristics. Beginning in Year 5, an analysis of variance (ANOVA), which can detect differences between three or more groups (i.e., years), will be used in the statistical analysis.

3.2 RESULTS

3.2.1 Native Vegetation Cover

Mean percent cover of native vegetation for the Thornbury ROW and Dillon Offset plots are summarized in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 3-4: Mean percent covers ± SE of native vegetation by restoration unit and Project Area

Location	Habitat Restoration Treatment Unit (Planted)		Natural Regeneration Treatment Unit (Control)		
	Upland (%)	Lowland (%)	Upland (%)	Lowland (%)	SG (%)
Thornbury	33.0 ± 6.8	60.0 ± 7.1	21.1 ± 6.9	81.6 ± 5.8	91.9 ± 3.0
Dillon	86.7 ± 6.0	96.7 ± 3.9	92.2 ± 5.8	94.7 ± 4.1	90.5 ± 4.3

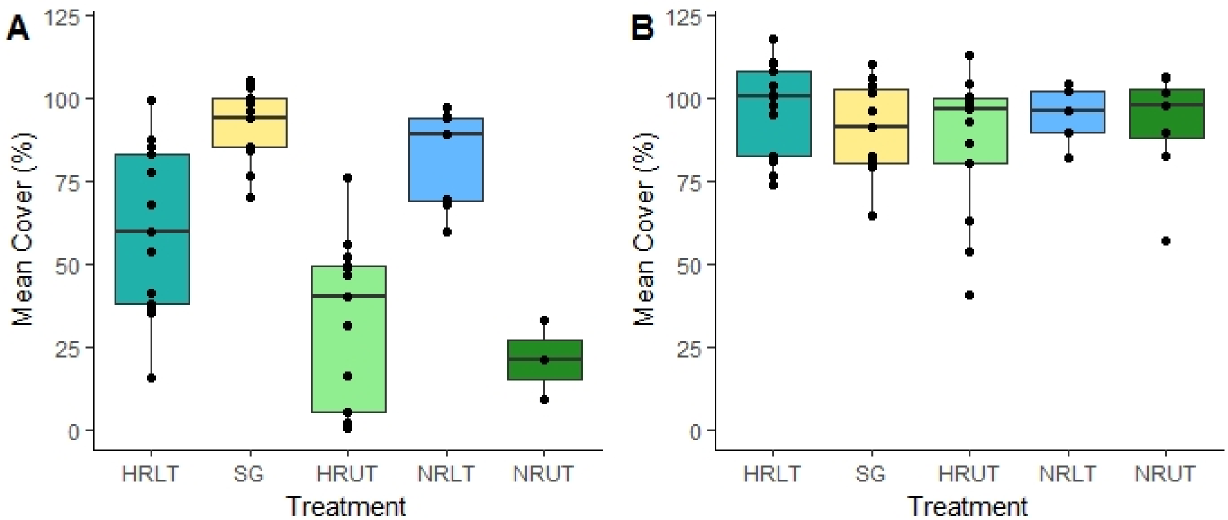


Figure 3-8: Distribution of percent covers ±SE of native vegetation by restoration unit and Project Area. Note: Thornbury = A, Dillon = B. HR = Habitat Restoration, NR = Natural Regeneration, LT = Lowland Treed, UT = Upland Treed, SG = Shrub/Graminoid. The centre line in the boxplot indicates the median value.

3.2.2 Thornbury

Native vegetation on Thornbury (A, left figure above) has shown good survival in all regenerating plots variations between treatment unit types. Natural regeneration of upland treed areas has the lowest relative percentage of mean cover, while shrub/graminoids exhibited the highest.

3.2.3 Dillon

On Dillon offsets (B, right figure above), native vegetation cover was equivalent between restoration plots and natural regeneration plots for all treatment types and native vegetation recovery is high (>80%) along the Dillon seismic lines.

3.2.4 Species Richness

Species richness is defined as the diversity of species occupying a given area (Brown et al., 2016). The species richness for native vegetation observed in each restoration treatment unit is presented in **Error! Reference source not found.**.

Table 3-5: Mean native vegetation species richness ± SE by restoration unit and location

Location	Habitat Restoration Treatment Unit (Planted)		Natural Regeneration Treatment Unit		
	Upland (%)	**Lowland (%)**	**Upland (%)**	**Lowland (%)**	**SG (%)**
Thornbury	15.6 ± 2.2	18.2 ± 1.5	10.0 ± 2.9	18.5 ± 1.2	18.3 ± 2.7
Dillon	16.8 ± 1.5	23.1 ± 1.6	17.4 ± 1.4	23.2 ± 2.3	16.6 ±1.3

3.2.5 Thornbury

Species richness was noted as being similar within lowland and shrub/graminoid with no obvious difference between restoration sites and natural regeneration plots. Species richness was greater in restored upland plots compared to naturally regenerating upland plots. Upland plots were generally dominated by forbs, graminoids and shrubs under 2.0 m tall, while lowland plots were dominated by mosses and small shrubs. In general, species richness was highest in the lowland restoration units and lowest in upland treatments.

3.2.6 Dillon

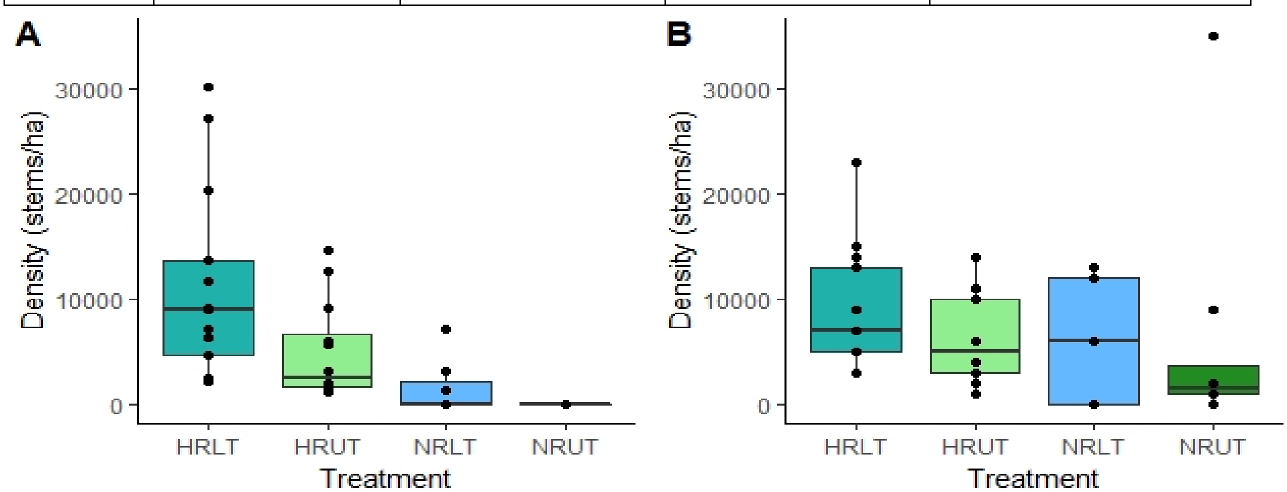
The results between Thornbury and Dillon indicate similar trends. However, Dillon has consistently higher specie richness values. Higher values are in line with predictions for the Dillon offsets, which as described in Section 3.2.1 are characterized by a smaller footprint, less ground disturbance, further natural regeneration, and better enclosure with the surrounding forest habitat than Thornbury.

3.2.7 Seedling Density

Error! Reference source not found. and **Error! Reference source not found.** Figure 3-4 provide the mean tree seedling densities (total of naturally occurring and planted seedlings), by location and restoration treatment unit

Table 3-6: Mean seedling density (stems per hectare) ±SE by restoration unit and location.

Location	Habitat Restoration Treatment Units (Planted)		Natural Regeneration Treatment Unit (Control)	
	Upland (stems/ha)	Lowland (stems/ha)	Upland (stems/ha)	Lowland (stems/ha)
Thornbury	**8430.8 ± 3546.9**	**11323.1 ± 2569.3**	0.0	1685.7 ± 1025.3
Dillon	**9000.0 ± 3038.2**	**8923.1 ± 1626.9**	6375.0 ± 4208.6	**6200.0 ± 2800.0**



Note: bold values indicate the probability of the mean being less than the measurable target is less than 0.05, indicating the measurable target (i.e. 1600-2000 stems/ha for Upland, 400-

). Mean percent cover of measured planted and naturally regenerating tree seedlings (tree species only) ranged from 0.5% to 4.6% for Thornbury.

3.2.12 Dillon

In 2018, most tree seedlings were classified as S3 (0 – 50 cm tall) and S2 (50 cm to 200 cm tall) (

). Mean percent cover of measured planted and naturally regenerating tree seedlings (tree species only) ranged from 2.2 to 0 4.9% on Dillon.

3.2.13 Characteristic Lowland Species

All **lowland** treed and shrub/graminoid (planted or naturally regenerating) plots on Thornbury and Dillon contained at least two characteristic species based on the species assemblages described in the Alberta Wetland Classification System (AEP, 2015).

3.2.14 Noxious Weeds and Undesirable Species

Sightings of weeds as defined by the Alberta Weed Control Act (2017) were reported for both Thornbury and Dillon, so that appropriate weed control measures could be **subsequently** applied. The presence of the various non-native invasive species observed within ground-based monitoring plots are summarised by location in **Error! Reference source not found.**.

Table 3-8: Number of plots and percent covers of restricted weeds and undesirable (non-native) species found within habitat restoration plots

Species Name	Common Name	Thornbury		Dillon	
		# of Plots	% Cover	# of Plots	% Cover
Noxious					
	Common tansy	1	1.0	--	--
Other non-native					
	Cicer milk vetch	2	30.0 – 61.0	--	--
	Bird's-foot trefoil	5	1.0 – 12.0	--	--
	Common plantain	3	0.1 – 3.0	--	--
	Common chickweed	4	0.1 – 0.5	2	0.5
	Common dandelion	4	0.1 – 0.5	--	--
	Alsike clover	15	0.1 – 59.0	--	--
	Red clover	3	5.0	--	--

3.2.15 Thornbury

No prohibited noxious weeds listed in the Weed Control Regulation of Alberta (2010) were found in Thornbury. A small amount (1.0% cover) of noxious weed common tansy (**Tanacetum** *vulgare*) was detected in a single upland habitat restoration plot. Invasive species, bird's-foot trefoil (*Lotus corniculatus*), cicer milk-vetch (*Astragalus cicer*), red and alsike clover (*Trifolium* species) were also observed in patches of up to 61% cover in 2 – 15 plots on Thornbury. These species were observed in the highest abundance both in planted upland plots (25.4% non-native plant cover) and naturally regenerating treed upland plots (74.2% non-native plant cover.

3.2.16 Dillon

No occurrences of prohibited noxious or noxious provincially listed weed species were detected on Dillon. A small amount (0.5%) of common chickweed was observed on Dillon but overall the assessed areas appear to be predominately free of non-native species.

3.2.17 Access Control

ROW access control measures consisted of timber rollback and earth mounding. The **effectiveness** of access control structures was determined by the observed presence/absence of access, or magnitude (**Error! Reference source not found.**). If prior access was evident, the level of access was categorized based on a range from low to high.

Table 3-9: Qualitative and numerical definitions of access

Qualitative Rank	Description	Assigned Numerical Rank
Absent	No evidence of human access	0
Low	Tracks/trail evident but difficult to discern or appear infrequently used.	1
Moderate	Relatively easily discernible, vegetation may be slightly tramped, but no bare ground is visible.	2
High	Tracks and trails appear to be well used, vegetation is trampled around, bare ground may be visible from frequent use.	3

3.2.18 Thornbury

Low evidence of human access was observed circumventing access control or using parallel alignments to bypass access controls (Table 3-9). The ground-based monitoring **program** results indicate access control measures are intact and are performing as anticipated. Changes in access relative to baseline data collected in Year 1 of the program will be assessed in future years.

Table 3-10: Summary of human access level observed at access controls by location

Location	Access Control Type	Number	Effective Sites	Range of access level observed	Sites with High Level of Access %(*n*)
Thornbury	Mounding	6	6	Absent - Low	0
	Logs	1	1	Absent	0

Note: (n) indicates the number of access controls with high level of access.

Figure 3-9: Example of mounded hummock and pool access control along Thornbury in wetland habitat. Many of the habitats described in this report present challenge to non-frozen access during summer. Winter access is captured by the remote camera program discussed in Section 4 of this report

3.2.19 Dillon

Access controls were not defined for the Dillon offsets due to the different nature of the area, which is characterized by extensive regenerating seismic development and limited access due to its remoteness. However, felled trees (coarse woody debris) were combined or interspersed with planting treatments where required (Photo 3-2) to limit access and, secondarily, to slow down or discourage potential predator movements along seismic lines. Special attention was paid to existing signs of traffic along lines.

Figure 3-10: Example of a relatively open seismic line on Dillon. In such locations, access controls were implemented as on a case to case basis according to NGTL vegetation specialists' prescriptions as well as ongoing desktop research based on high definition aerial imagery. In the picture fallen coarse woody-debris deter access along a seismic line and block ground visibility

3.2.20 Line-of-Sight Assessments

Line of sight assessment and measurements of seedling growth were performed on Thornbury five line-of-sight vegetation screens. The vegetation screens were mostly composed or rapidly regenerating shrub species and trees adapted to the treatment unit in question. Vegetation screens were assessed for survival and woody stem per hectare (**Error! Reference source not found.**).

Table 3-11: Mean seedling density (stems per hectare) on treed line-of-sight breaks

Location	Upland Mean Seedling Density (stems/ha)	Lowland Mean Seedling Density (stems/ha)
Thornbury	3500.0 ± 288.7	2000

Note: bold values indicate the probability of the mean being less than the measurable target is less than 0.05, indicating the measurable target (i.e. 1600-2000 stems/ha for Upland, 400-1000
was too low to test seedling density in lowland plots.

The density of woody stems within the 5 plots was consistent and exceeded the target. Nevertheless, their height is not yet sufficient to provide effective line of sight breakage along the ROW. Line of sight capacity will increase over the course of the Monitoring Program and will continue to be assessed.

4.0 REMOTE CAMERA MONITORING

NGTL implemented the remote camera monitoring program along the operational (post-construction) Thornbury ROW and in the Dillon Offset areas. The goals of the program are to:

- verify the effectiveness of access controls along the ROW during pipeline operations; and
- detect wildlife use through incidental observations.

The target of the Monitoring Program is to decrease access by 20% at access control locations along the ROW within five years following the completion of restoration activities (Appendix D) Year 1 (2018) data will be compared to Year 3 data (2020) to assess whether this target has been met. This section provides a summary of camera monitoring activities conducted from August 2018 to August 2019.

As stated in the Update to Final Caribou Habitat Restoration Plan (Final CHRP)[10] and Final Caribou Habitat Restoration and Offset Measures Program (August 2018),[11] LiDAR High-resolution light detection and ranging (LiDAR), LiDAR High-resolution light detection and ranging (LiDAR) will be conducted in Year 5 of this Monitoring Program. NGTL decided to defer these surveys to Year 5 since previous studies conducted on other projects, found challenges in measuring and classifying small tree seedlings and distinguishing trees from grasses until a certain level of growth has been achieved.

4.1 METHODS

Access control measures implemented for the Project Area include mounding, planting within rollback and/or on mounds, and layering of coarse woody debris. These measures were built in areas of new alignment or where the ROW intersects other linear features to prevent or deter human access to portions of the ROW within Caribou range.

Remote motion-triggered cameras installed at or near access controls offer a non-invasive monitoring method to capture seasonal variation in human and wildlife occurrence and provide a tool to study their effectiveness. Time-stamped digital photographs are taken when outside movement triggers the sensor record over a continuous timeframe and create permanent records (O’Connell et al., 2010).

4.1.1 Site Selection

Cameras were deployed at the same locations where access control measures were implemented. Using a repeated experiment design, the camera program will utilize

[10] NEB Filing IDs: A87455, A88198, A89273.
[11] NEB Filing ID: A93698-1.

the same locations and techniques for the duration of the Monitoring Program. Camera locations were selected based on the following criteria:

- located within a designated caribou range boundary;
- located on a section of new alignment created by the proposed or constructed footprint;
- located near an active intersection with the proposed or constructed ROW and another linear feature (i.e., roads, pipelines, transmission lines); and
- located within a treed area with trees of adequate size to mount a camera.

An element of flexibility was retained in camera deployment at the ground level to allow for optimum placement in consideration of adjacent vegetation type and structure and deviations in site characteristics (e.g., height of vegetation, or position of suitable trees to mount the camera).

4.1.2 Equipment

Seventeen (17) Reconyx cameras labelled with unique numerical identifier were deployed: seven on the Thornbury line and ten within corresponding offsets within the Dillon River Wildlands. Prior to deployment, cameras were pre-set to take five rapid pictures followed by a 60-minute rest period and to use nighttime shutter speed and high resolution. Cameras were equipped with twelve AA lithium batteries and a labelled 32 GB SD card and were tested to ensure correct functioning prior to deployment.

Field crews accessed Program Area locations via helicopter. Helicopter landings within the Dillon River Wildlands were reported to the AEP as required by AEP access permitting procedures. A tablet/laptop was used for documenting site information, navigation and photographic data collection. After inserting a desiccant packet into each camera case, the camera was mounted and locked to a tree using a cable lock and a Reconyx Hyperfire security enclosure.

4.1.3 Camera Deployment

Cameras were generally deployed between 0 m to 50 m of the pre-selected site and 20 m to 75 m away from the access control measure to allow for suitable trees for camera mounting and to account for topographical restrictions. The units were deployed in a manner that would effectively capture the point of interest; to test this, a walk test of the camera was conducted immediately after deployment to ensure the camera was operational.

4.1.4 Camera Checks and Maintenance

Remote camera work is inherently limited by prolonged cold weather events, which impair battery life (O’Connell et al., 2010). To verify camera operation and to prepare for the winter season, crews revisited camera locations between October and December 2018. At this time cameras were inspected, and SD memory cards, desiccant packs, and AA lithium batteries replaced. Vegetation management (clearing of obstructing grasses and shrubs) and camera repositioning was completed as required to minimize the number of photographs triggered by vegetation or the sun passage. Data from the cameras was downloaded by the field crews and subsequently backed up onto portable hard drives. To ensure that no data was lost, crews conducted checks at the end of each day; prior to upload to the main database in Calgary, a post-field quality check was conducted.

4.2 DATA COLLECTION

Camera data collected for each site included:

- unique identifier number and site name
- SD memory card unique identifier
- dates and times of deployment, maintenance and retrieval
- field crew name(s)
- UTM (NAD 83)
- ecosite/wetland type
- description of the camera location (e.g., pipeline ROW, seismic line)
- description of access control treatment type (e.g. coarse woody debris, mounding)
- linear feature width (estimate)
- binary variable indicating evidence of human access (yes/no)
- human access type (off-highway vehicle [OHV], truck, equipment, N/A)
- binary variable indicating evidence of wildlife access (yes/no)
- classification of human access level (low: track/trail evident but difficult to discern or appears to be infrequently used; or high: tracks/trails well used, vegetation trampled, bare ground may be visible [NGTL, 2015])
- classification of wildlife access level (low/ high as defined above)
- photographs of camera placement on the tree, and a photograph of the view from the camera.
- date/time stamped photographs taken by each remote camera

4.2.1 Data Management and Analysis

Data analysis of visual data such as photographs poses unique challenges. In wildlife research, distinguishing individual animals of the same species or tracking populations over a prolonged timeframe has proven problematic and effort intensive.

Consequently, there is the potential to over-estimate wildlife abundance and density (Rowcliffe et al., 2008; Tigner et al., 2014). As the primary goal of the camera program is to determine the effectiveness of access controls and not wildlife count or population survey, the methodology adopted by NGTL focused on human access and on recording incidental wildlife occurrence only. While incidental recording cannot be used to accurate population counts, it is a valid tool to provide inferences about local species movements and habitat use.

Each camera was set to take five pictures in rapid succession upon triggering; therefore, a subject may have been documented multiple times in the same time sequence. Human individuals are relatively easy to distinguish from each other, while individual animals can be more difficult to identify when the subject is blurred or partially obscured. As some wildlife species travel in groups and individuals can be more difficult to distinguish, each photo was considered a separate observation. Replicate images of the same individuals in the same timestamped sequence were therefore not removed but accounted for. Counting each wildlife photo as a separate observation decreases the likelihood of missing an individual animal but the final number of observations for each group is, however, most likely overestimated.

Due to operational constraints (e.g., camera malfunctions and/or deployment and retrieval logistics) the number of days each camera was fully functional (i.e., camera effort) was not the same for every camera. Therefore, differences in count data (i.e., the number of observations of a given species) between cameras might reflect differences in camera effort rather than differences in subject counts (O’Connell et al., 2010). To account for this issue, the daily access rate for each group of interest was calculated for each camera location using the following formula:

Where observations equal the number of observations for a given species and effort equals the number of days a given camera was fully operational (NGTL, 2017).

Human access was further categorized as non-motorized, truck, or other off-highway vehicles (OHVs: i.e., UTVs, ATVs, Argos, Sherpas, snowmobiles), and divided between recreational users or workers.[12] Human visitors were classified as workers if they were observed carrying equipment (e.g., tools, clipboards, measuring devices) and/or if they were using personal protective equipment (i.e., hard hats, high-vis vests, fire-retardant coveralls, etc.). Individuals wearing camouflage clothing and/or carrying hunting gear were assumed to be recreational users.

4.3 ACCESS CONTROL EVALUATION CRITERIA AND MEASURABLE TARGETS

[12] Workers are in this context authorized NGTL personnel and subcontractors using the ROW for pipeline maintenance or monitoring purposes.

Evaluation criteria used to verify the effectiveness of access controls were developed by NGTL for the Project Area following provincial recommendations and guidelines (Pyper and Vinge, 2012). **Error! Reference source not found.** below presents the evaluation criteria used to verify the effectiveness of access controls outlined in the CHROMMP[13] (NGTL, 2017). Year 1 data will be compared in the future to assess whether the 20% access reduction in 5 years target is being achieved.

Table 4-12: Access control evaluation criteria and measurable targets

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management
Access Control	Remote Camera Monitoring	Evidence and level of vehicular use along the ROW and at offset locations will be measured using the following criteria: Evidence of access: Yes/No Evidence of U-turns at access barriers: Yes/No Access type: non-motorized over-snow vehicle all-terrain vehicle truck other (details to be noted) Access level metrics: absent low (tracks/trail evident but difficult to discern or appear to be infrequently used) high (tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use)	Access control targets are designed to prevent access along sections of new alignment of the ROW, except for segments paralleling dispositions, and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term: <20% increase in access against baseline along sections of new alignment on the ROW or at offset locations Success of habitat restoration targets, specifically sustained growth trends, is a good indicator that access is not inhibiting habitat restoration	Adaptive management actions for access control will enhance or alter current access control measures to improve the effectiveness of these measures for limiting access to areas undergoing restoration. The location, and source and type of access will be investigated, with enhanced access controls added where evidence of access is identified. This will be in the form of physical access barriers such as enhanced use of coarse woody debris, tree felling/tree bending (Cody 2013; Golder 2014), large rocks or fencing.

Note:
Abbreviations: equal to or less than (right-of-way (ROW).
Baseline, for the purpose of this Monitoring Program, means 'the first monitoring year' as pre-construction access data is not available.

4.4 RESULTS

Camera data and ground-based data were ultimately combined to study the success of access controls; a discussion of collective results is presented in Section 5 of this document. This section focuses, therefore, solely on the results of camera data and on the analysis of ancillary wildlife information gathered during Year 1 of this

[13] NEB Filing ID: A89738-1.

Monitoring Program. While not yet sufficient to draw inferences about the long-term success of access controls or not gathered for survey or counting purposes, understanding the type of access and knowing the general number and type of wildlife species frequenting the ROW and its adjacent restored habitat can help decision-makers understand the response of humans and wildlife to disturbance and to restoration efforts; this, in turn, will allow procedural leaning to occur through the adaptive management process.

4.4.1 Results of Camera Deployment, Maintenance and Retrieval

The figures and the table in Appendix E provide the geographic and temporal information for each camera. Field maintenance of the cameras and download of data occurred between October 20 - 21, 2018 on Thornbury and the Dillon Offsets. All cameras were retrieved between August 7 - 24, 2019.

4.4.2 Human access

Due to the remoteness of most areas (and particularly of the Dillon offsets), NGTL anticipated low to no human access along the monitored ROW sites. This assumption was reflected in the data collected, which has shown low evidence of human access throughout Year 1, especially in winter. Most human access consisted of workers or recreational users travelling in off-highway vehicles (OHVs), including Argos, ATVs and snowmobiles (Photo 4-1). Recreational access OHV access ranged from 0 to 0.016 observations per day per camera on Thornbury, but was absent on Dillon.

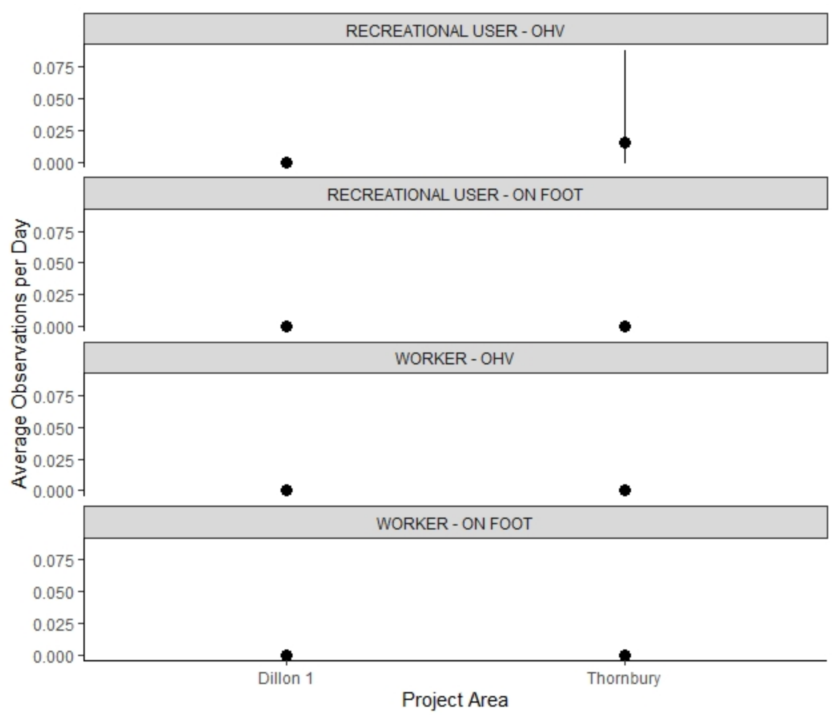


Figure 4-11: Mean observations per day per camera by Project area

Figure 4-12: Example of recreational user access travelling by off-highway vehicle (left: Argo; right: snowmobile). Much of the Project Area is located in hard to access locations; often, the only access is in winter during frozen ground conditions

4.4.3 Wildlife occurrence

The average wildlife observations per day are presented by camera and Program Area in Figures 4-2 and 4-3; species are detailed in Figure 4-4. A detailed summary by species is provided in Appendix C. Wildlife were observed at all camera locations. No obvious trend is apparent between the frequency of wildlife occurrence and the type of access control; total wildlife varied by camera for all Project Areas. While the exact cause of variability is unknown, habitat characteristics are the most likely cause of specie variation. The presence of wildlife suggests that access controls are not deterring wildlife occurrence or access along the ROWs.

Table 4-13: Mean OHV observations per day at access controls during each camera monitoring period

Project Area	Camera Effort	OHV Access
Thornbury	308.7 ± 41.0	0.016 ± 0.012
Dillon Offset	336.9 ± 11.4	0

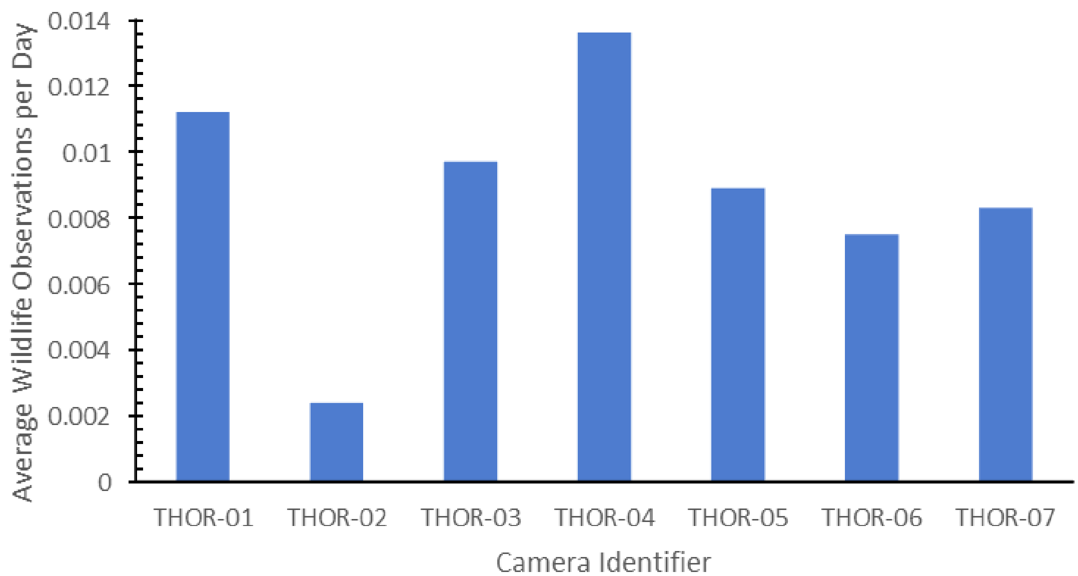


Figure 4-13: Average wildlife (all species) observations per day on the Thornbury ROW

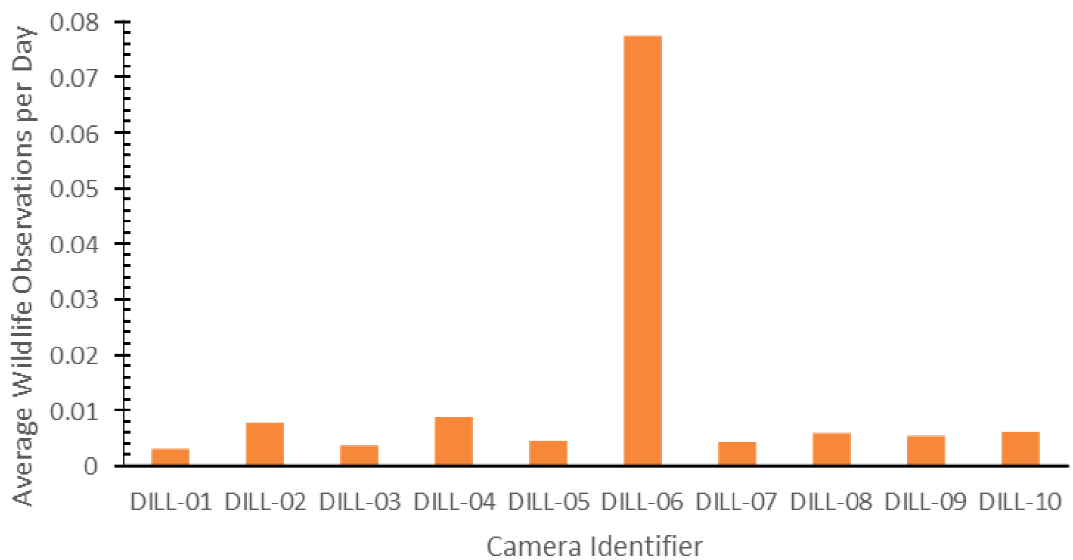


Figure 4-14: Average wildlife (all species) observations per day in the Dillon Offsets

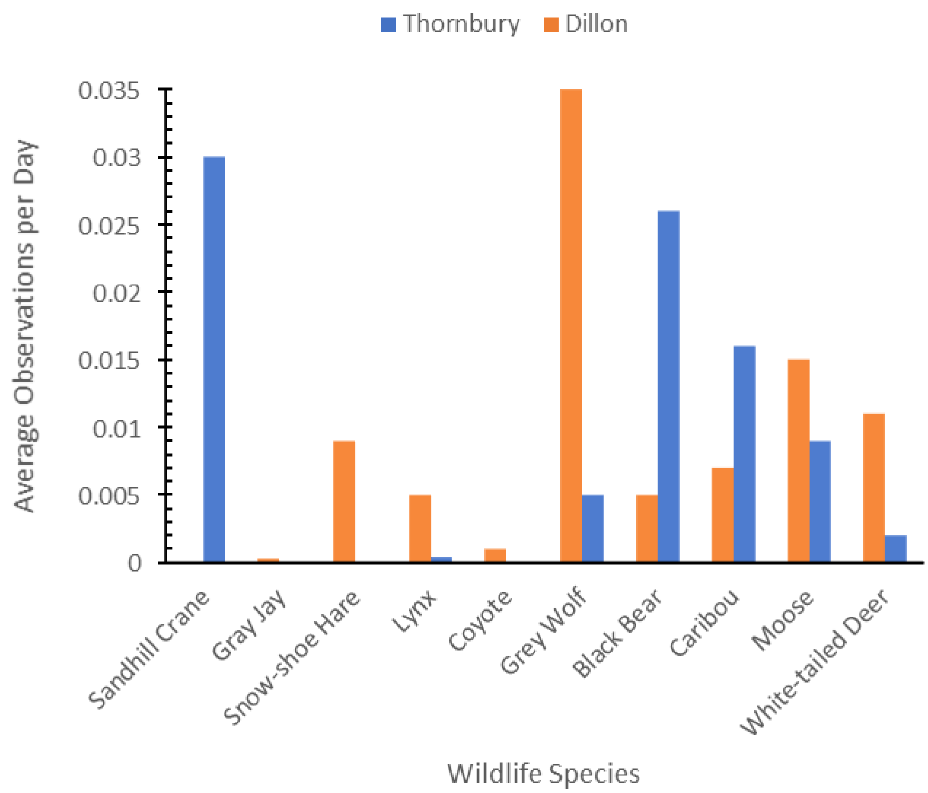


Figure 4-15: Average wildlife observations by species per day for each Project Area

Of the wildlife observed, woodland caribou (Rangifer tarandus caribou: 0 to 0.063 observations per day; Photo 2-2), black bears (Ursus americanus: 0 to 0.102 observations per day; Photo 2-3) and sandhill cranes (Grus canadensis), including fledgling birds, (0 to 0.088 observations per day: Photo 2-4) were the most abundant species observed on Thornbury. In Dillon, moose (Alces alces: 0 to 0.061 observations per day; Photo 2-5), white-tailed deer (Odocoileus virginianus: 0 to 0.028 observations per day; Photo 2-6) and gray wolf (Canis lupis: 0 to 0.708 observations per day; Photo 2-7) were the most observed species. Observations of lynx (Lynx canadensis: 0 to 0.019 observations per day; Photo 2-8) and snowshoe hare (Lepus americanus: 0 to 0.037 observations per day; Photo 2-9) were infrequent but widespread on Dillon. Lynx were observed rarely (0.003 observations per day) on Thornbury. Coyotes (Canis latrans) and gray jay (Perisoreus canadensis) were also observed rarely (0 to 0.003 observations per day) on Dillon but were not observed on Thornbury.

4.4.4 Wildlife Photographs

The photographs below are a visual sample of the wildlife species encountered during Year 1 Wildlife Camera Monitoring.

Figure 4-16: Black bear foraging on the Thornbury ROW. The presence of vegetation at a younger stage of growth provides space and forage for several boreal species, including bears

Figure 4-17: Sandhill Crane and its fledgling photographed on Thornbury. A pair of adults and two fledglings were frequently observed at this location.

Figure 4-18: Moose cow and calves photographed foraging along the Thornbury ROW.

Figure 4-19: White-tailed Deer buck photographed passing in front of the camera on Dillon.

Figure 4-20: Grey Wolves photographed on Dillon. A family of six Wolves were photographed resting and playing in front of this camera for several months.

Figure 4-21: An adult Lynx photographed passing in front of the camera on Dillon

Figure 4-22: A snowshoe hare photographed in front of a camera along the Dillon seismic line. Several Snowshoe Hares were seen resting and foraging in front of cameras on Thornbury and Dillon.

5.0 SUMMARY OF RESULTS

The first year of any restoration program is a key phase for the establishment of functional forests. During this time, seedling's survival can be affected by wind and water erosion, frost, colonization from competitive species, and wildlife. Year 1 of this Monitoring Program was therefore a benchmark period as it provided crucial baseline information on restoration following cleanup. While subject to the same monitoring methodology, the restoration of the Thornbury Section and of the seismic lines within Dillon are inherently different in terms of type and nature of disturbance. The restoration of Thornbury needs to account for longer operational needs, the presence of parallel dispositions, and previous disturbance for 93.3% of the ROW length. The following subsections discuss the overall progress of monitoring activities and correlations found in the data collected.

5.1 THORNBURY

In 2018, the plots assessed through ground-based surveys in Thornbury achieved all measurable performance indicators (**Error! Reference source not found.**). Ground based surveys indicate that planted vegetation has a high degree of survival. Natural regeneration of upland treed areas has the lowest relative percentage of mean cover, while shrub/graminoids exhibited the highest in all plots. These results are consistent with habitat predictions, as upland trees require a much longer time frame than shrubs to fill ground cover and typically result in lower mean coverage percentages.

Species richness indicate comparable trends between restored and natural regeneration plots for treatment units in lowland and shrub graminoid habitat. Upland plots were typically dominated by thick forb, graminoid and shrub cover up to 2.0 m of height, while lowlands were occupied by regenerating mosses and low shrubs. Due to faster nutrient turnover in upland sites, greater diversity was expected in uplands than in lowlands. However, plant understory diversity exceeded values in lowlands, likely due to soil moisture (Mallon et al., 2016).

Seedling density exceeded measurable targets in all plots, and particularly for planted sites. More time is however needed for the natural ingress of seedlings to reach target densities in naturally regenerating locations. Ingress will be determined by the presence of highly competitive species on adjacent land, as well as nutrient and nutrient cycles affecting each site individually. Vascular plant communities are anticipated to grow considerably in a shorter time frame, whereas other species will require a longer time frame. Further, the rate of ingress and plant regeneration can widely vary across locations, depending on the method and time of time of clearing, site characteristics, drainage, and the degree of enclosure to surrounding vegetation communities.

Seedling height measurements during Year 1 are considered too premature to generalize. On average, most seedlings performed according to growth standards and were classified as S3 (0-50 cm tall). Seedling growth does not seem to be affected by weeds or invasive species. Prohibited noxious or noxious weeds as defined by Alberta regulations (2017) are a key monitoring criterion of both this Monitoring Program. Due to the high level of previous disturbance along the ROW (93.3%), the presence of highly competitive weeds or agronomic species could be problematic to restoration, particularly in the early stages of the Program. As time passes, native species are expected to fully establish and reduce the competition threat from invasive species.

The Project Areas were mainly accessed by NGTL crews performing PCRM activities. Recreational access was minimal in all locations, due to the remoteness of the area and the access control measures implemented on the ROW.

5.2 DILLON

The restoration of Dillon benefits from remoteness, more years of recovery, a smaller overall relative footprint of disturbance, and no influence from adjacent disposition or activities. Restoration efforts in Dillon are, therefore, consistent with the objective of a shorter timeframe for habitat restoration within the ESAR and Cold Lake ranges and within Dillon – a location which due to its provincially designated status will remain protected against future developments.

Factors affecting seismic disturbance restoration, particularly for old lines, mostly relate to impacts to topsoil from stripping activities. In Dillon, as anticipated, the plots assessed by ground-based surveys achieved all measurable performance indicators (**Error! Reference source not found.**).

Native vegetation cover was consistent between restoration and natural revegetation plots; species richness exceeded values in lowlands. Average stem density significantly surpassed stem/ha targets ($p < 0.05$) for lowland and upland restoration plots; lower and more diverse values were noted in natural regeneration plots and between lowland and upland treatment units. This difference was anticipated, but the gap between the two types of sites is expected to close over the course of time. Mean percent cover of measured planted and naturally regenerating tree seedlings ranged 2.2 to 4.9% on Dillon.

5.3 ALL AREAS

Overall, Year 1 results suggest that while similar dynamics affect treatment units and plot types across the Project Area, it is anticipated that the survival and establishment of vegetation in Dillon will surpass Thornbury. Dillon will also benefit from the relative absence of invasive species; while a small amount (0.5%) of common chickweed was observed on Dillon, the natural area is predominately invasive species free. Due to the lack of access to the Park, potential migration of invasive species and impacts from human use are not forecasted.

5.3.1 Human Access to Project Areas

The results of camera data and ground-based monitoring suggest that access to Project Areas was minimal. Recreational access has been noted on Thornbury as being equivalent to less than 6 observations per camera per year, while no observations were recorded in Dillon. Most human access consisted of NGTL crews performing monitoring and maintenance activities.

5.3.2 Wildlife Movement and Numbers

Wildlife observations from camera data recorded large ungulates (including caribou and moose), bears, and birds more frequently than small mammals. The higher occurrence of ungulate and bear species relative to smaller animal species is consistent with other remote camera studies, which found a positive correlation between larger-sized animals and the likelihood of triggering camera sensors (Tobler et al., 2008, O'Connell et al., 2010). Furthermore, these species may also be more likely to utilize early seral forest stages, where abundant forage can be found. Tobler and colleagues (2008) also found that remote cameras are more likely to capture less secretive animals (unless specifically targeting species) which may be a factor in differences between species occurrence in this study.

Wildlife occurrence data suggests the access controls themselves are not deterring the movement of wildlife along the ROWs. Caribou were observed in both Thornbury and Dillon. Although anecdotal, observations by field crew during remote camera work frequently documented tracks (deer, moose, wolf, coyote, lynx and bear), scat (moose, deer, wolf, coyote and bear) and browse sign within and around the access controls. It was observed that tracks were especially frequent at mounding access controls, possibly indicating animals are using the pools as a source of water or dissolved minerals.

5.3.3 Line-of-sight-breaks

Consistent with habitat restoration plots, seedling density on vegetation screens is meeting targets for line-of-sight breaks on Thornbury; indicating seedlings have been planted at adequate density and are surviving. Given that this is only the first year after planting, seedlings are currently too small to provide effective predator line-of-sight breaks along the ROW.

Figure 5-23: Caribou travelling along the seismic line within the Dillon offsets. The felled tree (access control) the Caribou is about to cross does not seem to pose immediate mobility problems.

5.4 YEAR 1 STATUS OF MEASURABLE TARGETS

Table 5-1 provides a summary of the status of measurable final targets. Where targets are not met, Year 1 monitoring results generally indicate restoration measures are approaching targets, but as expected, have not yet achieved target levels, due to the early stage of regeneration and/or insufficient number of data points to demonstrate a trend (i.e., performing as expected). Subsequent monitoring events will determine if the targets have been met (see Section 6). Measures will continue to be assessed in subsequent monitoring years, and adaptive management measures will be applied as required to achieve the goals of the CHROMMP (Figure 5.2).

Table 5-14: Summary of the Status of Each Measurable Target for Each Project Area after Year 1 Monitoring

Habitat Unit	Measurable Target	Pipeline Section	
		Thornbury	Dillon Offset
Upland	Seedling density 1600-200 stems/ha on non-mounded sites	Yes[1]	Yes[1]
	Seedling density 800-1400 stems/ha on mounded sites	N/A[2]	N/A[2]
	unit[4]	N/A	N/A
	growth trends	N/A[3]	N/A[3]
Treed Lowlands	Natural regeneration includes at least two characteristic species	Yes[1]	Yes[1]
	No prohibited or noxious weeds.	No[6]	Yes[1]
		Yes[1]	Yes[1]
	Seedling density 400-1000 stems/ha on mounded sites	Yes[1]	Yes[1]
	unit[4]	N/A	N/A
	growth trends	N/A[3]	N/A[3]
Shrub/Graminoid Lowlands	Natural regeneration includes at least two characteristic species	Yes[1]	Yes[1]
	No restricted weeds or invasive species	Yes[1]	Yes[1]
		Yes[1]	Yes[1]
All		N/A[3]	N/A[3]
	Success of sustained growth trends	N/A[3]	N/A[3]
Upland	Line-of- 500 m	N/A[3]	Performing as Expected
All	Vegetation screen seedling densities meet restoration targets	Yes[1]	N/A[5]
	Vegetation screen sustained growth trends meet restoration targets	N/A[3]	N/A[5]
	Vegetation screen line-of-sight breaks are in good condition and effectively block line-of-sight	Performing as Expected	N/A[5]

Note:

Target range met or exceeded.

Upland sites were not mounded.

Not measurable at Year 1.

Spatial distribution was not measured in 2018. This was due to limitation of LIDAR to differentiate seedlings from surrounding herbaceous vegetation during an early growth stage.

These measures were not used in the Dillon River Wildlands.

Target not met. Corrective action required.

5.4.2 Corrective Actions

A summary of corrective actions identified during Year 1 of this Monitoring Program:

- A small amount (1.0% cover) of common tansy (Tanacetum vulgare) was detected in a single upland habitat restoration plot in Thornbury. This plot/area has been flagged for weed management.

No further actions are required at this moment.

6.0 RESIDUAL EFFECTS, RESTORATION TRAJECTORY AND OFFSETS

6.1 INTRODUCTION

The restoration of large caribou home ranges characterized by a diverse and complex habitat is challenging to implement because these ranges are not limited to discrete areas (Arkle et al., 2014), and because of the long timelines required to rehabilitate plant communities critical to this species such as lichens. In the context of this Monitoring Report, restoration targets focus on minimizing the adverse effects from development to caribou habitat during and after the life of Thornbury, as well as continuing to offset residual effects through the work executed in Dillon. These targets feed into the main goal of NGTL, which consists of the establishment of a firm trajectory towards normal ecosystem-level functioning for impacted areas.

Regular measurements of the restoration trajectory are critical to monitor growth in the long term. Yet, as for other forms of prediction, restoration trajectories must be informed by multiple data points. The limited timeframe of this Year 1 Program inhibits NGTL's ability to make predictions on trajectories. As restoration of the ROW progresses, NGTL will continue to chart and present trajectories through the Monitoring Program and the adaptive management process. Year 5 of the Program has been chosen as a suitable time frame for a more accurate characterization of the restoration trajectory and associated corrective decisions, if required.

6.2 RESIDUAL EFFECTS

The mitigation of adverse effects to the environment included an analysis of residual effects[14] from Thornbury conducted as part of the Environment and Socioeconomic Assessment(s) (ESA).[15] The degree that residual effects contribute to cumulative effects at the regional scale varies with time and changing environmental conditions. NGTL's offset strategy including advanced tools such as the use of temporal and spatial multipliers to ensure that the spatial-temporal relevance of the offset measures relative to the footprint being offset is maintained. Scientific literature and past research suggest a multiplier range from 1.0 through 5.0 is required (DEFRA, 2011; Northern Resources, 2014; Northern Resources, 2016). NGTL adopted this multiplier range within their restoration and offset plans. The proposed timing of re-calculation is discussed below (Section 6.2.1), and further detail can be found in the OMPs.[16]

6.2.1 Timelines for Re-calculating Offset Requirements

Industry standards (Alberta Agriculture and Forestry, 2017; Table 6-1) recommends survival surveys in Year 1 of monitoring; establishment surveys are completed no

[14] Effects that cannot be mitigated.
[15] NEB Filing ID: A62944
[16] NEB Filing IDs: A74936, A97781.

earlier than four years after disturbance and no later than eight years after disturbance, and performance surveys to be completed between Years 11 and 14. By starting re-evaluations at Year 5 and including a last survey at Year 15, the cycles of monitoring and adaptive management are extended.

Table 6-15: Overview of monitoring years and survey schedule. Year 1, 3, and 5 will evaluate habitat restoration and vegetation establishment efforts, allowing NGTL to implement site-specific adaptive management actions as needed. Years 10 and 15 will enable NGTL to assess ongoing habitat restoration performance and the success of adaptive management actions taken in previous years.

Monitoring Years 1, 3, 5, 10 and 15														
Survival Survey			**Establishment Survey**							**Performance Survey**				
2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032

7.0 ADAPTIVE MANAGEMENT AND LESSONS LEARNED

7.1 ADAPTIVE MANAGEMENT

Adaptive management emerged as a structured decision-making approach in habitat restoration science from the need to respond to rapidly changing environmental conditions and a wide variety of stakeholders. The term adaptive connotates flexibility and responsiveness to changing conditions; the primary principle underlying this approach is simple, and yet effective: "learning by doing".[17] While this notion seems straightforward, the practical application of adaptive management involves a clear decision-making framework and unambiguous delineation of roles and responsibilities to make informed adjustments in policies, and long-term thinking (Figure 7-24).

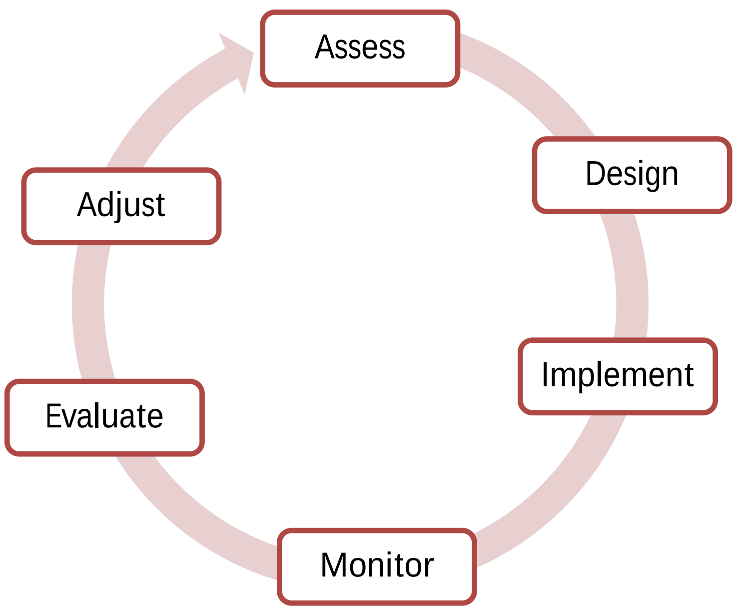


Figure 7-24: Traditional adaptive management wheel. Continuous monitoring throughout the cycle is required to inform decision making and adjust policies and design

NGTL's adaptive management framework has been under development since the inception of the CHROMMP programs in 2016[18] and have been enhanced from knowledge, experiences and lessons learned during the development of numerous linear corridors across western Canada. In the context of this CHROMMP, data are collected via aerial and ground-based monitoring programs (including remote camera monitoring). This feed informs decision makers at various points of the restoration timeline, allowing adjustments that are often site-specific. The process of monitoring

[17] John F. Organ, Daniel J. Decker, Shawn J. Riley, John E. McDonald, Jr., and Shane P. Mahoney (2012). Adaptive Management in Wildlife Conservation. 7th Edition, Vol. 2, John Hopkins University Press. Baltimore, US.
[18] For the Northwest Mainline Expansion Project

is, in the NGTL process, also highlighted as a key component of the adaptive management process and remains ongoing throughout the 15-year program.

NGTL's caribou habitat restoration and offset measures are considered successful when they result in self-sustaining and ecologically appropriate vegetation communities that are on a trajectory to the compatible surrounding landscape. 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 and monitoring will continue until the targets are met.

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APPENDIX A

CHROMMP TARGETS

Table 4a Habitat Restoration Evaluation Criteria and Measureable Targets On Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Habitat Restoration	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Performance Surveys	• Total density of planted seedlings and naturally regenerating seedlings (i.e., from seed ingress or suckering) • Height and percent cover of seedlings • Vigour of seedlings (evidence of chlorosis, pests/disease, browse, other damage) • Vegetation community composition (percent cover, species present, abundance): – conifer tree – deciduous tree – palatable shrub – non-palatable shrub – herb/graminoid – nonvascular (mosses and lichens) – introduced (non-native, weed, invasive)	Habitat restoration measurable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends following completion of restoration. Upland Conifer, Deciduous, Mixedwood and Transitional: • Seedling density will vary by species with target range from 1600 to 2000 stems/ha (combined planted seedlings and/or natural regeneration) on sites that are not mounded. • Seedling density will vary by species with target range from 800 to 1400 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites, dependent on mound density. • Spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit (footprint available for restoration). • ≥80% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover). Treed Lowlands: • Natural vegetation is regenerating, including at least two characteristic species (vascular and/or nonvascular; e.g., Carex sp. and Sphagnum moss sp.) (classified as per Halsey et al. 2004). • As indicators of healthy vegetation community, no restricted weeds or invasive species such as cattails or reed grass. • ≥80% cover of native vegetation species in the footprint. • Where tree seedlings are planted (e.g., mounded sites): – seedling density of 400 to 1000 stems/ha (combined planted seedlings and/or natural regeneration), dependent on mound density – continuous spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit • ≥70% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover). Shrub/Graminoid Lowlands: • Natural vegetation is regenerating, including at least two characteristic species (as per Halsey et al. 2004). • No restricted weeds. • ≥80% cover of native vegetation species in the footprint.	Adaptive management actions for habitat restoration are implemented at sites where the measurable targets have not been met and take into consideration site conditions and other ecological factors that may affect successful restoration. Upland Conifer, Deciduous, Mixedwood and Transitional: • If seedlings (planted or natural regeneration) are damaged due to access, assess and modify access control measures and plant seedlings to maintain desired seedling density targets. • If seedlings (planted or natural regeneration) are damaged due to disease, plant seedlings to replace those that have died to maintain desired seedling density targets. • If seedling growth/vigour (planted or natural regeneration) is impeded by competition from surrounding vegetation, such as grasses, implement spot spraying or manual vegetation control to reduce competition pressure and plant seedlings to maintain desired seedling density targets. Treed Lowlands: • If establishment and growth of planted seedlings is impeded by wet site conditions (e.g., flooding and ingress of invasive species such as cattails), modification of surface drainage patterns may be implemented to facilitate near-surface water flow. • If natural regeneration of vegetation is impeded, plant alder seedlings to facilitate natural regeneration of shrubs. • If noxious weed species occur on the Project ROW or on offset locations, implement spot spraying or manual control measures to manage weed populations. Shrub/Graminoid Lowlands: • If natural regeneration is impeded by wet site conditions (e.g., flooding and ingress of invasive species such as cattails), modification of surface drainage patterns) may be implemented to facilitate near-surface water flow. • If natural regeneration of vegetation is impeded, plant alder seedlings to facilitate natural regeneration of shrubs. • If noxious weed species occur on the Project ROW or on offset locations. implement spot spraying or manual control measures, as required to manage weed populations.

Notes: The ratio of palatable to non-palatable species will be measured using ground-based monitoring. Where naturally regenerating palatable species are observed restricting seedling growth for planted areas, adaptive management actions in the form of either mechanical or chemical control will be implemented, with special consideration for the need to minimize access at CHRP and OMP locations. ha = hectare; sp. = species; ROW = right-of-way; m = metre; $\geq$ = equal to or greater than; $\leq$ = equal to or less than.

Table 4b Habitat Restoration Evaluation Criteria and Measureable Targets On Non-Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Habitat Restoration	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Performance Surveys	• Total density of planted seedlings and naturally regenerating seedlings (i.e., from seed ingress or suckering) • Height and percent cover of seedlings • Vigour of seedlings (evidence of chlorosis, pests/disease, browse, other damage)	Habitat restoration measurable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends of conifer and deciduous trees within five years following completion of restoration. Upland Conifer, Deciduous, Mixedwood and Transitional: • Seedling density will vary by species with target range from 1600 to 2000 stems/ha (combined planted seedlings and/or natural regeneration) on sites that are not mounded. • Seedling density will vary by species with target range from 800 to 1400 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites (dependent on mound density). • Spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit (footprint available for restoration). • ≥80% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover). Treed Lowlands: • Where tree seedlings are planted (e.g., mounded sites): – seedling density of 400 to 1000 stems/ha (combined planted seedlings and/or natural regeneration), dependent on mound density – continuous spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit • ≥70% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover).	Adaptive management actions for habitat restoration are implemented at sites where the measurable targets have not been met and take into consideration site conditions and other ecological factors that may affect successful restoration. • If seedlings (planted or natural regeneration) are damaged due to access, assess and modify access control measures and plant seedlings to maintain desired seedling density targets. • If seedlings (planted or natural regeneration) are damaged due to disease, plant seedlings to replace those that have died.

Notes:ha = hectare; sp. = species; ROW = right-of-way; m = metre; ≥ = equal to or greater than; ≤ = equal to or less than.

Table 5a Access Control/Line-of-Sight Evaluation Criteria and Measureable Targets On Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Access Control	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Performance Surveys • Remote Camera Monitoring	Evidence and level of vehicular use along the Project ROW and at offset locations will be measured using subjective criteria ratings, as follows: • Evidence of access: – Yes/No • Evidence of U-turns at access barriers: – Yes/No • Access type: – non-motorized – over-snow vehicle – all-terrain vehicle – truck – other (details to be noted) • Access level metrics: – absent – low (tracks/trail evident but difficult to discern or appear to be infrequently used) – high (tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use)	Access control targets are designed to prevent access along sections of new alignment of the Project ROW and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term : • ≤20% increase in access against baseline[1] along sections of new alignment on the Project ROW or at offset locations. • Success of habitat restoration targets, specifically sustained growth trends, is a good indicator that access is not inhibiting habitat restoration.	Adaptive management actions for access control will enhance or alter current access control measures to improve the effectiveness of these measures for limiting access to areas undergoing restoration. • The location, and source and type of access will be investigated, with enhanced access controls added where evidence of access is identified. This will be in the form of physical access barriers such as enhanced use of coarse woody debris, tree felling/tree bending (Cody 2013; Golder 2014), large rocks or fencing.
Line-of-Sight Breaks	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Performance Surveys • Remote Camera Monitoring	• Woody debris (log)/earth berms: – footprint width – length of berm (perpendicular to ROW) – length of berm with height ≥1.5 m – sight-line model results • Vegetation screens: – spatial distribution (distance between live woody stems) – height of live woody stems – percent cover of live woody stems	Line-of-sight breaks are designed to block sight lines along sections of new alignment of the Project ROW and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term. • Line-of-sight is limited to ≤500 m along the linear feature in upland forested areas. • Where log/earth berms are installed to break the line-of-sight, berms are in good condition and functional (in terms of blocking line-of-sight). • Where vegetation screening is used to break the line-of-sight: – seedling densities and growth trends meet the targets for habitat restoration – line-of-sight breaks are in good condition and functional (in terms of blocking line-of-sight)	Adaptive management actions for line-of-sight breaks will enhance the effectiveness of line-of–site measures and include: • Where log/earth berms are installed, repairing berms to maintain height and length requirements (i.e., revegetating berm to prevent erosion). • Implementing adaptive management actions associated with habitat restoration to create effective vegetation screens as line-of-sight breaks. For example, adding alder seedlings to a site to enhance rate of shrub growth for establishment of a line of site or use of tree-felling or tree-bending (refer to Cody 2013, Golder 2014), across the ROW where there is suitable thick, adjacent forest cover of either non-merchantable or merchantable coniferous trees.

Notes: ha = hectare; sp. = species; ROW = right-of-way; m = metre; ≥ = equal to or greater than; ≤ = equal to or less than.

[1] Baseline for the purpose of this CHROMMP means 'the first monitoring year' as pre-construction access data is not available; future projects will established preconstruction.

Table 5b Access Control/Line-of-Sight Evaluation Criteria and Measureable Targets On Non-Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Access Control	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Sample Plots • Remote Camera Monitoring	Evidence and level of access will be measured using criteria ratings as follows: • Evidence of access: – Yes/No • Evidence of U-turns at access barriers: – Yes/No • Access type: – non-motorized – all-terrain vehicle – over-snow vehicle – truck – other (details to be noted) • Access level metrics: – absent – low (tracks/trail evident but difficult to discern or appear to be infrequently used) – high (tracks/trails appear to be well used; vegetation is trampled down; bare ground might be visible from frequent use)	Access control targets are designed to prevent access at offset locations that are not contiguous with adjacent linear features within five years following completion of restoration in caribou range and continuing through the long-term: • ≤20% increase in access against baseline[2] at offset locations that are not contiguous with adjacent linear features. • Success of habitat restoration targets, specifically sustained growth trends, is a good indicator that access is not inhibiting habitat restoration.	Adaptive management actions for access control will enhance or alter current access control measures to improve the effectiveness of these measures for limiting human use of areas undergoing restoration. • The location, and source and type of access will be investigated, with enhanced access controls added where evidence of access is identified. This might be in the form of physical access barriers such as enhanced use of coarse woody debris, tree felling/tree-bending (Cody 2013; Golder 2014).
Line-of-Sight Blocking	• Aerial Monitoring – LiDAR Imagery – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Sample Plots • Remote Camera Monitoring	• Coarse woody debris: – footprint width – length of berm (perpendicular to ROW) – length of berm with height ≥1.5 m – sight-line model results • Vegetation screens: – spatial distribution (distance between live woody stems) – height of live woody stems – percent cover of live woody stems	Line-of-sight breaks are designed to block sight lines along offset locations within five years following completion of restoration in caribou range continuing through the long-term: • Line-of-sight is limited to ≤500 m along the linear feature in upland forested areas. • Where log berms are installed to break the line-of-sight, berms are in good condition and functional (in terms of blocking the line-of-sight). • Where vegetation screening is used to break the line-of-sight: – seedling densities and growth trends meet the targets for habitat restoration – line-of-sight breaks are in good condition and functional (in terms of blocking line-of-sight)	Adaptive management actions for line-of-sight breaks will enhance the effectiveness of line-of–sight measures and include: • Implementing adaptive management actions associated with habitat restoration to create effective vegetation screens as line-of-sight breaks. For example, adding alder seedlings to a site to enhance rate of shrub growth for establishment of a line of site or use of tree felling or tree bending (Cody 2013; Golder 2014), across the ROW where there is suitable thick, adjacent forest cover of either non-merchantable or merchantable coniferous trees.

Notes: ha = hectare; sp. = species; ROW = right-of-way; m = metre; ≥ = equal to or greater than; ≤ = equal to or less than.

[2] Baseline for the purpose of this CHROMMP means 'the first monitoring year' as pre-construction access data is not available future projects will established preconstruction.

APPENDIX B

GROUND-BASED MONITORING FIELD PROTOCOL

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APPENDICES

Table 1 Revisions Log

Date	Section	Description
June 26, 2018	**1.2**	**Update Objectives to reflect the revised description of objectives of ground-based monitoring as per the current revision of the CHROMMP**
	2.1.1	**Update experimental design to reflect description contained within the current revision of the CHROMMP**
June 26, 2018	3.3.3 Staking of Permanent Monitoring Plots	In 2016 ground disturbance activity was not permitted by NGTL, preventing the permanent marking of plot locations. Provided a ground disturbance variance is issued, the 2018 program will utilize metal pin flags pushed into the ground by hand to a depth not exceeding 30 cm
June 26, 2018	3.3.5 Plot Maintenance	Updated wording to match changes in section 3.3.3.
June 26, 2018	Table 4. Plot Description	Updated soil descriptors: Soil drainage and soil type have been removed as there will be no ground disturbance activity during the 2018 program.
June 26, 2018	Table 5. Vegetation Community Field Data	Updated to reflect full inventory of vegetation species in each plot. Average vigour for weedy or invasive species will no longer be recorded.
June 26, 2018	3.4.3.3 Photographs	Due to the low seedling height observed in 2016, the photographic records of access controls or line-of-sight breaks will be captured at a distance of 25m from the structure instead of 50 m in cases where seedling height is insufficient to capture at a distance of 50 m.
June 26, 2018	1.2 Ground-Based Monitoring Objectives	Updated ground-based monitoring objectives and protocols to provide more detail.
June 26, 2018	2.1.1 Experimental Design	Removed paragraph referencing Table 1 and sampling frequency.
June 26, 2018	2.1.4 Preliminary Monitoring Plot Locations	Updated Plot Locations: 13 plot locations and 4 contingency plot locations will be selected in each planted habitat unit (i.e., treed upland and treed lowland), shrub/graminoid lowlands and in naturally regenerating areas. Since shrub/graminoid lowlands do not have a significant treed component, natural regeneration is the primary restoration measure, except where trees have been planted as a line-of-sight break. The distribution of natural regeneration control plots will be proportional to the area of treed upland and treed lowland that exist within the Project area. For example, if the Project is 80% treed upland and 20% treed lowland, natural regeneration control plots would be distributed such

		that 10 plots are in treed upland and 3 plots are in treed lowland habitat units.
June 26, 2018	3.3.3 Staking of Permanent Monitoring Plots	Updated intro paragraph: In addition, GPS waypoints, plot sketches, and photographs will aid in locating sampling plot locations, particularly in the event that a plot flag becomes removed. Removed paragraph explaining permanent sign protocols.
June 26, 2018	3.3.5 Plot Maintenance	Removed sentence explaining differential replacement ID data.
June 26, 2018	3.4.3.2 Line-of-sight Breaks	Updated line-of-sight description: In early stages of regrowth (ie Years 1 and 3), regrowth may not have attained sufficient height relative to surrounding vegetation for useful measurement.
June 27, 2018	References	Reference additions: Montgomery (2001), Kuehl (2000), and Faul et al. (2009).

1 INTRODUCTION

1.1 Background

The following document contains the field protocols for ground-based monitoring of caribou habitat restoration (the Protocols) for TCPL. The ground-based monitoring program described in this document has been developed to verify the effectiveness of measures provided in the Caribou Habitat Restoration Plans (CHRPs) and Offset Measures Plans (OMPs) using evaluation criteria and measurable targets (Northern Resources 2015). The intent of TransCanada's CHRPs and OMPs is to reduce and offset residual direct and indirect project effects on caribou habitat through habitat restoration, access control, and line-of-sight breaks (Northern Resources 2015). The field protocols are designed to evaluate the effectiveness of TCPL's caribou habitat restoration methods (physical restoration measures implemented) over a span of 15 years. All of the data and information collected from the ground-based monitoring will be reviewed to inform TCPL's future caribou habitat restoration (habitat restoration follow-up program).

Objectives of the ground-based monitoring programs align with those of the Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP; Northern Resources 2015) and include:

- verification that CHRPs and OMPs measures achieve their respective targets over the monitoring timeframe
- implementation of adaptive management to reduce uncertainty associated with the survival and sustainability of habitat restoration and offset measures; and,
- identification of continuous improvement initiatives to better inform the development of future monitoring programs .

This document outlines the processes and procedures required to implement a successful field program to meet the objectives of the ground-based monitoring components of the caribou habitat restoration follow-up program. There are different parts to the field program. Office based pre-field activities (Section 2) are described in terms of planning, personnel, H&S, literature review, and equipment (Appendix A). The field work component (Section 3) details plot establishment and data collection (Appendices B and C). And finally, post-field data management is then described in Section 4. This document will be reviewed after implementation of the Protocols in 2016 and revised as needed to meet the overarching objectives of the caribou habitat restoration follow-up program.

1.2 Ground-Based Monitoring Objectives

Ground-based monitoring will provide detailed information on species composition and ecological conditions to confirm that restoration targets are on a trajectory toward establishment of natural ecosystem types.

The objectives of ground-based monitoring are to:

- collect data to evaluate restoration performance with respect to the measurable targets (e.g., seedling survival, vegetation height, percent ground cover and species composition);
- verify restoration performance data obtained from LiDAR data in each restoration unit where ground-based sample plots are located (for monitoring years where LiDAR is collected)
- evaluate the condition of access control measures and collect data used to verify their effectiveness; and,

- document incidental observations (e.g., wildlife, wildlife tracks, evidence of wildlife browsing and general observations concerning measure effectiveness).

Ground-based monitoring will allow a reclamation specialist to verify the measure's effectiveness and recommend corrective actions if required.

1.3 Guidance Documents

The Protocols were developed using the following guidance documents. Although less intensive and with varying objectives, these Protocols align with other monitoring protocols such as those used by the Alberta Biodiversity Monitoring Institute for terrestrial surveys (ABMI 2014), and the Alberta Regeneration Standards (ASRD 2000; ESRD 2013a). The ultimate objective of the ground-based monitoring protocols is to evaluate restoration performance as it relates to caribou habitat. Data is meant to be collected in a manner that allows it to be shared with industry partners.

- *Alberta Regeneration Standards for the Mineable Oil Sands* (ESRD 2013a)
- *Alberta Regeneration Survey Manual: Field Edition* (ASRD 2000)
- *Alberta Wetland Policy* (ESRD 2013b)
- CHROMMP (NGTL 2015; 2018))
- *Ecological Land Survey Site Description Manual* (Second Edition) (ASRD 2003)
- *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases (2nd edition)* (AENV 2008)
- *Reclamation Criteria for Wellsites and Associated Facilities for Peatlands* (AEP 2015a)
- "Reclamation Assessment Criteria for Pipelines" (AENV 2001)
- *Terrestrial Field Data Collection Protocols (Abridged Version) 2015-02-19* (ABMI 2014)
- *2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* (ESRD 2013c)

2 PRE-FIELD PLANNING

This section includes background information, sampling design rationale, pre-field planning and health and safety (H&S) considerations, preliminary plot location planning, and field map preparation requirements.

2.1 Sampling Protocol

Experimental design and sampling protocol are presented in this section. These are scientifically based and were developed based on the recommendations from Northern Resources (2015), and recognized monitoring and vegetation survey methods (ABMI 2014; ASRD 2003). The design and sampling protocol align with reclamation and revegetation assessment practices in the province (ESRD 2013a, 2013b; ASRD 2000; AEP 2015a).

2.1.1 Experimental Design

A one-way repeated measures experimental design will be used to evaluate restoration performance for each individual habitat restoration unit separately because of the inherent differences associated with their biophysical characteristics (i.e., treed upland/transitional vs. treed lowlands vs. shrub/graminoid lowlands). Repeated measure designs are generally preferred over other factorial designs (where they can be implemented) as they improve the precision of estimates derived on the response variable (Montgomery 2001; Kuehl 2000).

Measurements of restoration performance collected as part of the ground-based monitoring program will be repeated at each sample plot location each monitoring year. Within each habitat restoration unit, sample plots will also be established at control locations where no restoration measures are applied to evaluate natural regeneration. Control locations will be randomly selected in natural regeneration areas within treed habitat restoration units along operational and non-operational locations. The experimental design is represented by the following model:

$y_{ik} = \mu + \alpha_i + \tau_j + \varepsilon_{ij}$

where:

y_{ik} is the estimated response of the measurable target, μ is the overall mean, α_i is the effect of each monitoring year, τ_j is the effect of each sample plot and ε_{ij} is the natural variability (i.e., error) (Montgomery 2001).

The model term τ_j denotes the repeated measure effect associated with monitoring each sample plot, each monitoring year. The degree to which restoration measures achieve their respective targets will be determined by a positive (greater than zero) regression coefficient for the parameter "year", where the first monitoring year will act as a baseline.

2.1.2 Power Analysis

A power analysis was conducted for the ground-based monitoring program to determine the required number of sample plots necessary to effectively identify statistical differences for measurable target responses between each monitoring year (i.e., increasing values for vegetation height and ground cover, and sustained planted stem density). The power analysis was conducted using software developed by Faul et al. (2009), which has applications specific to repeated measure designs. The power analysis assumes five repeated measurements, representing each monitoring year, taken on each sample plot, an alpha (α) of 0.05 (i.e., level of significance for hypothesis tests) and an effect size of 0.4 (recommended by Faul et al. [2009] for one-way repeated measure designs).

Results of the power analysis indicate that for each restoration unit a minimum of 13 sample plots will provide sufficient statistical power ($1 - \beta = 0.95$) to detect statistical differences for measurable target responses between each monitoring year. Although there is no absolute method for determining the most appropriate sample size for a study, a general rule for data to conform to a normal distribution coincides with statistical power greater than 0.8 (Montgomery 2001). Thus, for the ground-based monitoring program, a minimum of 52 sample plots (13 plots x 4 units) will be monitored each monitoring year for each restoration unit, including natural regeneration areas.

2.1.3 Restoration Units

Restoration units, as developed for the CHRP and OMP, relate to ecosite phases in the footprints. These were further grouped for monitoring purposes; vegetation community types (e.g., ecosite phases) have been reduced to four main restoration units (including natural regeneration units; Table 1) to facilitate the development of evaluation criteria and measurable targets (Northern Resources 2015). These four units are ecologically based, and correspond to different types of caribou habitat.

Natural regeneration plots will be established to evaluate natural regeneration in disturbed areas (operational and non-operational dispositions and/or lines) where no restoration measures were applied. Natural Regeneration plot locations will be randomly selected in naturally regenerating areas on project footprints and offset locations where no restoration measures (e.g., tree planting, mounding, seeding) have been applied. The age of regeneration in naturally regenerating plots should be comparable to the age of regeneration in plots where restoration measures were implemented. Natural Regeneration plots should be established equally in uplands and lowlands where no restoration measures have been implemented (Section 3.3).

Table 2 Description of Restoration Units

Restoration Unit	Description
1. Treed upland/transitional	• mineral soil or transitional soil • ≥5% tree cover
2. Treed lowland (wetland)	• organic soil • ≥5% tree cover
3. Shrub-graminoid lowland (wetland)	• organic soil • <5% tree cover • dominant vegetation cover is shrubs and/or graminoids
4. Natural regeneration control	• equally distributed between upland and lowland

2.1.4 Preliminary Monitoring Plot Locations

Existing information (e.g., aerial photographs, vegetation mapping, alignment sheets) will be used to select the monitoring plot locations. Pre-field maps will be developed with the following attributes (in addition to standard GIS attributes) to aid in plot site selection:

- vegetation community polygon boundaries
- aerial photography (highest resolution available)
- locations, types, and planting rates of implemented restoration measures
- locations and types of implemented access control measures and line-of sight breaks
- access layers (e.g., roads, cutlines, seismic lines)
- other disturbance layers as available (e.g., fire, seismic)

Using the pre-field map, 13 plot locations and 4 contingency plot locations will be selected in each planted habitat unit (i.e., treed upland and treed lowland), shrub/graminoid lowlands and in naturally regenerating areas. Since shrub/graminoid lowlands do not have a significant treed component, natural regeneration is the primary restoration measure, except where trees have been planted as a line-of-sight break.

The distribution of natural regeneration control plots will be proportional to the area of treed upland and treed lowland that exist within the Project area. For example, if the Project is 80% treed upland and 20% treed lowland, natural regeneration control plots would be distributed such that 10 plots are in treed upland and 3 plots are in treed lowland habitat units. Preliminary plot locations will be randomly selected (i.e., avoiding bias placing preliminary locations), while incorporating the following selection criteria:

- restoration/habitat unit
- geographical distribution of plots provides coverage throughout study area
- plot accessibility

- avoidance of transitional areas unless they are extensive in the study area and are determined to be important monitoring areas; if required in the monitoring program, they should be included in the treed upland restoration unit

The types and planting rates of implemented restoration measures will also inform selection of monitoring plot locations. The four contingency plot locations in each restoration unit may be used in situations where a preliminary plot location is found to not meet the criteria, once assessed in the field (i.e., the pre-field vegetation community mapping was incorrect and the actual vegetation community is not representative of the restoration unit, or what looked like an accessible location is discovered not to be once on the ground).

2.1.5 Pre-Field Access Planning

Access to monitoring plot locations will vary depending on local conditions, and could include the use of helicopters, trucks and/or offhighway vehicles. Access methods, as well as access and egress plans, must be developed during pre-field planning. Contact the regional TCPL office and consult line lists or other available sources of existing access information to guide planning decisions. Shapefiles and/or alignment sheets will be provided by TCPL to help field personnel avoid damaging existing seedlings or other restoration measures.

2.1.6 Selection of Qualified Personnel

At least one surveyor per survey crew will have the following skills:

- be experienced in applying field vegetation survey protocols and procedures
- have and understanding of and familiarity with the local plant communities and soils in the study area
- be able to classify local plant communities using appropriate regional classification system (i.e., to ecosite phase level in northern Alberta)
- have expertise in plant ecology, including the ability to measure health and vigour of vegetation
- be competent in plant taxonomy and able to identify most plant species, to the species level, while in the field
- be familiar with soil and landscape classification systems
- have the ability to interpret aerial photographs
- be familiar with GIS*
- be competent in the operation of GPS equipment

* While field personnel may not be required to use GIS tools directly (depending on whether GIS-based digital field data collection tools are used or not), they should have a basic understanding of how GIS applications work. However, **the consulting company must have a GIS expert** to process and export the data in spatial geo-databases.

2.2 Health and Safety

Field personnel must comply with TCPL H&S standards. Safety planning considerations include but are not limited to:

- required personal protective equipment (PPE)

- required H&S training, including Standard First Aid and TCPL Contractor Orientation
- required field equipment
- all ground disturbance requirements, including buried facility locates (if applicable)
- General Work Permit
- field communication
- job safety analysis
- Site-specific Safety Plan (SSSP)

All H&S documentation must be reviewed by a TCPL representative in advance of the ground-based monitoring program.

2.3 Review of Background Information

Background information to be reviewed before field work includes but is not limited to:

- these Protocols, and any information provided by the TCPL coordinator for the applicable area
- project-specific caribou habitat monitoring program, including local certificate conditions, for site-specific requirements (i.e., additional data parameters to collect)
- project-specific caribou habitat restoration plan and associated caribou offset measures plan
- provincial Weed Act and Weed Control Regulations
- field maps (in hard copy or digital format; Section 2.5), including location of implemented restoration measures
- any other relevant environmental information (e.g., local vegetation communities and species)

2.4 Field Equipment

Refer to Appendix A for a checklist of recommended field and safety equipment. A laptop computer (preferably with internet connection) will be required to download data from digital cameras, GPS units and field tablets (if used) each evening while in the field.

2.5 Field Maps

Field maps (digital and/or hard copy) will be produced with standard GIS attributes, as well as the following:

- vegetation community polygon boundaries (e.g., Alberta Vegetation Inventory)
- vegetation community classification labels (and wetland classes where applicable)
- aerial photography (highest resolution available)
- locations, types, and planting rates of implemented restoration measures
- locations and types of implemented access control measures and line-of-sight breaks
- preliminary monitoring plot locations
- contingency monitoring plot locations

- access layers (e.g., roads, cutlines, and seismic lines)
- other disturbance layers as available (e.g., fire, seismic, and buried facilities)

If field tablets* are used, all of the above data layers can be uploaded into the units as digital field maps, including shapefiles of restoration measures, etc. (provided by TCPL). However, a hard copy of the field maps should still be taken in the field as backup (in case of equipment failure), along with a handheld GPS unit and compass.

At minimum, preliminary and contingency monitoring plot locations and locations of restoration measures, access control measure, and line-of-sight breaks must be uploaded into handheld GPS units for accurate navigation and avoidance of damage to existing seedlings or other restoration measures. The other data layers can be taken to the field in hard copy (i.e., on paper maps).

* Some field tablets such as iPads may require additional external GPS receivers to improve spatial accuracy.

2.6 Data Management Preparation

A spatial geo-database (or several) must be set up before field data collection. The geo-database attributes must contain all data fields included on the different datasheets (Appendix C), which will be linked to a geo-referenced plot location (so location can be accurately displayed on a figure). If GIS-based field data collection tools (e.g., GPS-enabled field tablets) are available, data may be collected directly into a digital data sheet (must contain all fields from data sheets in Appendix C). Otherwise, field data may be collected on hard copy data sheets (using a handheld GPS unit to obtain location data) and the data subsequently entered into the geo-database upon completion of the field work. The spatial geo-database files will be submitted to TCPL upon completion of the ground-based fieldwork.

3 FIELD PROCEDURES

This section presents timing and access considerations, procedures for establishing, marking and maintaining monitoring plots, and data collection protocols. The field data collected in ground-based monitoring will allow assessment of vegetation performance against criteria and measurable targets (e.g., species composition, seedling survival, percent cover; Northern Resources 2015). The end goal of monitoring vegetation is to assess the effectiveness of caribou habitat restoration methods.

3.1 Timing of Field Surveys

The surveys must be completed in Q3 after July 15 of each monitoring year (Years 1, 3, 5, 10 and 15), outside of the Restricted Activity Period for caribou (February 15 to July 15). For consistency in data collection, it is preferable to complete field surveys at the same time each monitoring year, and must be done during the growing season. This allows more precise and consistent data to be collected (e.g., percent cover, vigour, line-of-sight measurements). Year 1 will be defined as the first growing season 1 year after planting tree seedlings, to allow a growing season following implementation of restoration measures and planting.

3.2 Site Access

Access to monitoring plot locations could include the use of helicopters, trucks, and/or offroad vehicles, and will be determined during pre-field planning. Care must be taken to not disturb potential monitoring plot locations or established plots; a shapefile (or layer displayed on hard copy field maps) must be on hand to guide crews around planted areas to avoid damage to seedlings when accessing the line. Activities are expected to take place in areas where access has not been controlled and access is gained without disrupting access control measures.

3.3 Monitoring Plot Establishment

Monitoring plots will be established in Year 1 (unless a permanent plot becomes unsuitable for use in the monitoring program in future years and needs to be replaced). An example plot diagram is shown on Figure 1 (Section 3.3.4).

3.3.1 Plot Location

Permanent monitoring plots will be established on operational and non-operational lines where CHRP or OMP measures have been implemented, as well as on natural regeneration control sites (i.e., on operational and non-operational lines where no mitigation measures have been implemented).

Preliminary plot locations selected in the pre-field activities will be displayed on field maps and will be used as starting points. Each plot location will be assessed once onsite to determine if it is characteristic of that restoration unit before a plot is established. If a preliminary plot location is not representative of that restoration unit, a more characteristic location must be selected from the four contingency locations selected for that restoration unit.

3.3.2 Plot Size

Size of plots will differ depending on if the plot is on operational or non-operational lines or dispositions (Table 2). Plot sizes and disturbance definitions are consistent with those presented in the CHROMMP (Northern Resources 2015). Operational lines or dispositions are the portions of the footprint which are still in use (e.g., right-of-way [ROW] of active pipeline, temporary workspaces still in use). Non-operational lines are parts of the project footprint that are not in active use (e.g., seismic lines, inactive winter roads, decommissioned/abandoned pipelines).

Table 3 Size of Monitoring Plots

Disturbance Type	Circular Plot Size
Operational TCPL dispositions (e.g., pipelines and temporary workspace 24 m wide or greater)	3.99 m radius (50 m^2)
Non-operational lines (e.g., seismic lines approximately 8 m wide, other lines less than 24 m wide)	1.79 m radius (10 m^2)
Natural regeneration (consistent with disturbance type)	3.99 m radius (50 m^2) or 1.79 m radius (10 m^2)

Plot size on wider disturbances may be reduced to the smaller 1.79 m radius if ground disturbance constraints limit the placement of the plot (Section 3.3.3).

3.3.3 Staking of Permanent Monitoring Plots

Provided a Ground-Disturbance variance is issued prior to field montoring, plots should be staked and labeled to aid in locating plots in subsequent monitoring years and also to ensure they are not removed during operational and maintenance activities of active pipeline RoWs. In addition, GPS waypoints, plot sketches, and photographs will aid in locating sampling plot locations, particularly in the event that a plot flag becomes removed.

1. Ensuring all TCPL ground disturbance protocols are followed, mark plot centre using a metal pin flag inserted by hand approximately 15cm into the ground..

    - Plot centre must be located greater than 5 m from a pipeline that has been line-located. Clearly mark the setback and the azimuth from pipeline centre on the plot diagram (offset must be sufficient to allow for integrity digs to occur if required).

    - The rest of the plot can overlap the 5 m distance from pipeline centre, but stakes or posts marking the outer edges of a plot must not be within 5 m of a pipeline. Ground disturbance within 5 m of a pipeline requires hand exposure of the pipe and must be avoided.

    - If the minimum 5 m offset of a plot centre on operational lines causes the 3.99 m radius plot to cover a transitional area (between disturbance and surrounding undisturbed vegetation), a smaller plot (1.79 m radius) may be used instead, to be more representative of the area.

2. Write the plot name (e.g., U002) on the pin flag, using permanent/waterproof black marker.
3. Take and record GPS coordinates at the centre stake.
4. Create plot diagram (Appendix C1 and Section 3.3.4).

In the event a plot stake has been removed, re-establish the plot as close as possible to the original location using the original coordinates and plot diagram as references.

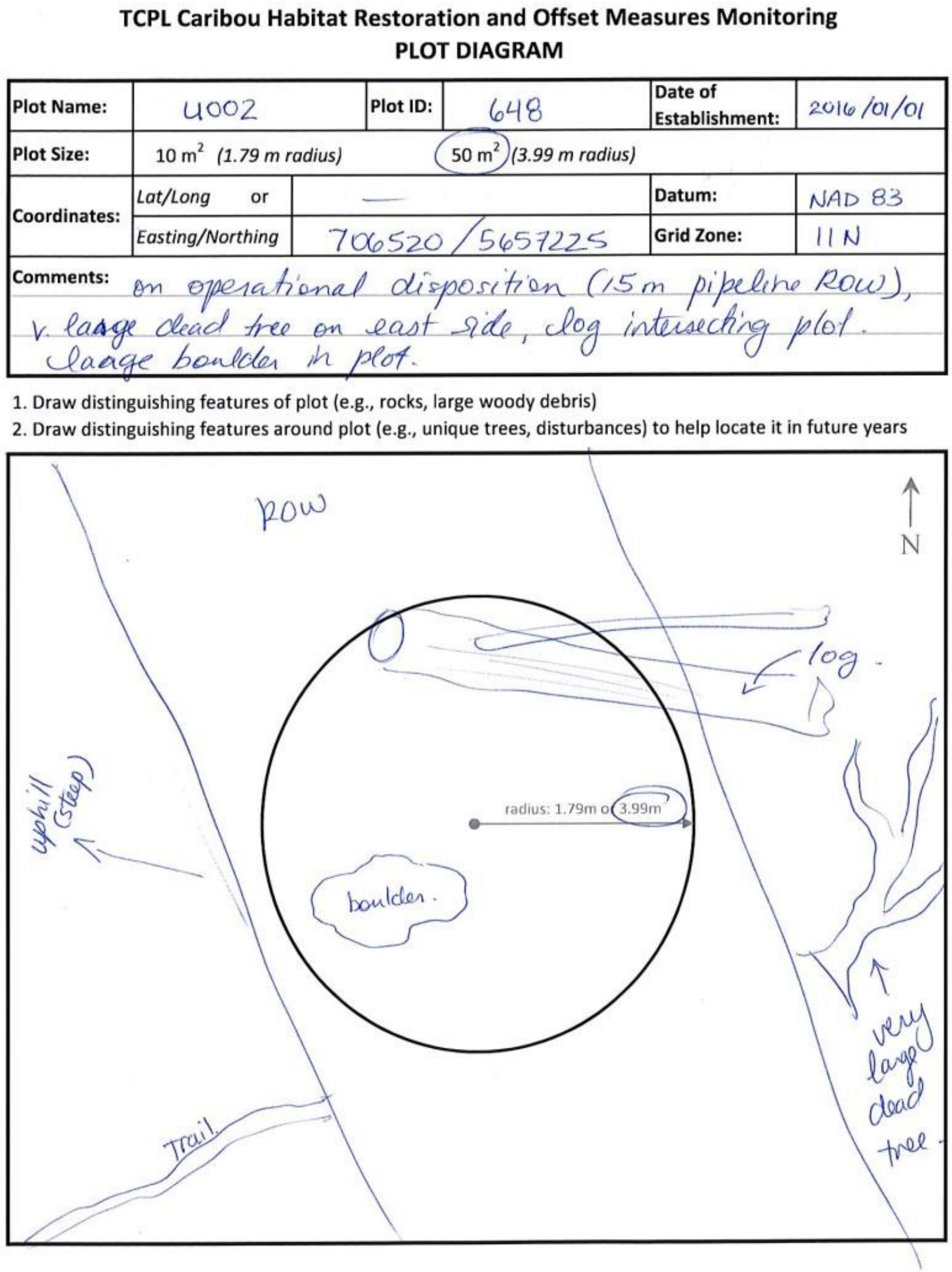
3.3.4 Plot Diagram

Plot diagrams must be created immediately after plot establishment so that the plot can be re-established if damaged or if the marker is lost. Plot diagrams must be detailed enough that people other than the original establishers can locate the site. Complete diagrams using the plot diagram template (Appendix C1) and include the following:

- name of plot (refer to Table 3 for naming convention) and plot ID (metal tag)
- date of establishment
- size of plot
- GPS coordinates (e.g., Universal Transverse Mercators [UTM]) of plot centre
- distinguishing features of plot (e.g., rocks, large woody debris)
- distinguishing features around plots (e.g., unique trees, disturbances)

As per Figure 1, the data reported in the top portion of the template (i.e., everything except the drawing) will be entered and stored in a spatial database (geo-database) once the field program is completed (Section 4). Any features drawn on the plot diagram that were not included as text in the Comments field should be described and added to the geo-database data.

Figure 1 Example Plot Diagram



TCPL Caribou Habitat Restoration and Offset Measures Monitoring
PLOT DIAGRAM

Plot Name:	U002	**Plot ID:**	648	**Date of Establishment:**	2016/01/01
Plot Size:	10 m² *(1.79 m radius)*	50 m² *(3.99 m radius)*			
Coordinates:	*Lat/Long* or	—		**Datum:**	NAD 83
	Easting/Northing	706520/5657225		**Grid Zone:**	11 N
Comments:	on operational disposition (15m pipeline ROW), v. large dead tree on east side, log intersecting plot. large boulder in plot.				

1. Draw distinguishing features of plot (e.g., rocks, large woody debris)
2. Draw distinguishing features around plot (e.g., unique trees, disturbances) to help locate it in future years

3.3.5 Plot Maintenance

In subsequent monitoring years, visually inspect plot identification markers (e.g., pin flagging, flagging tape) to ensure they remain in place, and are intact and legible. If the markers or signs are in poor or deteriorating condition, they must be replaced. Replace any faded, worn, or missing flagging tape to ensure visibility of plot centre. Review the plot diagram (hardcopy/digital) and make any related to maintenance changes.

3.4 Field Data Collection

Field data will be collected using the Appendices C2 (Habitat Restoration) and C3 (Access Control and Line-of-sight Breaks) field data sheet templates. Data collection at each habitat restoration plot is anticipated to take (on average) approximately 1.5 hours, not including plot establishment. All data from the field data sheets must be entered and stored in a geo-database once the field program is completed (Section 4).

Data collection is divided into two main types: Habitat Restoration (Section 3.4.1; Appendix C2) and Access Control and Line-of-sight Breaks (Section 3.4.2; Appendix C3). The latter does not require permanent plot establishment; however, temporary plots will be used for vegetation screen assessment. Although the detailed descriptions for data fields common to each type of survey (e.g., coordinates, surrounding vegetation community) have not been repeated in each section, all data fields on the data sheets must be filled out, except where not applicable (i.e., access control measures and line-of-sight breaks have been included on a single data sheet template, but only the applicable section on the lower portion of the page would be used for any one site).

3.4.1 Habitat Restoration

The following section presents detailed data collection methods for habitat restoration monitoring. These data include evaluation criteria such as seedling density, percent cover and vigour that will be used to assess whether habitat restoration measures meet or are on trajectory to the measurable targets set out in the CHROMMP (NGTL 2015, 2018). The goal of restoration is to achieve growth that is similar to natural yields found in Alberta forests. Habitat restoration data will also be used to verify aerial monitoring data and to inform adaptive management actions to be implemented in areas where measurable targets have not been met.

3.4.1.1 Monitoring Plot Identification & Geographical Information

Collect plot information (Table 3) using the Habitat Restoration Field Data Sheet (Appendix C2). Ensure all fields have been filled out.

Table 4 Plot Identification and Location

Field	Description	Example
Project Identification	• Project name or geographical location of study area	Northwest Mainline Expansion Project
Surveyors	• Names of people collecting the field data (list field lead or primary surveyor first)	Aspen Anderson/Willow Wilson

Plot Name	• Mandatory unique identifiers, which will identify the plot throughout the monitoring program • Use this naming convention: ✦ Treed upland plot 001 = U001 ✦ Treed lowland plot 001 = L001 ✦ Shrub/graminoid lowland plot 001 = S001 ✦ Natural regeneration control plot 001 = C001 • Use three-digit numbering for database sorting purposes (i.e., U001, not U1)	U001, U002...U013 L001, L002....L013 S001, S002...S013 C001, C002...C013
Plot Identification Number	• Unique number on metal tag used to permanently mark plot	648
Date	• Date of survey as YYYY/MM/DD	2016/08/21
Natural Subregion or Ecozone	• Natural subregion where plot is located	Central Mixedwood
Restoration Unit	• Treed upland, treed lowland, shrub/graminoid wetland or control	Treed upland
Plot Size	• Size of plot area to the nearest m^2	10 m^2 or 50 m^2
Waypoint Number	• Take waypoint at centre stake on handheld GPS unit • Record waypoint name/number	012
GPS Location Information (Coordinates)	• GPS location information is collected using a handheld GPS device (minimum ±10 m accuracy) • Record coordinates of centre stake waypoint • Format: UTMs or latitude and longitude (lat/long)	UTMs:6516048/474594 or Latitude/Longitude: 49°00’00.00” /110°00’00.00”
Grid Zone	• GPS Grid Zone (only if using UTM format)	12U
Datum	• North American Datum 83	NAD83
Elevation	• Elevation in metres (using GPS unit)	1,100 m
Surrounding Vegetation Community/Wetland Class	• Determine the surrounding (i.e., non-disturbed) vegetation community and wetland class (if applicable) using the local classification system (e.g., ecosite phase [Canada Forest Service field guides], or Alberta Wetland Classification System for wetlands [ESRD 2015])	i1 treed bog/BWcfa

3.4.1.2 Monitoring Plot Description

Collect plot information in Table 4 using the Habitat Restoration Field Data Sheet (Appendix C2).

Table 5 Plot Description

Factor	Description	Example
Slope	• Slope is the amount of incline where the plot is located • Measure slope with a clinometer and record to the nearest 1% (level ground has a slope of 0%)	4%

Aspect	• Aspect is the orientation of the slope where the plot is located (1° to 360°) • Measure aspect using a compass (facing downhill) • Level ground has no aspect (record as -1)	270°
Meso Site Position	• Meso site position is the position of the plot along a slope segment • Reference Table B1 for descriptions of meso site position	Upper slope
Moisture Regime	• Classify the soil moisture regime at the plot • Reference Table B2 and Figure B1 for moisture regime categories and characteristics	Mesic
Nutrient Regime	• Classify the soil nutrient regime at the plot based on the plot ecosite • Reference Table B3 for nutrient regime categories and characteristics	Medium
	Classify surficial soil within the plot as mineral or organic	Organic or mineral
Surface Substrate	• Classify the ground surface within the whole plot into various types • Assign % cover to: water, cobbles and stones, mineral soil, organic soil, organic matter, coarse woody debris, live plant material • The total should be around 100%, but may not be exactly that due to some overlap (e.g., live plant material may overlap coarse woody debris to some degree) • Reference Table B5 for surface substrate definitions	Water = 5% Cobbles and Stones = 0% Mineral Soil = 0% Organic Soil = 0% Organic Matter = 20% Coarse Woody Debris =5% Live Plant Material = 70%

3.4.1.3 Vegetation Community Composition

Collect and record data listed in Table 5 at each plot on the Habitat Restoration Field Data Sheet (Appendix C2).

Table 6 Vegetation Community Field Data

Field	Description	Example
Vegetation Structure		
Vegetation Strata Percent Covers	• Record the total percent estimate of cover of each stratum within the plot (ASRD 2003) • The total percent cover for a stratum does not necessarily equate to the sum of all plant covers for a particular stratum as foliage overlap may occur • Reference Table B6 and Figure B2 for stratum categories and definitions	T1 – 0% T2 – 0% S1 – 0% S2 – 4% S3 – 20% G – 5% H – 3% M – 50% L – 2%
Vegetation Strata Heights	• Record average height of each stratum within the plot (exclude M and L strata) to the nearest 5 cm • Reference Table B6 and Figure B2 for stratum categories and definitions	T1 – 0 cm T2 – 0 cm S1 – 0 cm S2 – 165 cm S3 – 30 cm G – 35 cm H – 20 cm
Vegetation Species Composition		
Vegetation Species Code and Stratum	• Identify all species for each stratum, to species level where possible • Identification to genus level is sufficient for vegetation that cannot be identified in the field (e.g. *Sphagnum* sp., *Salix* sp., *Carex* sp.) • Use scientific botanical nomenclature following provincial standards (e.g., ACIMS nomenclature; AEP 2015b or most current) • A 7-letter code (in upper case) will be used to identify specific species, composed of two parts reflecting the scientific name of the plant; the first four letters of the code represents the genus, and are extracted from the first four letters of the scientific genus name and the last the three the species (ASRD 2003).	black spruce = *Picea mariana* = PICE MAR willow species = *Salix* sp. = SALI SP.
Vegetation Percent Cover	• Percent cover is the percent of the ground area covered by a vertical projection of the foliage onto the ground surface • Determine the percent cover for each species within the plot • Cover values must all be numeric, and no ranges of values are allowed • Reference Figure B3 for examples of percent cover	S2 – PICE MAR = 2% S3 – PICE MAR = 15%
Plant Vigour	• Vigour is a measure of the relative health of a plant • Determine average vigour for each non-invasives species within the plot • Reference Table B7 for vigour categories	PICE MAR – 4 - Excellent
Plant Health Observations	• Note insect infestations, changes in colour or any other plant health observations • Take photos of any specific plant health concerns	Leaves on *Salix* sp. have brown spots

3.4.1.4 Tree Seedling/Tree Data

Collect data in Table 6 at each plot and record on the Habitat Restoration Field Data Sheet (Appendix C2). These data will be used in assessing the success of habitat restoration measures and include criteria such as seedling density, percent cover, and seedling damage (Northern Resources 2015). Vigour and percent cover for tree species will have already been collected in the Vegetation Community Composition portion of the habitat restoration data sheet (Table 5) and do not need to be recorded again for this portion.

Table 7 Tree Seedling Field Data

Field	Description	Example
Damage (Plot)	• Assess and record damage to seedlings/tree species for the entire plot • Use a maximum of two codes per plot • Select class code, severity code and causal code (only if reasonably certain) • Reference Table B8 for damage categories	FO-2-ID, PD-1-UK
Species Code	• Record the 7-letter code (Table 5) for each dominant tree species (i.e., those species that have the potential to grow into trees, including those in seedling and shrub stages/strata)	PICE MAR; POPU TRE; PINU BAN
Density (Count)	• Count the number of seedlings in each plot (for each species) • When possible, differentiate between planted or natural regeneration (do not guess); if both are present, use a separate row for each one (i.e., one row for planted stems and one row for natural stems of the same species)	PICE MAR – 4 – P PICE MAR – 5 – N
Density Distribution	• Determine density distribution class Reference Table B9 for plant distribution class categories	7
Spatial Distribution	• Qualitatively assess the distribution of seedlings over the entire plot • This is not a canopy cover measurement, but distribution throughout the entire plot	seedlings are distributed over 80% of the plot
Height	• Measure and record the height of five representative seedlings of each species in the plot to the nearest cm • The height of the seedling/tree is measured from the base of the seedling/tree, at the average ground level, to the tallest reaching point of the live matter of the seedling/tree (Figure B4) • In older trees, measure the height to the nearest cm for trees <100 cm and to the nearest 10 cm for trees >100 cm	PICE MAR 12 cm 15 cm 14 cm 15 cm 12 cm
Age Estimate	• Determine and record the estimated age of each of the five stems selected for height measurements • To determine age, count the number of branch whorls on coniferous trees, and number of bark scars (breaks in bark consistency) on deciduous trees • Start at present year’s growth (terminal shoot/leader) and work down to base (root collar node; ASRD 2000; ESRD 2013a)	

3.4.1.5 Noxious and Restricted Weeds/Invasive and Agronomic Species

Record any observations of noxious and prohibited noxious weeds, as well as invasive and agronomic species (Table 7) on the Habitat Restoration Field Data Sheet (Appendix C2).

Table 8 Noxious and Restricted Weeds/Invasive and Agronomic Species

Field	Description	Example
Noxious or Restricted Weeds	• Identify and record noxious or restricted weeds to species level	Canada thistle *Cirsium arvense* = CIRV ARV
Invasive and Agronomic Species	• Identify invasive or agronomic plants to species level	alsike clover *Trifolium hybridum* = TRIF HYB
Growth Stage	• Record average growth stage – seedling, bolt, bud, flower, seed set or mature	Flower
Percent Cover Code	• Determine percent cover, and record code ✦ trace = <1% cover ✦ low = ≥1% and <5% cover ✦ moderate = ≥5% and <25% cover ✦ high = ≥25% cover	Low
Density Distribution	• Determine density distribution class • Reference Table B9 for plant distribution class categories	2
Photographs	• Take photographs of the general infestation and a representative individual of each species	-

3.4.2 Photographs

A minimum of seven photographs will be taken at each survey plot. Record the photograph file number and description on the Habitat Restoration Field Data Sheet (Appendix C2).

1. north from centre of plot (capture plot by angling toward edge of plot)
2. east from centre of plot (capture plot by angling toward edge of plot)
3. south from centre of plot (capture plot by angling toward edge of plot)
4. west from centre of plot (capture plot by angling toward edge of plot)
5. ground cover (looking down)
6. from outside edge of plot, parallel to linear disturbance (to capture entire plot), facing opposite side of plot
7. from opposite outside edge of plot, facing other direction (parallel to linear disturbance; to capture entire plot)

3.4.3 Access Control and Line-of-sight Breaks

Access control and line-of-sight break monitoring will be conducted in combination with habitat restoration monitoring. Collect information for access control measures and line-of-sight breaks. Data in the top portion of the data sheet (location and identification information) is similar to fields described in Table 3. Fields specific to access control and breaks are explained below.

3.4.3.1 Access Control

Inspect all access control measure locations (Table 8) and record data on the Access Control and Line-ofsight Breaks field data sheet (Appendix C3). Complete all data fields on the data sheet (e.g., date, GPS coordinates), even though they are not described again in Table 8.

Table 9 Field Data Collection for Access Control Evaluation Criteria

Evaluation Criteria	Description	Example
Physical Materials	• Visually inspect and comment on condition of physical materials used for access control • Record condition and average height of planted trees (where applicable)	Access control in good physical condition; trees healthy, average height 2 m
Evidence of Access	• Look for evidence of access (e.g., trampled vegetation, bare ground, rutting, trails)	Yes – trail observed
Evidence of U-turns at Access Barriers	• Look for evidence of U-turns at access barriers (e.g.,trampled vegetation, bare ground)	Yes – bare ground observed
Access Type	• Determine type of access ✦ non-motorized ✦ all-terrain vehicle ✦ truck ✦ other (details to be noted)	All-terrain vehicle
Access Level Metrics	• Determine level of access ✦ absent ✦ low (tracks/trail evident but difficult to discern or appear to be infrequently used) ✦ moderate (relatively easily discernable; vegetation may be slightly trampled, but no bare ground is visible) ✦ high (tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use)	High
Adjacent Habitat Disturbance	• Visually inspect adjacent habitat for signs of disturbance	No signs of disturbance in habitat adjacent to control measure

3.4.3.2 Line-of-sight Breaks

Inspect all line-of-sight breaks (Table 9) and record data on the Access Control and Line-of-sight Breaks field data sheet (Appendix C3). Record all data fields on the data sheet even if not listed below (e.g., date, GPS coordinates).

Table 10 Field Data Collection for Line-of-sight Break Evaluation

Line-of-sight Break Type	Evaluation Criteria	Description	Example
Berms	Footprint Width	• Measure footprint width using tape measure	32 m
	Length of Berm	• Measure length of berm (perpendicular to RoW) using tape measure	50 m
	Length of Berm with Height ≥1.5 m	• Measure length of berm (perpendicular to RoW) ≥1.5 m using tape measure	20 m
	Berm Composition	• Record what the berm is made of (e.g., fabricated, earthen)	Fabricated
	Condition of Berm	• Record any observations regarding the condition of the berm	Berm looks to be in good condition
Fabricated Screens	Screen Composition	• Record materials the screen is made from (e.g., burlap, snow fencing)	Burlap
	Screen Condition	• Comment on condition of fabricated screen (including sagging issues)	Burlap in poor condition, needs replacing
Vegetation Screens ***(select a representative 10 m^2 circular plot within vegetation)***	Spatial Distribution	• Measure/calculate the spatial distribution (distance between) 10 of live woody stems to the nearest cm (within a representative 10 m^2 circular plot)	10 cm, 12 cm, 25 cm, 9 cm, 15 cm, 40 cm, 17 cm, 20 cm, 33 cm, 46 cm
	Density of Woody Stems	• Count woody stems within the 10 m^2 circular plot	37
	Height of Live Woody Stems	• Measure the average height of live woody stems within the 10 m^2 circular plot	60 cm
	Percent Cover of Live Woody Stems	• Measure the percent cover of live woody stems within the 10 m^2 circular plot	25%
	Line-of-sight Measurements	• Use a cover/Robel pole for line-of-sight measurements (see below for more detailed methods)	-

3.4.3.3 Vegetation Screen Line-of-sight Measurements

Line-of-sight measurements are only to be completed for vegetation screens. Vegetation obstruction (line-of-sight) is measured using procedures adapted from Herrick et al. (2009); these are similar to the Robel Pole Method (BLM 1996). Where feasible based on seedling height, a cover pole (Appendix A, Figure A1), divided into increments or “bands” of alternating colour, is used to measure the degree to which the vegetation is obstructing visibility to the other side of the screen. Ensure your cover pole has 0.5 m segments and 10 cm bands for consistency across monitoring years. In early stages of regrowth (ie Years 1 and 3), regrowth may not have attained sufficient height relative to surrounding vegetation for useful measurement.

1. Select three to five representative positions at regular intervals along the length of the vegetation screen (number of positions and interval distance will depend on width of the disturbance).

2. Record interval distance (to the nearest metre) on the Access Control and Line-of-sight Breaks field data sheet.

3. Start at one end of the vegetation screen (note Position name/number on the datasheet).

    a) One surveyor holds the cover pole at the location of first position (take GPS coordinates).

    b) A second surveyor walks perpendicular to the vegetation screen (parallel to the linear disturbance), holding the sighting pole, until the 5-metre cord is pulled taut. This will be the “Observation A” location.

    c) Crouching down, the second surveyor looks just over the top of the sighting pole to the cover pole, and calls out which bands (10-cm intervals) are obstructed.

    d) First surveyor can note the observations on the datasheet:
        - band is obstructed if ≥25% visually covered by vegetation (alive or dead);,write “1” on the datasheet
        - if band is not obstructed (<25% covered), write “0” on the datasheet

    e) Repeat steps b) to d) on the other side of the vegetation screen (i.e., second surveyor walks across the screen and pulls the cord taut to 5 m on the opposite side of the screen, parallel to the linear disturbance). This will be the “Observation B” location.

4. Both surveyors move to the next position along the vegetation screen.

    f) Repeat steps a) to e) at each position (GPS coordinates are only taken at first position).

5. When both sides of the 3 to 5 positions have been completed, calculate the totals on the datasheet.

3.4.3.4 Photographs

Take a minimum of six photographs from different angles to document the condition of the access control measure or line-of-sight break:

- one on each side of the break/access control, from centre of RoW: 25 m from structure or far enough to capture entire structure (Figures 2 and 3, star symbols)

- wider disturbances (e.g., operational lines): one photograph from each edge of the RoW at about 50 m from structure, on both sides of the structure, to show different perspective (Figure 2, dot symbols)

- narrower disturbances (e.g., non-operational lines): reduce distance to about 20 m, one photograph from each edge of the RoW (Figure 3, dot symbols)

Record the photograph file number (GPS coordinates for each photograph will be recorded automatically using GPS-enabled camera; ensure GPS function is enabled). Take photographs from the same locations in subsequent monitoring years. Also take photographs of any signs of natural or anthropogenic disturbance, damage to structure, or anything else of note.

Figure 2 Access Control and Line-of-sight Breaks Photograph Locations (Wider Lines)

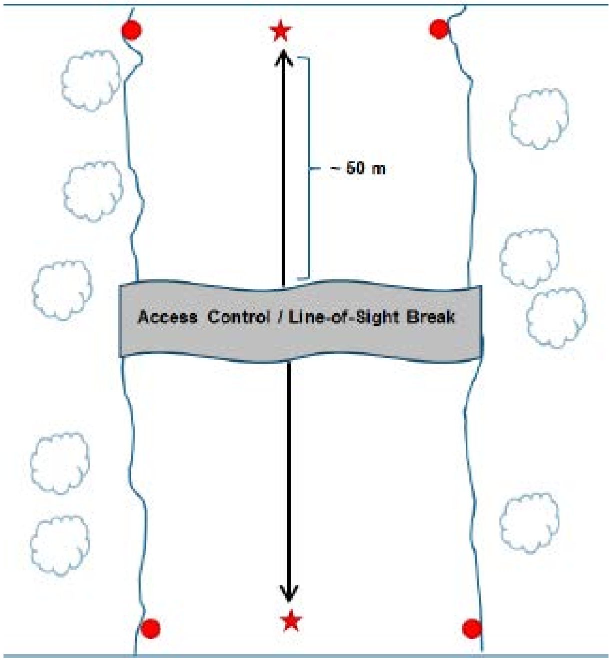
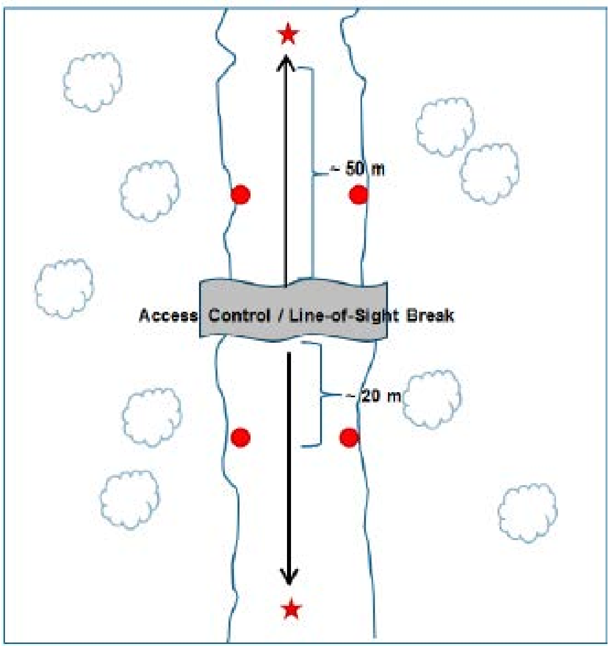


Figure 3 Access Control and Line-of-sight Breaks Photograph Locations (Narrower Lines)



3.4.4 Incidental Wildlife Observations

While completing surveys, document and photograph (when possible) any incidental wildlife observations onto the field data sheets. If photographs are taken, record photograph file number. Incidental wildlife observations include the following:

- wildlife sightings
- wildlife tracks or other signs of habitat use (e.g., dens, sleeping areas)
- signs of browsing or predation (e.g., kill sites, bones)
- scat

3.4.5 Field Data Management

Post-field (end of field day) debriefing and data processing will be an ongoing process from the end of the first day of the field survey. If possible, data will be reviewed nightly by the field lead to ensure blanks are complete and errors noted and corrected while the day's survey is still fresh in the memory.

The following steps will also be taken:

- If using digital field tablets, nightly data backups are required to ensure an offsite backup of field data exists in case the field tablet is lost, stolen or damaged.
- If using hard copy datasheets, photographs will be taken of the datasheets in the field after each site (plot or access control/break) is complete, to ensure a backup exists in case the datasheets are lost or damaged.
- Photographs and GPS handheld units will be backed up nightly and uploaded offsite if local internet can accommodate this, in case cameras/GPS units are lost, stolen or damaged.
- Failure to properly complete these procedures increases the risk of lost data.

4 POST-FIELD DATA MANAGEMENT

Data processing, data entry and quality assurance/quality control (QA/QC) should be completed as soon as possible upon returning from the field. Steps include but are not limited to:

- Scanning hard copy data sheets immediately upon returning from the field and saving resulting digital files in a secure location (e.g., server with regular backup routine) accessible to multiple people (i.e., not on an individual's desktop).
- Backing up all final digital files (e.g., photographs, field data entry files, data downloaded from GPS unit) in a secure location (as above).
- Entering all data from hard copy data sheets into a spatial geo-database (refer to Appendix E for format requirements).
- Completing a QA/QC process on the final digital data and ensuring any edits are incorporated into the geo-database. Examples of items to verify include but are not limited to:
    - looking for spatial outliers, or any plots that seem not to be where they should be (e.g., not on an operational or non-operational disposition, or outside of the project area)
    - verifying that species lists make sense with habitat where plot was located and vegetation communities reflect the restoration unit type
    - checking for outlier data (e.g., nonsensical date, percent cover, or height values) or duplicate or incorrect plot names
    - cross-checking that recorded photograph numbers match digital file names of downloaded photos

Data (including digital files) must be formatted to meet TCPL requirements (Appendix D). All field data collected on data sheets (hard copy or digital version) will be stored in a spatial geo-database and subsequently submitted to TCPL, along with any other digital field files (e.g., photographs).

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APPENDIX A

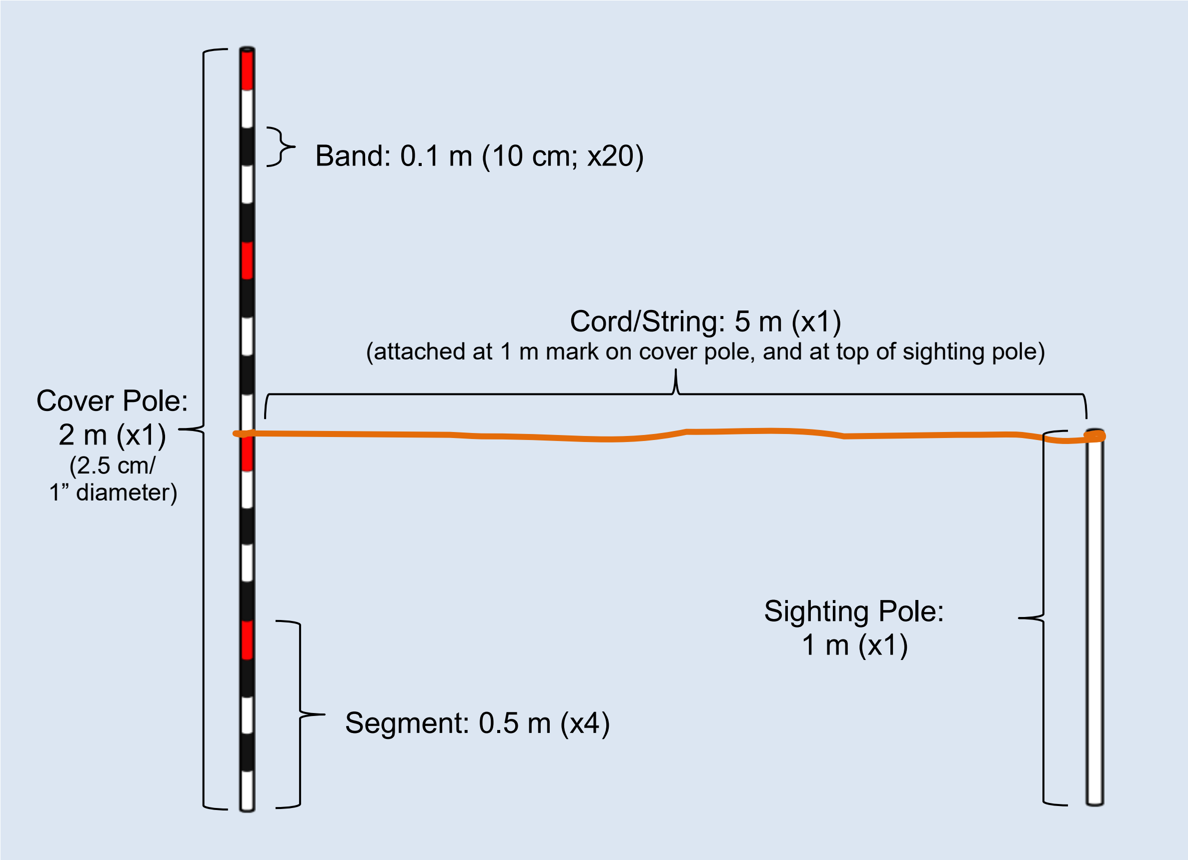
FIELD EQUIPMENT CHECKLIST

Table A1 – Field Equipment Checklist

General
☐ Field maps (to Section 2.6 standards)
☐ Compass
☐ Clinometer
☐ GPS handheld unit
☐ Digital camera – GPS-enabled (ensure GPS function is activated)
☐ Digital field tablet*
☐ Field Data Sheets on all-weather paper (x60: 52 plots + 8 extra)
☐ Spare batteries/chargers (as required)
☐ Hand lens
☐ Field notebook
☐ Pencils
☐ Permanent markers (Sharpies)
☐ Tape measure (pocket-sized)
☐ Clipboard
☐ DBH (diameter at breast height) tape
☐ Cover pole (e.g., Robel pole) with sighting pole (Figure A1)
Plot Establishment
☐ Tape measure (30 m)
☐ Stake with 3.99 m rope (radius for 50 m^2 plot)
☐ Stake with 1.79 m rope (radius for 10 m^2 plots)
☐ Hammer (i.e., mallet)
☐ Post pounder
☐ Flagging tape and plot markers (e.g., metal tree tags)
☐ Permanent/waterproof black markers
☐ Metal posts (e.g., t-posts or other permanent stake)
☐ Metal pins (flagged; for ground-level marking of plot centres)
☐ Permanent signs to alert others at each monitoring plot
Reference Material
☐ These Protocols
☐ Field guides and taxonomic keys (vegetation)
☐ Ground Disturbance Package
☐ CHROMMP
☐ TCPL General Work Permit, Site Specific Safety Plan (SSSP) and all other required H&S documentation (comprehensive H&S requirements are outside the scope of these Protocols)
Health and Safety
☐ Appropriate PPE as per company and TCPL policy – may include but not limited to: o Long sleeves and long pants o Cruise vest (high-visibility) o Safety-toed boots o Safety glasses o Hard hat
☐ Bear spray/bangers, air horns
☐ Survival kit (for remote areas)
☐ First Aid kit

*If using a digital field tablet, it is recommended to take hard copy field data sheets in case of device failure

Figure A1 Cover Pole Specifications (not to scale)



APPENDIX B

FIELD REFERENCE SHEETS

Table B1 Meso Site Position Definitions

Meso Site Position	Definition
Crest	The generally convex uppermost portion of a hill (meso scale); it is usually convex in all directions; no distinct aspect.
Upper Slope	The generally convex upper portion of the slope of a hill (meso scale) immediately below the crest; it has a convex surface profile with a specific aspect.
Middle Slope	The area of the slope of a hill between the upper slope and the lower slope, where the slope profile is not generally concave or convex; rather it has a straight or somewhat sigmoid surface profile with a specific aspect.
Lower Slope	The area toward the base of the slope of the hill. It generally has a concave surface profile with a specific aspect.
Toe	The area below and adjacent to the lower slope. It is apparent by an abrupt decrease in slope. Zone of potential accumulation at the bottom of a slope.
Depression	Any area that is concave in all directions; generally at the foot of a meso scale hill or in a generally level area.
Level	Any level meso scale area not immediately adjacent to a meso scale hill. The surface profile is generally horizontal with no significant aspect.

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*
Hill also generally refers to mound or ridge

Table B2 Moisture Regime Characteristics

Moisture Regime	Description	Primary Water Source	Slope Position	Soil Properties			
				Texture	Internal Drainage	Surface Humus Depth	Available Water Storage Capacity
Very xeric	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after precipitation	Precipitation	Ridge crests shedding	Very coarse (gravelly-sand); abundant coarse fragments	Very rapid	Very shallow	Extremely low
Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation	Precipitation					
Subxeric	Water removed rapidly in relation to supply; soil is moist for short periods following precipitation	Precipitation	Upper slopes shedding	Coarse to moderately coarse (LS-SL); moderately coarse fragments	Rapid	Shallow	Very low
Submesic	Water removed readily in relation to supply; water available for moderately short periods following precipitation	Precipitation			Rapid to well		Low
Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year; available moisture reflects climatic inputs	Precipitation in moderately to fine-textured soils and limited seepage in coarse textured soils	Mid slope rolling to flat	Moderate to fine (L-SiL); few coarse fragments	Well to moderately well	Moderately deep	Moderate
Subhygric	Water removed slowly enough to keep the soil wet for significant part of the growing season; some temporary seepage and possibly mottling below 20 cm	Precipitation and seepage	Lower slopes receiving	Variable depending on seepage	Moderately well to imperfect	Deep	High
Hygric	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possibly weak gleying	Seepage			Imperfect to poorly		Variable depending on seepage
Subhydric	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral soils or organic soils; permanent seepage less than 30 cm below the surface	Seepage or permanent water table	Depressions and level receiving	Variable depending on seepage	Poor to very poorly	Very deep	Variable depending on seepage
Hydric	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral soils or organic soils	Permanent water table			Very poorly		

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Figure B1 Ecological Moisture Regime in relation to landscape position and geologic material (ASRD 2003)

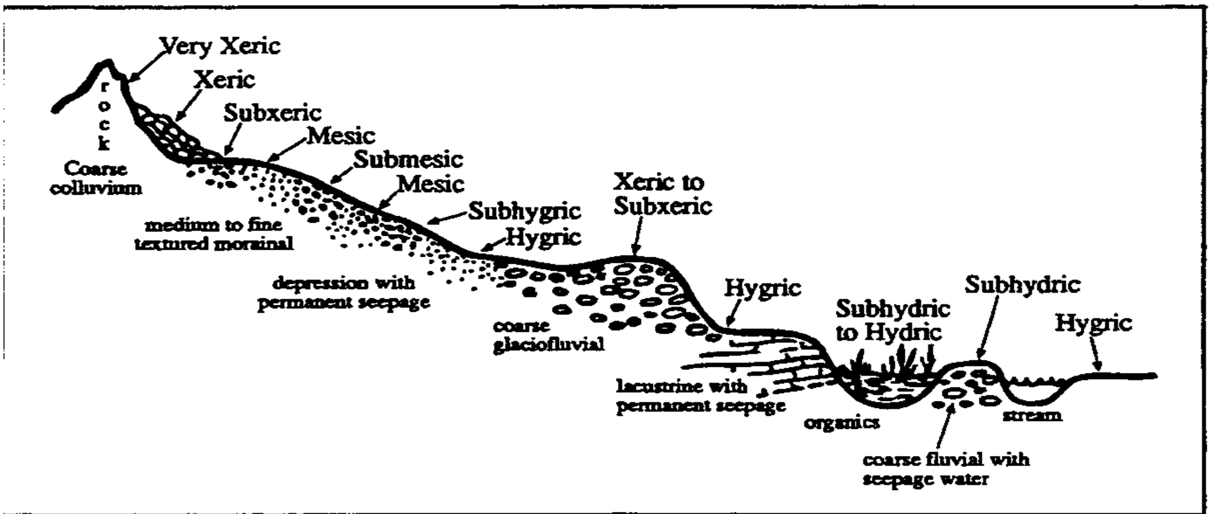


Table B3 Nutrient Regime Characteristics

Characteristic	Very Poor (Oligotrophic)	Poor (Submesotrophic)	Medium (Mesotrophic)	Rich (Permesotrophic)	Very Rich (Eutrophic)
Definition	Very poor nutritional status, very small supply of available nutrients	Poor nutritional status, low supply of available nutrients	Medium nutritional status, medium supply of available nutrients	Rich nutritional status, plentiful supply of available nutrients	Very rich nutritional status, abundant supply of nutrients
Texture	Very coarse	Coarse	Medium	Fine	Very fine
Organic Matter Content	Low	Moderate	Moderate	High	High

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B4 Soil Drainage Definitions

Drainage	Description
Very rapidly drained	**The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.** Water is removed from the soil very rapidly in relation to supply. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Water source is precipitation.
Rapidly drained	**The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.** Soils are free from any evidence of gleying or mottling throughout the profile. Rapidly drained soils often occur on steep slopes.
Well drained	**The soil moisture content seldom exceeds field capacity in any horizon (except possibly the C) for a significant part of the year.** Soils are usually free from mottling in the upper 1m, but may be mottled below this depth.
Moderately well drained	**The soil moisture remains in excess of field capacity for a small but significant period of the year.** Soils are often faintly mottled in the lower B and C horizons or below a depth of 0.7 m. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium textured soils that have a slowly permeable layer below the A and B horizons.
Imperfectly drained	**The soil moisture remains in excess of field capacity in subsurface horizons for moderately long periods during the year.** Soils are often distinctly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. Soils are generally "gleyed" subgroups of mineral soil orders.
Poorly drained	**The soil moisture remains in excess of field capacity in all horizons for a large part of the year.** The soils are usually strongly gleyed. Soils are generally in the Gleysolic or Organic order.
Very poorly drained	**Free water remains at or within 30 cm of the surface most of the year.** The soils are usually strongly gleyed. Soils are generally in the Gleysolic or Organic order; mineral soils are usually a peaty phase.

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B5 Surface Substrate Definitions

Surface Substrate	Definition
Water	Areas of open water
Cobbles and Stones	Exposed unconsolidated rock fragments greater than 7.5 cm in diameter
Mineral Soil	Unconsolidated mineral material of variable texture not covered by organic materials
Organic Soil	Organic soil not covered by organic material
Organic Matter	Organic layers, including living and dead plant materials, which have accumulated on the soil surfaces, ranging from easily recognizable undecomposed vegetation parts to humified organic material (excluding decaying wood as defined below).
Coarse Woody Debris	Fallen trees, large branches on the ground surface or partially buried stumps with an exposed edge, >7.5 cm diameter
Live Plant Material	Any live plant material, not including canopy area (e.g., moss, live stem area)

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B6 Definition of Vegetation Layer Strata

Vegetation Layer Code	Vegetation Layer Name	Definition
T1	Tree (Main Canopy)	This stratum (T1) consists of the **dominant (tallest) tree species in the main canopy**. These are the trees that make up the upper part of the height distribution population and form the general layer of the canopy or foliage. These may include trees of the same age group that are significantly taller than the others in the canopy. Any woody species may meet this requirement as long as they meet a minimum height criterion of greater than 5 m.
T2	Tree (Understory)	This stratum (T2) is composed of trees and/or shrubs (see above) whose **crowns, extend into the bottom of the general level of the canopy or are located below the main canopy**. Trees and/or shrubs in this layer must exceed 5 m in height. Any species meeting these criteria should be identified as part of this stratum (This layer may or may not be present).
S1	Shrub (Tall)	All **woody plants between 2.0 m and 5.0 m tall** are recorded as part of the Tall Shrub (S1) stratum. Shrub and tree regeneration is included in this stratum.
S2	Shrub (Medium)	This stratum (S2) includes **shrubs and regenerating trees that are between 0.5 m and 2.0 m tall**. Shrub and tree regeneration is included in this stratum.
S3	Shrub (Low)	All **woody plants up to 0.5 m tall** are considered part of the Low Shrub stratum (S3). Some plants which have a minimal amount of woody tissue, such as bunchberry *(Cornus canadensis)* strongly resemble herbaceous plants but are actually part of this layer. Shrub and established tree regeneration may be recorded here.
H	Herb (Forb)	Only **forb (generally broad-leafed herbaceous) species** are to be recorded in this stratum (H). Some plants which superficially could be viewed as shrubs because of hard woody stem tissue near the crown are actually forbs. Some plants which may look like grasses or grass-like plants, such as cattail *(Typha latifolia)* are also forbs.
G	Grass/graminoid	Only cover estimates for **graminoid (grasses or grass-like) species** are recorded as part of this stratum (G). For a listing of these species check the Master Species list (Alberta Environmental Protection 1993).
M	Moss	**Bryophytes and hepatics (mosses and liverworts) growing on the dominant substrate** make up this stratum (M).
L	Lichen	**Lichen species growing on the dominant substrate** (usually mineral or organic soil) are considered part of this stratum (L).

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Figure B2 Stratification of Forest Stand, Shrubs and Trees (ASRD 2003)

Figure B3 Examples of Percent Cover (ASRD 2003)

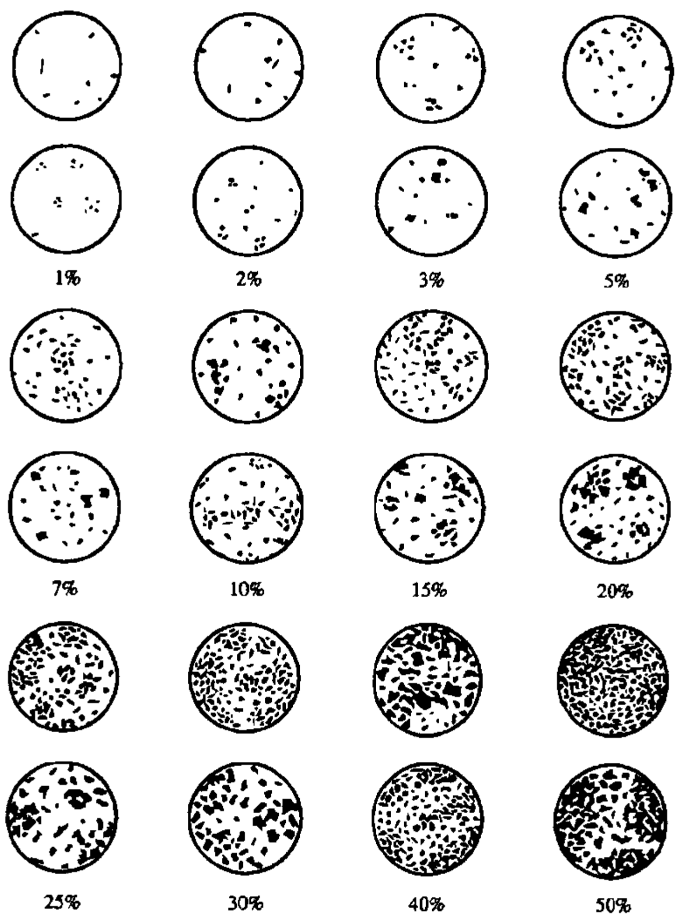


Table B7 Vigour Classes

Vigour Code	Vigour Class
0	Dead
1	Poor
2	Fair (Average)
3	Good
4	Excellent
5	Unknown

Table B8 Tree/Seedling Damage Classes and Severity Codes

Damage Class	Severity	Severity Code	Description
DE (Dead)	Minimal	1	Dead trees/ vegetation (1-25% stems)
	Moderate	2	Dead trees/ vegetation (26-50% stems)
	Significant	3	Dead trees/ vegetation (51-75% stems)
	Severe	4	Dead trees/ vegetation (76-100% stems)
FO (Foliage discolouration/ loss)	Minimal	1	Foliage discolouration/ loss 1-25%
	Moderate	2	Foliage discolouration/ loss 26-50%
	Significant	3	Foliage discolouration/ loss 51-75%
	Severe	4	Foliage discolouration/ loss 76-100%
MI (Missing/ low density)	Minimal	1	Density 1-25% less than expected
	Moderate	2	Density 26-50% less than expected
	Significant	3	Density 51-75% less than expected
	Severe	4	Density 76-100% less than expected
PD (Physical damage)	Minimal	1	Damaged trees/ vegetation 1-25%
	Moderate	2	Damaged trees/ vegetation 26-50%
	Significant	3	Damaged trees/ vegetation 51-75%
	Severe	4	Damaged trees/ vegetation 76-100%
PG (Poor growth/ form)	Minimal	1	Vegetation is expected to recover
	Moderate	2	Growth rate/ form will be reduced by 26-50%
	Significant	3	Growth rate/ form will be significantly reduced
	Severe	4	Vegetation is expected to die

Adapted from AESRD 2013 *Alberta Regeneration Standards from Mineable Oil Sands*

Table B9 Tree/Seedling Damage Causal Codes

Cause of Damage	Causal Code	Cause of Damage	Causal Code
Animal Codes		***Weather Codes***	
Bear damage	AU	Frost damage	WD
Beaver felling/chewing	AC	Hail	WH
Horse/cattle trampling	AH	Snow/ ice	WN
Rodent chewing/damage (porcupine, rabbit or squirrel)	AD	Wind damage/ blowdown	WB
Ungulate browsing	AB	***Human Codes***	
Other animal	AO	Equipment/ machine	HE
Disease Codes		Land clearing/ soil	HL
Dieback	DD	Poor planting	HP
Needle rust	DN	Other human damage	HO
Other disease	DO	***Environment Codes***	
Insect Codes		Aspect/ exposure	EA
Aphid	IA	Drought	ED
Defoliator	ID	Fire	FR
Wood borer	IB	Flooding/ seepage/ water	EF
Other insect	IO	Soil erosion	EE
Unknown Codes		Other climate extremes	EC
Unknown	UK	Other soil factors	ES

Adapted from AESRD 2013 *Alberta Regeneration Standards from Mineable Oil Sands*

Table B10 Description of Plant Distribution Classes and Codes

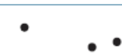
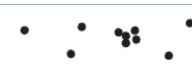
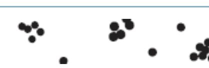
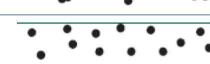
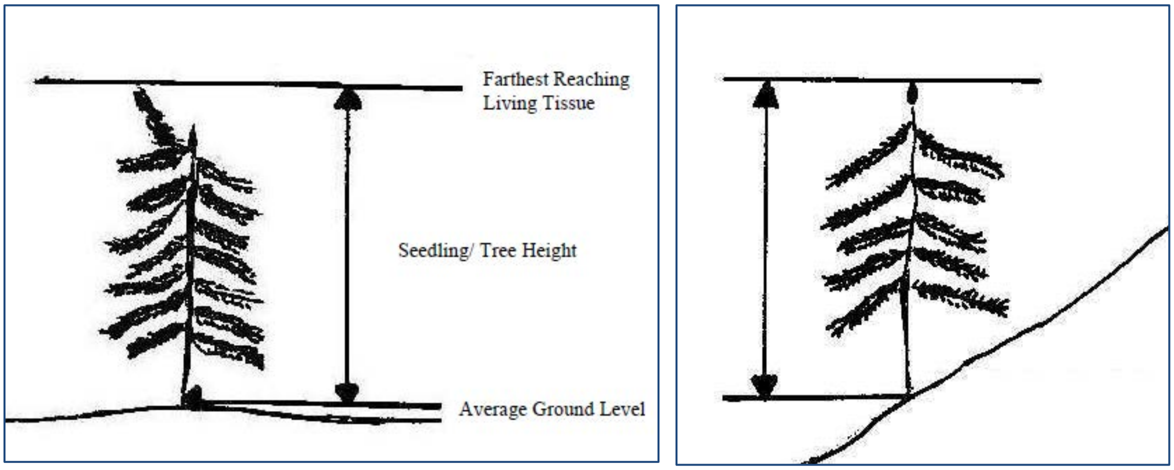
Code	Plant distribution class	
1	Rare individual, a single occurrence	
2	A few sporadically occurring individuals	
3	A single patch or clump of a species	
4	A single patch plus a few sporadically occurring individuals	
5	Several sporadically occurring individuals	
6	A single patch plus several sporadically occurring individuals	
7	A few patches or clumps of a species	
8	A few patches plus several sporadically occurring individuals	
9	Several well-spaced patches or clumps	
10	Continuous uniform occurrence of well-spaced individuals	
11	Continuous occurrence of a species with a few gaps in distribution	
12	Continuous dense occurrence of a species	
13	Continuous occurrence of plants with a distinct linear edge in the polygon	

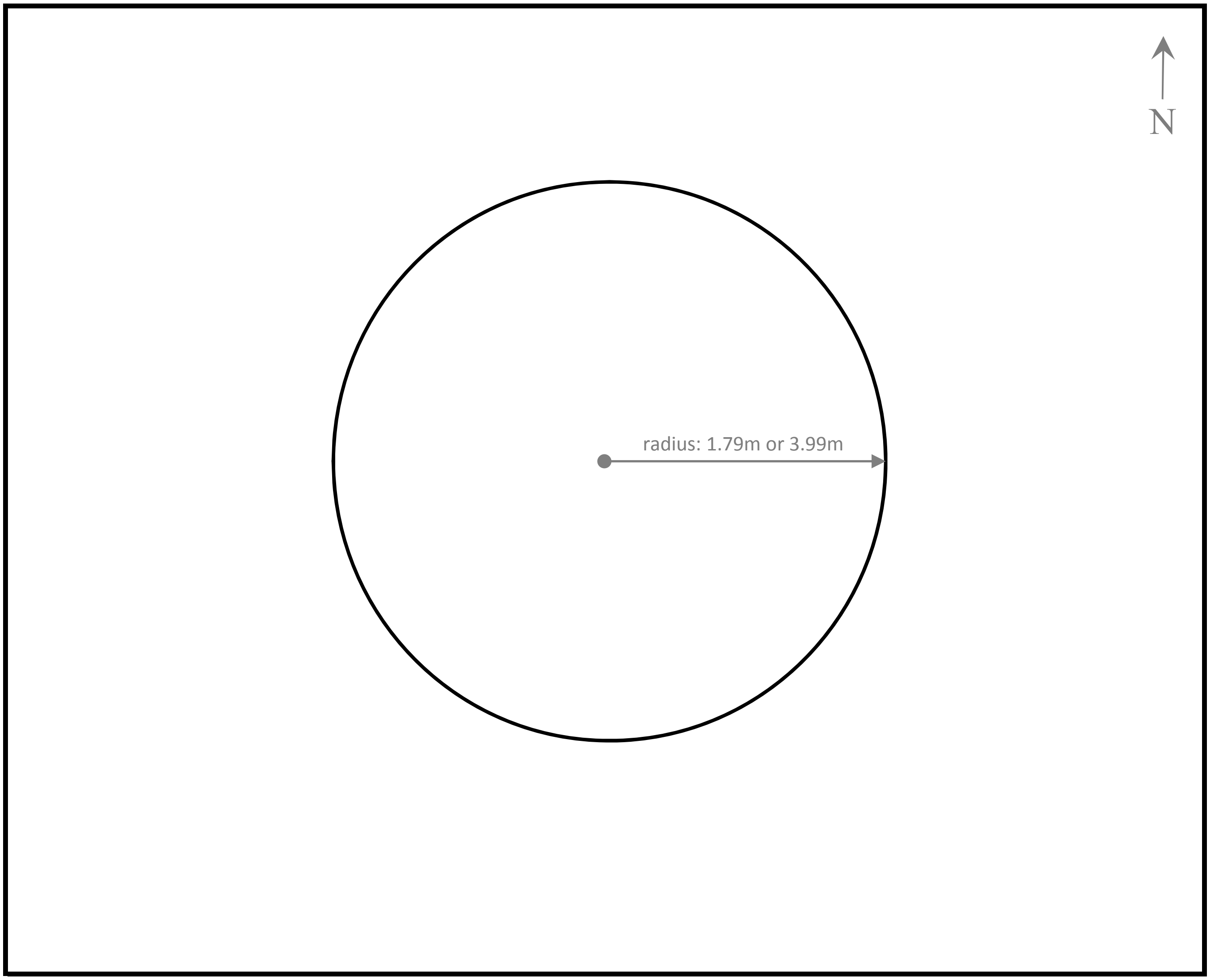
Figure B4 Measurement of Tree Seedling Height on Flat and Sloped Ground (ASRD 2001)



TCPL Caribou Habitat Restoration and Offset Measures Monitoring
PLOT DIAGRAM

Plot Name:		**Plot ID:**		**Date of Establishment:**	YYYY/MM/DD
Plot Size:	10 m^2 *(1.79 m radius)* 50 m^2 *(3.99 m radius)*				
Coordinates:	*Lat/Long* or			**Datum:**	
	Easting/Northing			**Grid Zone:**	
Comments:					

1. Draw distinguishing features of plot (e.g., rocks, large woody debris)
2. Draw distinguishing features around plot (e.g., unique trees, disturbances) to help locate it in future years



TCPL Caribou Habitat Restoration and Offset Measures Monitoring

FIELD DATA SHEET - HABITAT RESTORATION

PLOT IDENTIFICATION / LOCATION

Project Name:		**Plot Name:**		**Plot ID:**	
Surveyors:				**Date:**	YYYY/MM/DD
Plot Type:	habitat restoration measures plot		natural regeneration control plot		
Restoration Unit Type:	treed upland/ transitional		treed lowland		shrub-graminoid lowland
Plot Size:	10 m^2 50 m^2	**Waypoint #:**		**Nat. Subregion/ Ecozone:**	
Coordinates:	*Lat/Long* or		**Datum:**		**Grid Zone:**
	Easting/Northing		**Elevation (m):**		
Surrounding Vegetation Community:			**Wetland Class:**		

PLOT DESCRIPTION

Slope (%):					**Aspect (degrees):**					
Meso Site Position:	Crest	Upper Slope	Mid-slope	Lower Slope	Toe	Depression	Level			
Moisture Regime:	Very Poor	Poor	Medium	Rich	Very Rich	Saline				
Nutrient Regime:	Very Xeric	Xeric	Sub-xeric	Sub-mesic	Mesic	Sub-hygric	Hygric	Sub-hydric	Hydric	Aquatic
Soil Drainage:	Very Rapidly	Rapidly	Well	Moderately Well	Imperfect (Gleyed)	Poorly (<50cm)	Very Poorly (Standing)			

Soil Type:		**Surface Substrate:**	*Type*	*Cover (%)*	*Type*	*Cover (%)*
	Mineral		Water		Organic Matter	
			Cobbles/Stones		Coarse Woody Debris	
	Organic		Mineral Soil		Live Plant Material	
			Organic Soil			

PLOT PHOTOS

From **Plot Centre** (capture plot by angling down towards edge of plot):		At **edge** of plot, parallel to linear disturbance (to capture entire plot):	
Facing:	*Photo File #*	*Facing:*	*Photo File #*
1. North		6.	
2. East		7.	
3. South			
4. West			
5. Ground (down)			

Plot Comments / Incidental Wildlife Observations (include GPS coordinates):

NOXIOUS AND RESTRICTED WEEDS / INVASIVE AND AGRONOMIC SPECIES

Species Code	Growth Stage	Distribution Class	Cover Class	Photos File Numbers	Nox./ Restr. Weed?	Inv./ Agro. Sp.?

Growth Stages	Cover Classes (%)
SD: seedling	T: Trace <1
BL: bolt	L: Low ≥1 - <5
BD: bud	
FL: flower	M: Moder. ≥5 - <25
SS: seed set	
MA: mature	H: High ≥25

FIELD DATA SHEET - HABITAT RESTORATION

Project Name:		Plot Name/ID:		Date:	YYYY/MM/DD

VEGETATION COMMUNITY COMPOSITION

Vegetation Structure (*to nearest 5 cm)

Stratum	T1	T2	S1	S2	S3	G	H	M	L
Cover (%)									
Avg. Ht (cm*)								---	---

Vegetation Species Composition

Species Code	Stratum	Cover (%)	Vigour	Species Code	Stratum	Cover (%)	Vigour

Vegetation Health Notes:

TREE SEEDLING/TREE DATA

Tree/Seedling Damage (Entire Plot)	Codes 1:	Codes 2:

Species Code	Density Distrib. Class	Distrib. (% of plot where present)	Planted or Natural?	Density (Count)	Height (cm)					Estim. Age (yrs)				
					1	2	3	4	5	1	2	3	4	5

TCPL Caribou Habitat Restoration and Offset Measures Monitoring
FIELD DATA SHEET - ACCESS CONTROL & LINE-OF-SIGHT BREAKS

SITE LOCATION

Project Name:		**Site Name:**		**Waypoint #:**		
Surveyors:				**Date:**	YYYY/MM/DD	
Control Type:	access control *(use Section 1 of this sheet)*		line-of-sight break *(use Section 2 of this sheet)*			
Coordinates:	*Lat/Long* or		**Datum:**	NAD83	**Grid Zone:**	
	Easting/Northing		**Elevation (m):**			
Surrounding Vegetation Community:			**Wetland Class:**			

1 - ACCESS CONTROL

Evaluation Criteria	***Inspection Comments (describe observations)***		
Physical Materials:	Condition:		
	Average Ht (m) *(if vegetation)* :		
Evidence of Access:	yes	no	*Describe:*
Evidence of U-turns:	yes	no	*Describe:*
Access Type/ Method:	non-motorized all-terrain vehicle truck other*		***Details:**
Access Level:	absent low moderate high		
Low - tracks/trail evident but difficult to discern or appear to be infrequently used	*Moderate - relatively easily discernable; vegetation may be slightly trampled, but no bare ground is visible*	*High - tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use*	
Adjacent Habitat Disturbance:	yes	no	*Describe:*

2 - LINE-OF-SIGHT BREAKS

Break Type	***Evaluation Criteria***				
Berm	Composition (Materials) *(e.g., fabricated, earthen)*	Footprint Width (m)	Berm Length (m) (perpend. to ROW)	Length of Berm ≥1.5m High (m)	Condition of Berm:
Fabricated Screen	Composition (Materials) *(e.g., burlap, snow-fencing)*	Condition of Fabricated Screen *(including sagging, etc.)* :			

Vegetation Screen *(10 m² circular plot - 1.79 m radius)*											
Woody Stem Density (Count):		Cover of Live Woody Stems (%):			Avg. Height of Live Woody Stems (cm):						
Spatial Distribution (cm) *(measure 10 representative distances between random woody stems)*											Average:
Dominant Woody Species:											
Line-of-Sight Measurements: *See page 2 of this datasheet*											

NOTES

Site Comments / Incidental Wildlife Observations (include GPS coordinates and photo file names [if applicable]):

FIELD DATA SHEET - ACCESS CONTROL & LINE-OF-SIGHT BREAKS

Project Name:		**Site Name:**		**Wpt #:**		**Date:**	YYYY/MM/DD

SITE (BERM / BREAK) PHOTOS

Take a minimum of 6 photos from different angles, as per Protocols (including signs of disturbance)

Photo File #:	**Facing:**	**Description** ***(must be clear enough for similar photo to be taken in the next monitoring year)*****:**
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	

LINE-OF-SIGHT (VISUAL OBSTRUCTION) MEASUREMENTS

Pole Segm. (m):	*0.5*	**Pole Band Width (cm):**	*10*	**Position Intervals (m):**	
Coordinates (first position only):					

band is obstructed if ≥25% visually covered by vegetation (alive or dead) = "1"; if band <25% covered = "0"

Segm.	**Band #**	**Position:**		**Position:**		**Position:**		**Position:**		**Position:**				
		Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	*Visual Obstruction = 100% x Segm. Total / # of Obs.*		
1 *(bott.)*	**1**													
	2													
	3													
	4											Segm. Total	# of Obs.	Vis. Obstr.
	5													
Total # Bands														
2	**6**											*Segm. Total = Sum of "1"s observed for segment*		
	7													
	8													
	9											Segm. Total	# of Obs.	Vis. Obstr.
	10													
Total # Bands														
3	**11**											*# of Obs. = 5 bands x (# Positions x 2)*		
	12													
	13													
	14											Segm. Total	# of Obs.	Vis. Obstr.
	15													
Total # Bands														
4 *(top)*	**16**													
	17													
	18													
	19											Segm. Total	# of Obs.	Vis. Obstr.
	20													
Total # Bands														

Notes:

APPENDIX C

LIST OF CHARACTERISTIC SPECIES

LIST OF CHARACTERISTIC SPECIES

Table C-1. List of characteristic lowland species found on one or more pipeline ROW based on species assemblages in the Alberta Wetland Classification System

Species Name	Common Name
Andromeda polifolia	bog rosemary
Aulacomnium palustre	tufted moss
Betula glandulosa	bog birch
Betula pumila	dwarf birch
Calla palustris	water arum
Calliergon richardsonii	calliergon moss
Calliergon stramineum	calliergon moss
Campylium stellatum	yellow starry fen moss
Carex aquatilis	water sedge
Carex brunnescens	brownish sedge
Carex canescens	hoary sedge
Carex disperma	two-seeded sedge
Carex gynocrates	northern bog sedge
Carex magellanica	bog sedge
Carex tenuiflora	thin flowered sedge
Carex trisperma	three-seeded sedge
Carex utriculata	small bottle sedge
Chamaedaphne calyculata	leatherleaf
Cladonia mitis	reindeer lichen
Cladonia stellaris	star-tipped reindeer lichen
Comarum palustre	marsh cinquefoil
Dicranum undulatum	wavy dicranum moss
Drosera rotundifolia	round-leaved sundew
Eriophorum vaginatum	sheathed cotton grass
Hamatocaulis vernicosus	brown moss
Hylocomium splendens	stair-step moss
Kalmia polifolia	northern laurel
Larix laricina	tamarack
Maianthemum trifolium	three-leaved Solomon's-seal
Meesia triquetra	moss
Menyanthes trifoliata	buck-bean
Peltigera aphthosa	studded leather lichen
Peltigera malacea	veinless pelt lichen
Peltigera neopolydactyla	carpet pelt lichen
Picea mariana	black spruce
Platanthera dilatata	tall white bog orchid
Polytrichum strictum	slender hair-cap moss
Rhododendron groenlandicum	common Labrador tea

Rubus chamaemorus	Cloudberry
Salix discolor	pussy willow
Salix myrtillifolia	myrtle-leaved willow
Salix pedicellaris	bog willow
Salix planifolia	flat-leaved willow
Salix scouleriana	Scouler's willow
Sanionia uncinata	brown moss
Scorpidium scorpioides	Moss
Sphagnum angustifolium	peat moss
Sphagnum fallax	peat moss
Sphagnum fuscum	rusty peat moss
Sphagnum jensenii	pendant branch peat moss
Sphagnum magellanicum	midway peat moss
Sphagnum majus	peat moss
Sphagnum riparium	shore-growing peat moss
Sphagnum warnstorfii	peat moss
Tomentypnum nitens	golden moss
Triglochin maritima	seaside arrow-grass
Vaccinium oxycoccos	small bog cranberry
Vaccinium vitis-idaea	bog cranberry

Table C-2. List of characteristic shrub/graminoid species found on one or more pipeline ROW based on species assemblages in the Alberta Wetland Classification System

Species Name	Common Name
Agrostis scabra	rough hair grass
Alnus incana	river alder
Andromeda polifolia	bog rosemary
Aulacomnium palustre	tufted moss
Beckmannia syzigachne	slough grass
Betula glandulosa	bog birch
Betula pumila	dwarf birch
Calamagrostis canadensis	bluejoint
Calla palustris	water arum
Caltha palustris	marsh-marigold
Carex aquatilis	water sedge
Carex bebbii	Bebb's sedge
Carex diandra	two-stamened sedge
Carex media	Intermediate sedge
Carex utriculata	small bottle sedge
Chamaedaphne calyculata	leatherleaf
Cladonia mitis	reindeer lichen
Cladonia stellaris	star-tipped reindeer lichen

Comarum palustre	marsh cinquefoil
Cornus canadensis	Bunchberry
Dicranum undulatum	wavy dicranum moss
Drosera rotundifolia	round-leaved sundew
Eleocharis palustris	creeping spike-rush
Epilobium palustre	marsh willowherb
Equisetum fluviatile	swamp horsetail
Equisetum hyemale	common scouring-rush
Eriophorum vaginatum	sheathed cotton grass
Galeopsis tetrahit	hemp-nettle
Galium trifidum	small bedstraw
Geum macrophyllum	large-leaved yellow avens
Glyceria borealis	northern manna grass
Glyceria grandis	common tall manna grass
Glyceria striata	fowl manna grass
Hylocomium splendens	stair-step moss
Kalmia polifolia	northern laurel
Larix laricina	tamarack
Maianthemum trifolium	three-leaved Solomon's-seal
Menyanthes trifoliata	buck-bean
Peltigera aphthosa	studded leather lichen
Peltigera malacea	veinless pelt lichen
Peltigera neopolydactyla	carpet pelt lichen
Petasites frigidus	coltsfoot
Phalaris arundinacea	reed canary grass
Picea mariana	black spruce
Platanthera dilatata	tall white bog orchid
Pleurozium schreberi	Schreber's moss
Polytrichum strictum	slender hair-cap moss
Populus balsamifera	balsam poplar
Ranunculus gmelinii	yellow water crowfoot
Rhododendron groenlandicum	common Labrador tea
Ribes glandulosum	skunk currant
Ribes triste	wild red currant
Rubus chamaemorus	cloudberry
Rubus pubescens	dewberry
Salix arbusculoides	shrubby willow
Salix bebbiana	beaked willow
Salix discolor	pussy willow
Salix exigua	narrow-leaved willow
Salix glauca	smooth willow
Salix lasiandra	shining willow

Salix maccalliana	velvet-fruited willow
Salix pedicellaris	bog willow
Salix planifolia	flat-leaved willow
Salix scouleriana	Scouler's willow
Salix serissima	autumn willow
Schoenoplectus tabernaemontani	common great bulrush
Scripus atrocinctus	black-girdled bulrush
Scirpus microcarpus	small-fruited bulrush
Scutellaria galericulata	marsh skullcap
Sphagnum angustifolium	peat moss
Sphagnum fallax	peat moss
Sphagnum fuscum	rusty peat moss
Sphagnum jensenii	pendant branch peat moss
Sphagnum magellanicum	midway peat moss
Sphagnum majus	peat moss
Sphagnum riparium	shore-growing peat moss
Stellaria longifolia	long-leaved chickweed
Symphyotrichum boreale	marsh aster
Tomentypnum nitens	golden moss
Trientalis borealis	Northern starflower
Triglochin maritima	seaside arrow-grass
Vaccinium oxycoccos	small bog cranberry
Vaccinium vitis-idaea	bog cranberry
Viola renifolia	Kidney-leaved violet

APPENDIX D

CAMERA MONITORING PROTOCOL

Remote Camera Monitoring Protocol

Developed for the Caribou Habitat Restoration and Offset Measures Monitoring Program

July 2018

Table of Contents

Revisions Log

Date	Section	Description
July 3, 2018	Camera Deployment	Addition of “one desiccant packet for each camera case”
July 3, 2018	Camera Deployment	Addition of pliers or vice grips, and gloves to equipment requirements
July 3, 2018	Camera Deployment	Addition of “one desiccant packet for each camera case”
July 3, 2018	Camera Deployment	Updated wording from “NGTL has solar panel units available for use. The use of these units should be prioritized for sites where access is challenging or remote.” To NGTL has solar panel units available for use. The use of these units may be considered for sites where access is challenging or remote.” Rationale is that due to bear attraction to solar units and associated wiring, NGTL is generally avoiding use of solar panels.
July 3, 2018	Appendix A – Camera Deployment	Addition of “Insert a desiccant packet into the camera box.”
July 3, 2018	Appendix A – Camera Deployment	Addition of “Use pliers or vice grips as necessary to securely fasten the cable.”
July 3, 2018	Appendix A – Remote Camera Settings	Revise from “rapid fire” photo interval to “set for 1 minute photo interval” based on 2016 year 1 lessons learned

Introduction

This protocol is intended to be applied to specific NGTL pipeline projects occurring within caribou ranges while still providing a consistent monitoring approach across NGTL projects. The monitoring protocol is intended to be comparable to other programs where monitoring movement around access control measures is of primary concern. This document presents the protocol for the design and implementation of camera monitoring programs to record baseline and post-construction access levels along a project's pipeline right-of-way (ROW) at access control locations. The monitoring protocol will focus on the effectiveness of access control measures in preventing or deterring human access along the ROW. Wildlife response to access control will also be documented and form a separate analysis focused on wildlife occurrence.

Background

As part of National Energy Board (NEB) authorizations for construction and operations of pipeline projects in woodland caribou range on NGTL projects, the NEB requires a Caribou Habitat Restoration and Offset Measures Management Program (CHROMMP) be prepared pursuant to the conditions of the authorizations. Each CHROMMP is to outline the plan to verify the effectiveness of mitigation measures outlined in Caribou Habitat Restoration Plans (CHRPs) and Offset Measures Plans (OMPs) to avoid impacts, minimize Project effects on caribou, restore caribou habitat, and offset residual impacts. NGTL's approved CHROMMP establishes the founding principles which will guide future monitoring programs for projects requiring caribou habitat restoration or offset measures.

Objective

The primary objective of the camera monitoring protocol is to assess the effectiveness of access control measures by observing:

- baseline human and wildlife access conditions (pre-construction where possible);
- post-construction human access conditions; and
- wildlife occurrence to access control measures.

Study Timeframe

Baseline

Baseline access monitoring should be carried out over a one year period prior to construction when possible. This approach ensures seasonal variation in human and wildlife use is captured. For example human access may peak in the fall, coinciding with the hunting season or in winter when wet areas become accessible under frozen conditions. Baseline access monitoring can be carried out in conjunction with the characterization of baseline wildlife studies in support of the Environmental and Socio-Economic Assessment (ESA).

Should the project alignment change during the baseline monitoring period, the remote camera program should be adjusted accordingly, and as soon as possible. This will ensure cameras are deployed at monitoring sites on the proposed project ROW for as long as possible. Deploying cameras following project kick-off will increase the probability that they will successfully document a full year of baseline access prior to construction. If a full year of data has not been collected at the time of ESA preparation, cameras should remain deployed during the project's application and approval phase to try and achieve a minimum monitoring period of 12 months.

Post-Construction Monitoring

Post-construction short-term monitoring will be conducted at years 1, 3, and 5 to identify any need for adjustments as part of NGTL's adaptive management approach (NGTL 2015a). Long-term monitoring will be conducted at years 10 and 15 to evaluate performance and implement adaptive management actions if required (NGTL 2015a). After 10 to 15 years, planted seedling and naturally regenerating areas are anticipated to have grown to heights where they provide an additional level of access control. Although there are currently no mid-term objectives outlined for the monitoring program, this may change as the program matures. Access control effectiveness monitoring periods will be implemented for 12 months during each monitoring year.

Study Design

Baseline

Baseline surveys will document human access before project construction on a project's pipeline ROW. Remote camera monitoring sites (i.e., monitoring sites) will be placed at proposed access control locations to better represent baseline human access conditions prior to the project being constructed. Proposed access control locations may include areas of new alignment or where the proposed ROW intersects other linear features.

At the baseline study design phase, detailed construction alignment sheets outlining the exact placement of proposed access control measures may not be available to support planning. The site selection approach outlined below is consistent with design elements of access control implementation thereby increasing the likelihood of spatial overlap between baseline monitoring sites and future access control locations.

Baseline monitoring sites will be established along the proposed project ROW where access control measures can be implemented (i.e., areas of new alignment or where there are existing linear crossings). These baseline locations will act as controls and provide pre-construction data on human access and wildlife occurrence along the proposed ROW.

Monitoring is used to determine the effectiveness of access control measures implemented on the project ROW through the course of the monitoring timeframe. It is assumed human access along a proposed project ROW is at its lowest possible level prior to the project being constructed, as clearing of timber and vegetation has not occurred. Where baseline data cannot be collected (i.e., the project ROW was constructed without the opportunity to establish camera monitoring sites), the effectiveness of access control measures may compare future human access to observations and data collected during the first monitoring year.

Site Selection

Site selection for the baseline monitoring sites should be conducted using a Geographic Information System (GIS). Site selection should also consider:

- the proposed project route alignment;
- 360 degree imagery (if available);
- existing anthropogenic linear features which intersect the proposed project ROW alignment;
- the presence of trees of adequate size to facilitate camera mounting, or
- where appropriately sized trees are not available, posts or poles may be needed to mount the remote cameras.

Using GIS, the proposed project route will be overlaid onto recent geo-referenced satellite imagery where existing linear disturbances (i.e., roads, pipelines, transmission lines) can be identified.

Site selection for access control sites should meet the following criteria:

- within a designated caribou range boundary
- located on a section of new alignment created by the proposed or constructed project ROW
- near an active intersection with the proposed or constructed project ROW and another linear feature (i.e., roads, pipelines, transmission lines)
- within a treed area

Once the proposed sites are selected, the locations are used by field personnel to guide the deployment of cameras in the field. However, there needs to be flexibility to allow for optimum camera placement. Field personnel should select a suitable site within 50 m of the proposed site location when possible. A schematic showing a theoretical site selection is illustrated in Figure 1, where A and B are camera plot locations.

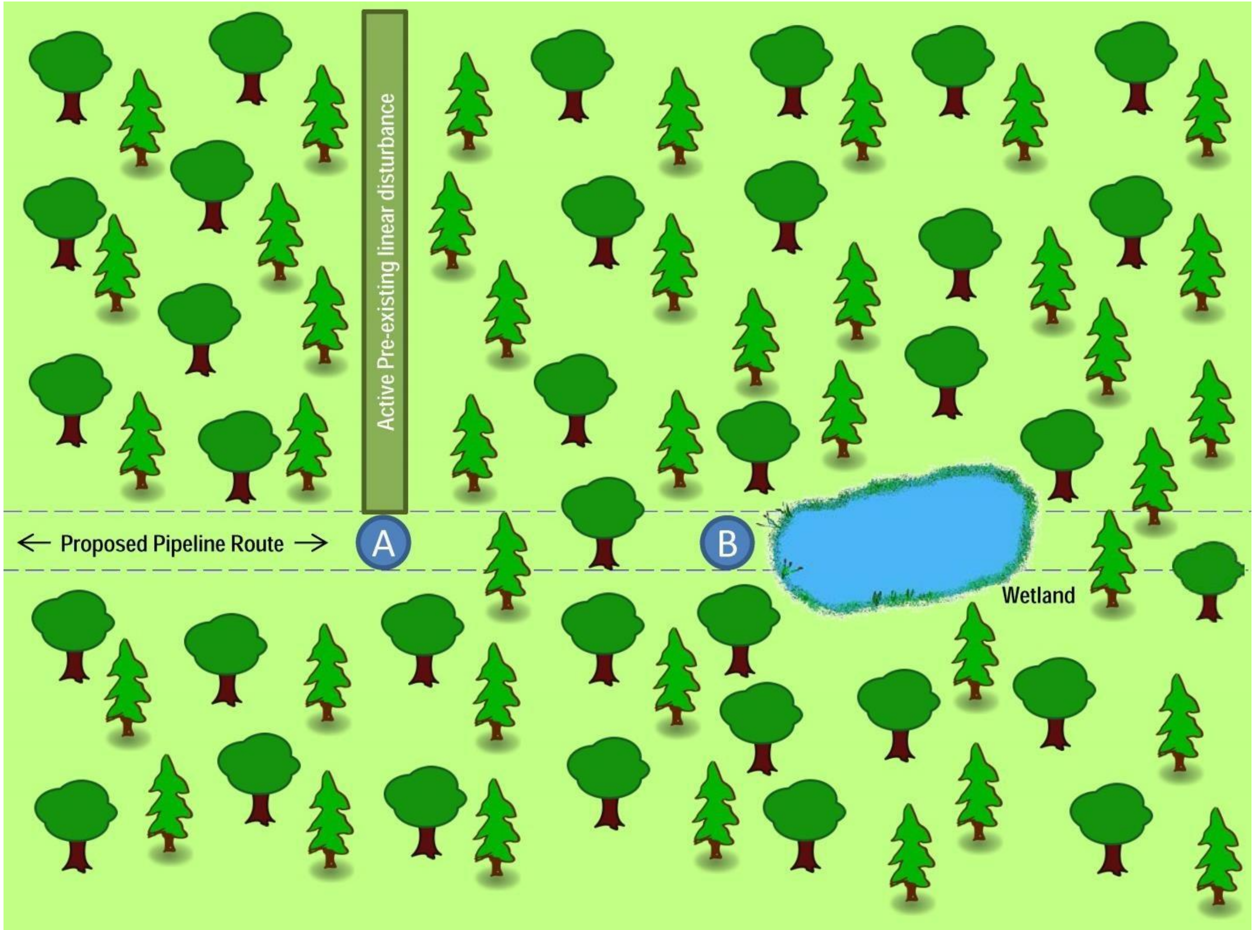


Figure 1: Example Site Diagram Showing Camera Plot Site Selection for Baseline Monitoring

Post Construction Monitoring

The study design implemented during post-construction monitoring will mainly be the same design used to conduct baseline monitoring described above. Additional considerations are as follows:

- remote camera monitoring sites will be located at actual access control mitigation locations (i.e., place cameras on the ROW where access control measures have been implemented);
- target treed areas where possible to ensure cameras can be successfully deployed; or
- posts or poles may be needed to mount cameras and/or solar panels in areas without appropriated sized trees.

Figure 2 shows examples of camera site locations on constructed segments of ROW, identified as A and B. The site selection of plot A is located where an access control measure is implemented. Site selection of plot B outside of the wetland is favored over the site selection of plot B within the wetland due to better accessibility and functionality.

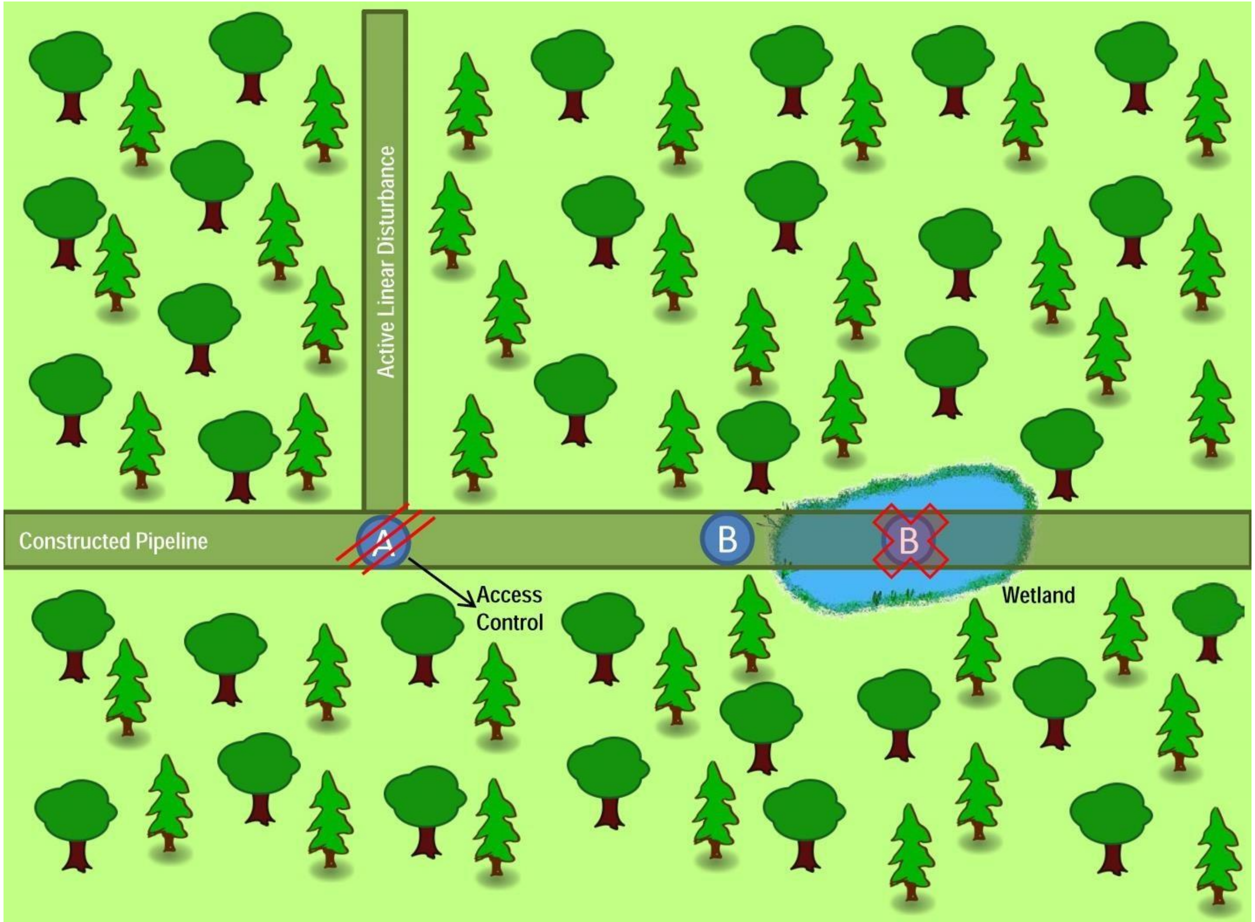


Figure 2: Example Site Diagram Showing Camera Plot Site Selection for Post-construction Monitoring

Statistical Considerations

The focus of the study is to test the effectiveness of access control measures in reducing or eliminating human access along the project ROW. Therefore, the total number of camera monitoring locations is equal to the total number of access control measures implemented along a project ROW, which will vary for different projects. The unit of measurement used to detect a change in human access at an access control location will be calculated as a daily human access rate (i.e., within a 24 hour period). Wildlife response to access control will also be collected and calculated as a daily access rate. The wildlife occurrence will form a separate analysis from the change in human access rate.

Assuming that each access control location will be monitored for approximately 365 days each monitoring year, for 5 monitoring years across the study timeframe, there will be adequate replication for statistical analysis (i.e., a total of 1,825 monitoring days per camera/access control location across the study timeframe). This will ensure statistical robustness of inferences used to assess both daily human access rates and wildlife occurrences between each monitoring year, including pre-construction baseline conditions if available. Upon completion of the 2nd monitoring year, inferences regarding seasonal differences in daily human access rate between monitoring years may also be incorporated into hypothesis tests.

Pre-Field Planning and Preparations

NGTL owns a number of PC900 HyperFire Professional Covert IR with HyperFire Security Enclosures. If additional cameras are required, similar cameras (i.e., PC Hyperfire covert or semi-covert series) may be purchased directly from Reconyx (www.reconyx.com). Cameras and memory cards should be programmed as per instructions included in Appendix A.

Camera Deployment

Cameras should be deployed as per instruction included in Appendix A. For each monitoring plot, the following equipment list will likely be required:

- one Reconyx camera;
- 12 AA lithium or rechargeable batteries and/or external power jack, cable and solar panel power unit;
- if using a solar panel, one wooden post, T-post or fence post for system mounting;
- two 32 GB (minimum size memory) memory cards (i.e., so camera cards can be swapped in the field). The larger sized memory card provides more storage space for cameras fitted with solar panel units;
- one desiccant packet for each camera case;
- locking mechanism (see Reconyx Hyperfire Instruction Manual for option details; http://images.reconyx.com/file/HyperFireManual.pdf):
- Hyperfire security enclosure and padlock;
- Heavy Duty Swivel Mount;
- Pliers or vice grips for pulling locking cable tight;
- Gloves for hand protection when tightening cables;
- Python lock and key; or
- wire cable (small loop on both ends) and small padlock (with key, if applicable).

NGTL has solar panel units available for use. The use of these units may be considered for sites where access is challenging or remote. The solar panels will reduce the need to access the cameras for battery changes. Instructions for setting up the panels are available online from Reconyx at http://images.reconyx.com/file/SolarPanelPowerUnit.pdf and in Appendix A. Data recorded at each plot during deployment is also included in Appendix A. Data should be QA/QC'd daily to ensure all field data is collected.

Camera Checks and Maintenance

With the exception of cameras fitted with solar panels, cameras should be revisited every 4-6 months to change memory cards and check batteries. Battery life is shorter during the winter months, so a 6 month maximum interval is recommended. Cameras fitted with solar panels should be visited a maximum of twice per year. In warmer weather, batteries should last at least 6 months, but this can vary depending on the number of photos taken, hence larger sized memory cards are to be used. Memory cards can fill quickly if moving vegetation triggers the cameras. This typically occurs in spring or summer when tall grass or shrubs grow quickly in front of a camera. Similarly, if a camera is deployed on a small tree (<25 cm), the camera will be triggered under windy conditions when the tree sways. Regular maintenance checks can ensure ongoing camera function and prevent gaps in monitoring data due to dead batteries or full memory cards.

Further instructions for camera checks and associated data collection are included in Appendix A.

References

NGTL (Nova Gas Transmission Limited). 2015a. Nova Gas Transmission Ltd. Caribou Habitat Restoration and Offset Measures Monitoring Program. Leismer to Kettle Rover Project, Northwest Mainline Expansion Project, Chinchaga Lateral Loop No. 3. Prepared by Northern Resource Analysts Ltd. Submitted to the National Energy Board.

NGTL. 2015b. Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station – Preliminary Caribou Habitat Restoration Plan. Submitted to the National Energy Board.

Appendix A

Remote Camera Settings

Before deployment, each camera's memory cards should be preset to desired settings using the Reconyx software provided with camera. The Reconyx Hyperfire Instruction Manual is available online at http://images.reconyx.com/file/HyperFireManual.pdf and can help the user get more familiar with the camera unit and software. Prior to programming the memory card, ensure the card is labelled to match the corresponding camera number. Preferred settings for PC Hyperfire series cameras are as follow:

1) Under the "Triggers" tab (Figure A-1);

- under 'Quickset' – select 'Advanced';
- when triggered, take 5 pictures;
- set for 1 minute photo interval;
- quiet period – ensure this is 0; and
- options – select 'Use the internal motion trigger'.

2) Under the "Images" tab (Figure A-1);

- ensure image setting sliders (brightness, contrast, sharpness, and saturation) are similar to the ones displayed in the screen capture (Figure 1-A);
- For Camera naming under 'Options' – Label each camera – [Project Name-Measure (M) or Control (C) Site – XXX] (ex. For Chinchaga, on an access control site and the first camera, use: CHI-M-001)
- under 'Temperature', select 'Celsius';
- under 'Time', select '24 hr';
- set 'Night Shutter Speed' in the middle;
- set 'Night ISO Sensitivity' in the middle; and
- set 'Resolution' to 'High'.

3) Set date and time on memory cards with the software and immediately insert the card into the corresponding camera.

4) Turn camera on for settings to become active. Settings will now remain active unless the memory card is formatted.

5) Battery life will read 0% until battery type is specified. Use the arrow key to cycle through to "Battery Type". Press OK. Select battery type (Lithium if applicable) and press OK. Press ok again to finish setting battery type.

6) Take a few pictures to ensure camera is functioning properly and delete prior to taking camera to the field.

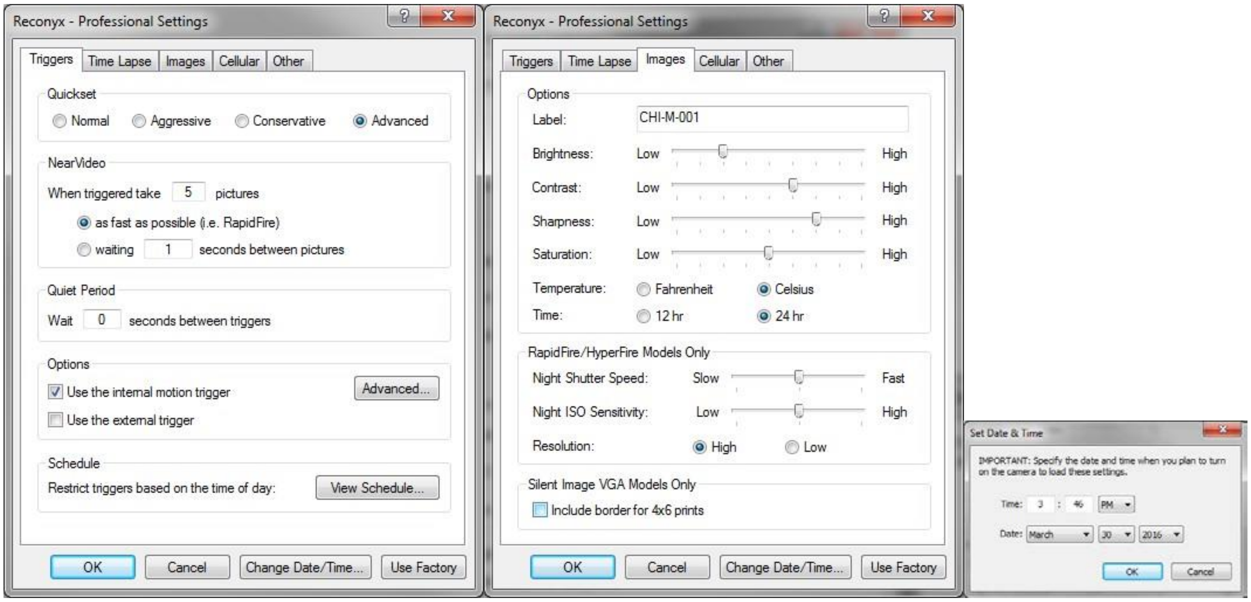


Figure A-1: Reconyx HyperFire Series Memory Card Camera Settings.

Camera Deployment and Retrieval

For each camera, a bungee cord, python lock, or security enclosure bolts will be required to secure the camera.

Deployment

- Insert a desiccant packet into the camera box.
- Place camera about 1 m above the ground.
- Angle camera to capture the point of interest (i.e., access control treatment location along a linear corridor ROW; Figure A-2).
- Camera should be a maximum of 20 to 25 m from the point of interest (Figure A-2) because the detection radius on Reconyx cameras is approximately 30 m.
- If possible, always orient the camera to face north.
- If the camera is placed in area of upward sloping ground, the camera may need to be higher and angled slightly upwards.
- If the camera is placed in an area of downward sloping ground, the camera may need to be lower and angled slightly downwards.
- Ensure there is no debris obscuring the view of the camera by removing any overhanging branches, shrubs or grass to avoid camera triggers from moving vegetation.
- Conduct a walk test.
- Reconyx PC Hyperfire cameras provide activation instruction on the screen once the camera is turned on. Conduct a walk test to confirm that the camera is functioning properly and to verify that the trigger zone covers your area of interest. A walk test is performed by following the steps below:
    1. select the setting ‘Walk Test’,

2. close the camera panel, and

3. walk in front of the camera in your area of interest (along the length of the treatment, i.e. access control).

o The camera will flash red if it is being triggered, but no photos will be recorded. Adjust the camera position as required.

- When ready, turn on the camera and Select ‘Arm Camera’.
- Loop the cable lock around the tree or post and lock the camera. Use pliers or vice grips as necessary to securely fasten the cable.

Refer to the Reconyx Hyperfire Instruction Manual to see mounting options available http://images.reconyx.com/file/HyperFireManual.pdf .

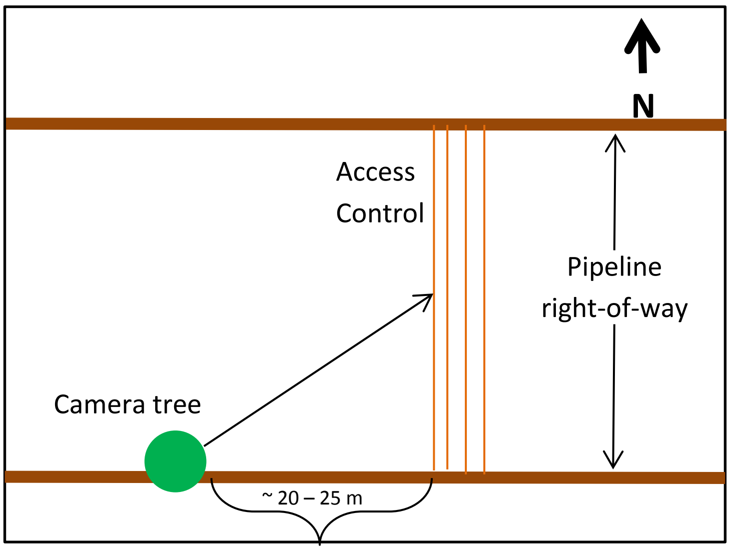


Figure A-1: Schematic of Camera Deployment on Pipeline Right-of-way

If the camera to be deployed is equipped with a solar panel, the following steps should be followed (see Photo 1 for example):

- Attach the solar panel to the mounting bracket using hardware provided.
- Mount the solar panel bracket and battery box on a wooden post, T-post or fence post (note: you will have to pre-drill holes to mount the battery box if using a T-post).
- The solar panel should face south.
- Ensure the connectors on the battery box face down.
- Connect the solar panel wire to the battery box.
- Place lithium or rechargeable batteries in the camera (these will act as a back-up power supply and the camera will automatically use the best power source).
- Plug the camera into the battery box using the power cable. If using a security enclosure, you will need to turn the power switch on before placing the camera in the enclosure. The power cable should be connected to the camera after the camera is installed in the security enclosure

Photo 1: Example Camera and Solar Power Panel Pack Mounted on a T-post (© Reconyx)

Camera Retrieval

When retrieving a camera, always walk in front of it to take a photo. This “take down photo” is used to determine if the camera was functional for the duration of its deployment. It also allows the date and time stamp to be cross-referenced with the datasheet to ensure they are correct. When retrieving a camera complete the following:

- Unlock and open the camera panel.
- Record the following on the datasheet:
    - camera battery level; o

      card capacity; and
    - “take down” date and time.
- If the camera is to remain deployed at its monitoring site, ensure batteries are replaced if below 50%, swap out the memory card for a new one, and repeat the camera deployment instructions (above).

Recording Data

The following information should be recorded at each plot during camera deployment and retrieval.

Camera Deployment

- plot name;
- SD memory card name or number;
- plot photos;
- date and time;
- names of observer(s);
- UTM location;
- ecosite or wetlands type;
- description of plot location (e.g., pipeline right-of-way, seismic line);
- description of access control treatment type, if applicable (e.g., coarse woody debris, roll back, mounding)
- linear feature width (estimate);
- binary variable indicating evidence of human access (yes/no);
- human access type (all-terrain vehicle, truck, equipment);
- binary variable indicating evidence of wildlife access (yes/no);
- classification of human access level (Low: track/trail evident but difficult to discern or appears to be infrequently used; or High: tracks/trail well used, vegetation trampled, bare ground may be visible [NGTL 2015]); and
- classification of wildlife access level (low/high, as defined above).

Camera Retrieval

- plot name;
- date and time;
- name of observer(s);
- percent (%) battery remaining (will display on camera screen once panel is opened);
- percent (%) memory used (will display on camera screen once panel is opened);
- number of pictures taken (will display on camera screen once panel is opened);
- SD memory card name or number for card being removed (this is important if camera is not being taken down); and
- SD memory card name or number for card being inserted (i.e., if camera is not taken down).

APPENDIX E

REMOTE CAMERA MONITORING SUMMARY DATA

Table E-5. Camera locations and deployment periods

Camera Identifier	UTM (NAD 83)	Project (Pipeline)	Deployment/Start Date (DD/MM/YEAR)	Retrieval/End Date (DD/MM/YEAR)
THOR-01	422657E 6204351N 12N	Thornbury	19/08/2018	08/08/2019
THOR-02	436824E 6203891N 12N	Thornbury	18/08/2018	07/08/2019
THOR-03	414668E 6208687N 12N	Thornbury	21/08/2018	07/08/2019
THOR-04	417693R 6206039N 12N	Thornbury	20/08/2018	07/08/2019
THOR-05	420105E 6204697N 12N	Thornbury	19/08/2018	07/08/2019
THOR-06	418451E 6205631N 12N	Thornbury	20/08/2018	07/08/2019
THOR-07	414640E 6205631N 12N	Thornbury	21/08/2018	07/08/2019
DILL-01	539268E 6164975N 12N	Dillon	25/08/2018	24/08/2019
DILL-02	538999E 6163511N 12N	Dillon	25/08/2018	24/08/2019
DILL-03	538356E 6161611N 12N	Dillon	25/08/2018	24/08/2019
DILL-04	546824E 6176331N 12N	Dillon	23/08/2018	24/08/2019
DILL-05	547639E 6169760N 12N	Dillon	23/08/2018	24/08/2019
DILL-06	539589E 6137247N 12N	Dillon	29/08/2018	24/08/2019
DILL-07	540362E 6137271N 12N	Dillon	29/08/2018	24/08/2019
DILL-08	538645E 6137263N 12N	Dillon	29/08/2018	24/08/2019
DILL-09	539286E 6140285N 12N	Dillon	27/08/2018	24/08/2019
DILL-10	545460E 6166307N 12N	Dillon	30/08/2018	24/08/2019

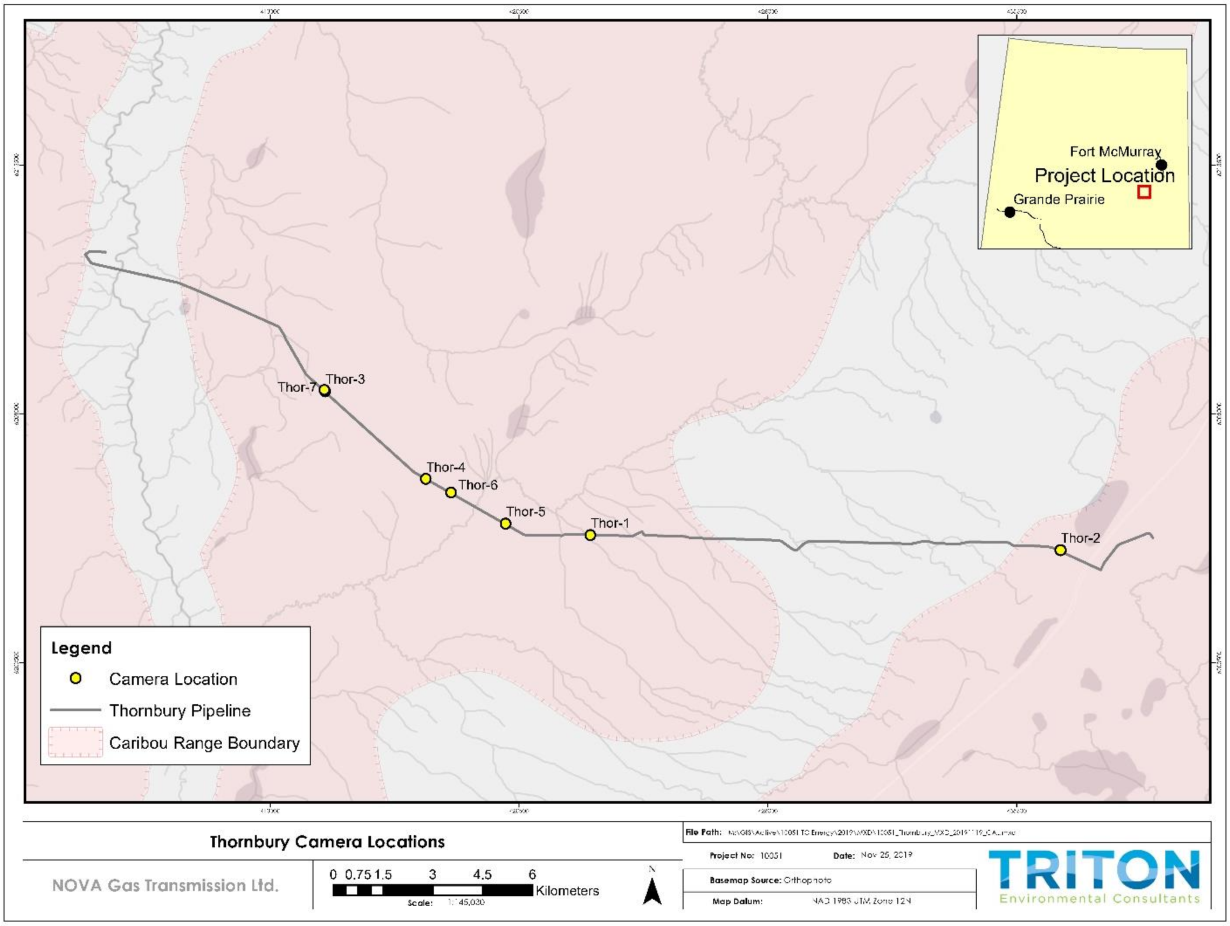


Figure E-14. Distribution of remote cameras deployed along the Thornbury ROW from August 18, 2018 to August 8, 2019.

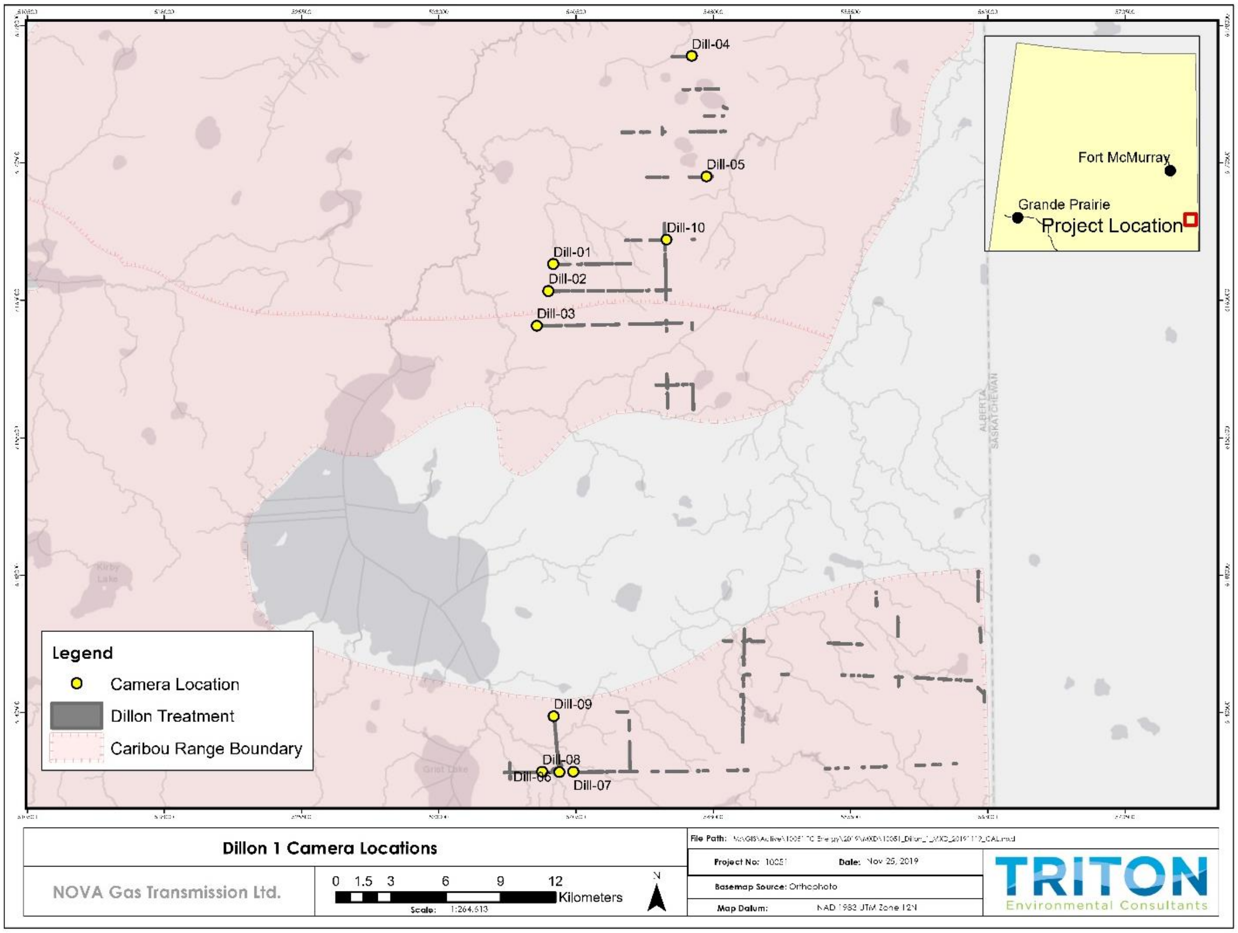


Figure E-15. Distribution of remote cameras deployed within the Dillon River Wildlands offsets from August 25, 2018 to August 24, 2019.

Table E-6. Summary of human activity observed at access controls during each camera monitoring period.

Camera Identifier	*Total # Days Online*	*Worker Foot Access (#, avg/day)*	*Recreational Foot Access (#, avg/day)*	*Worker OHV Access (#, avg/day)*	*Recreational OHV Access (#, avg/day)*	*Total Foot Access (#, avg/day)*	*Total OHV Access (#, avg/day)*
Thornbury							
THOR-01	354	12	0	0	0	**0**	**0**
		0.034	0	0	0	**0**	**0**
THOR-02	63	5	0	0	0	**0**	**0**
		0.079	0	0	0	**0**	**0**
THOR-03	351	12	0	0	2	**0**	**2**
		0.034	0	0	0.006	**0**	**0.006**
THOR-04	352	4	0	0	0	**0**	**0**
		0.011	0	0	0	**0**	**0**
THOR-05	338	14	0	0	0	**0**	**0**
		0.041	0	0	0	**0**	**0**
THOR-06	352	10	0	0	31	**0**	**31**
		0.028	0	0	0.088	**0**	**0.088**
THOR-07	351	7	0	0	6	**0**	**6**
		0.020	0	0	0.017	**0**	**0.017**
Dillon Offsets							
DILL-01	364	5	0	0	0	**0**	**0**
		0.014	0	0	0	**0**	**0**
DILL-02	299	4	0	0	0	**0**	**0**
		0.013	0	0	0	**0**	**0**
DILL-03	328	2	0	0	0	**0**	**0**
		0.006	0	0	0	**0**	**0**
DILL-04	366	6	0	0	0	**0**	**0**
		0.016	0	0	0	**0**	**0**
DILL-05	307	6	0	0	0	**0**	**0**
		0.020	0	0	0	**0**	**0**
DILL-06	360	17	0	0	0	**0**	**0**

Camera Identifier	*Total # Days Online*	*Worker Foot Access (#, avg/day)*	*Recreational Foot Access (#, avg/day)*	*Worker OHV Access (#, avg/day)*	*Recreational OHV Access (#, avg/day)*	*Total Foot Access (#, avg/day)*	*Total OHV Access (#, avg/day)*
		0.047	0	0	0	**0**	**0**
DILL-07	360	9	0	0	0	**0**	**0**
		0.025	0	0	0	**0**	**0**
DILL-08	360	7	0	0	0	**0**	**0**
		0.019	0	0	0	**0**	**0**
DILL-09	362	5	0	0	0	**0**	**0**
		0.014	0	0	0	**0**	**0**
DILL-10	263	4	0	0	0	**0**	**0**
		0.015	0	0	0	**0**	**0**

Note: Total number of days online indicates the number of days a camera was functioning during the monitoring period. The total number (#) of observations and the average number of observations over the functional camera days (avg/day) are reported for each human variable.