Shekilie Pipelines Abandonment Project

Caribou Habitat Restoration Plan

~~Final~~

Rev 1

October ~~2021~~2022

Westcoast Energy Inc.

Shekilie Pipelines Abandonment Project

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Acronyms and Abbreviations

AEP	Alberta Environment and Parks
~~ATV~~	~~all-terrain vehicle~~
BC	British Columbia
CER	Canada Energy Regulator
CHRP	Caribou Habitat Restoration Plan
~~cm~~	~~centimetre(s)~~
CWS	Canadian Wildlife Service
DTFN	Dene Tha' First Nation
ECCC	Environment and Climate Change Canada
~~FMA~~	~~Forest Management Agreement~~
FNFN	Fort Nelson First Nation
GoA	Government of Alberta
ha	hectare(s)
KLRA	Kotcho Lake Restoration Area
km	kilometre(s)
KP	Kilometre Post
m	metre(s)
m^2	square metre(s)
~~m^3~~	~~cubic metre(s)~~
~~m^3/ha~~	~~cubic metre(s) per hectare~~
MRA	Medzih'tene Restoration Area
NPS	Nominal Pipe Size
PCEM	post-construction environmental monitoring
Project	Shekilie Pipelines Abandonment Project
Westcoast	Westcoast Energy Inc.

1. Introduction

Westcoast Energy Inc. (Westcoast) has received approval (Order ZO-003-2021) from the Canada Energy Regulator (CER) under Section 241 of the *Canadian Energy Regulator Act* for the Shekilie Pipelines Abandonment Project (the Project). The "Shekilie Pipelines" comprise three small diameter natural gas pipelines. These pipelines are regulated by the CER and include the North Shekilie Pipeline (Nominal Pipe Size [NPS] 10), the South Shekilie Pipeline (NPS 10), and the South Shekilie Extension Pipeline (NPS 4) near the northern extremity of the Alberta/British Columbia (BC) provincial border.

The South Shekilie Extension Pipeline and a portion of the South Shekilie Pipeline were deactivated in 2007. The North Shekilie Pipeline and the remainder of the South Shekilie Pipeline were deactivated in 2011. Westcoast ~~is planning to take~~ completed abandonment of the Shekilie Pipelines in winter 2021/2022, and they are now permanently out of service~~ by moving on to the~~. This involved abandonment ~~phase. Specifically,~~in-place of approximately 60.4 kilometres (km) of the Shekilie Pipelines ~~will be abandoned in-place~~. The three carbon steel pipelines have been purged, cleaned of residual product, internally coated with corrosion inhibitor, and physically isolated from sources of upstream pressure.

~~The buried pipelines will be abandoned in-place.~~ Physical abandonment activities (e.g., cutting, capping) ~~will be~~were confined to the existing rights-of-way and areas where aboveground infrastructure is located. Existing infrastructure (e.g., roads and pipeline rights~~-~~-of-way) ~~will be~~was used for access. No new permanent access or new construction camps ~~are planned~~were used for the Project. Aboveground facilities associated with the Shekilie Pipelines and cathodic protection facilities ~~will be removed. Physical abandonment activities are planned to commence in December 2021 under frozen conditions.~~were removed.

Condition 3 of Order ZO-003-2021 requires Westcoast to file a Caribou Habitat Restoration Plan (CHRP) at least 60 days prior to commencing the abandonment activities. ~~This CHRP outlines the restoration measures that Westcoast will implement on the Project footprint located within the Bistcho caribou range. The CHRP was~~Westcoast filed a CHRP in accordance with this condition on October 4, 2021, and the CHRP was approved by the CER on November 23, 2021. During abandonment activities in winter 2021/2022, the very wet conditions created challenges for sufficiently freezing in access that would support the heavy equipment needed for the abandonment work. A very thick and heavily packed snow/ice road was required, which inhibited completion of habitat restoration site preparation (mounding and ripping) as originally planned. Westcoast engaged Fort Nelson First Nation (FNFN) and Jacobs to prepare a revised CHRP using alternate caribou habitat restoration methods that will employ smaller, lighter equipment, which will not require the same degree of winter access as needed for the physical abandonment activities. The restoration strategies in this revised CHRP leverage the experience and expertise of FNFN's recent caribou habitat restoration efforts in the Snake-Sahtenah boreal caribou range in northeastern BC, referred to as the Kotcho Lake Restoration Area (KLRA) and the Medzih'tene Restoration Area (MRA). This revised CHRP was also guided by provincial and federal regulations, policies, and best practices pertaining to caribou management, is consistent with the mitigation hierarchy (Environment Canada 2012; BC MOE 2014), considers objectives of the Recovery Strategy for the Woodland Caribou, Boreal population (*Rangifer tarandus* caribou) in Canada (Recovery Strategy) (ECCC 2020), and addresses issues or concerns raised through consultation with applicable regulatory authorities.

1.1 Project Interaction with Boreal Caribou

The Shekilie Pipelines are located in a remote area of northeast BC and northwest Alberta, approximately 170 km northeast of Fort Nelson, BC and approximately 85 km north/northwest of Rainbow Lake, Alberta.

Most of the segments of the Shekilie Pipelines within Alberta are within the Bistcho boreal caribou range (Figure 1-1). The portions of the North Shekilie and South Shekilie Pipelines in BC are located outside of identified boreal caribou ranges (BC CDC 2020~~).~~) but within caribou habitat.

Environment and Climate Change Canada (ECCC) reports the level of existing disturbance in the Bistcho caribou range at 75 percent, which exceeds the target level (35 percent) of disturbance at which boreal caribou are expected to be able to achieve self-sustaining status (ECCC 2020).

Existing disturbance in the range is attributed to fire (approximately 40 percent of the range) and human disturbance buffered by 500 metres (m) (approximately 58 percent of the range). Through habitat restoration following abandonment, the Project is expected to, in time, contribute to the area of undisturbed critical habitat within the Bistcho caribou range.

The extent of Project interaction with the Bistcho caribou range is summarized in Table 1-1 for each of the pipeline segments and their associated site features. Site features are the pipeline infrastructure components that ~~will require~~required physical works and habitat disturbance during abandonment activities.

The North Shekilie Pipeline right-of-way is within the Bistcho caribou range for approximately 15.2 km with three site features along this segment:

- NS-1: pig launch facility at Kilometre Post (KP) 0 where aboveground infrastructure ~~will be~~was removed and belowground pipe ~~will be~~was cut and capped
- NS-2: watershed boundary at KP 7.5 where the belowground pipe ~~will be~~was cut and capped
- NS-3: producer tie-in at KP 23.8 where aboveground infrastructure ~~will be~~was removed and belowground pipe ~~will be~~was cut and capped

The South Shekilie Pipeline right-of-way is within the Bistcho caribou range for approximately 12.5 km with two site facilities along this segment:

- SS-2: current pig launch facility at KP 9.3 where aboveground infrastructure ~~will be~~was removed and belowground pipe ~~will be~~was cut and capped
- SS-3: producer tap at KP 11.9 where aboveground infrastructure ~~will be~~was removed and belowground pipe ~~will be~~was cut and capped

The South Shekilie Extension Pipeline right-of-way is within the Bistcho caribou range for approximately 9.2 km with one site facility along this segment:

- SSE-1: extension pig launch facility at KP 0 where aboveground infrastructure ~~will be~~was removed and belowground pipe ~~will be~~was cut and capped

There ~~are~~were no new permanent access roads required for the Project. Access during physical abandonment activities ~~will be~~was via existing roads (e.g., high grade petroleum development roads, resource, and winter roads) as well as the existing North Shekilie Pipeline and South Shekilie Pipeline rights-of-way. Vegetation brushing ~~will be~~was required on the existing pipeline rights-of-way to facilitate an approximately 10 m wide access route for a length of approximately 22 km along the North Shekilie Pipeline, and for approximately 11.8 km along the South Shekilie Pipeline. Brushing ~~will be~~was avoided to the extent practical ~~where~~ by walking down and packing snow over low-regenerating vegetation~~ is young and can be walked down or packed in snow during freezing in of the temporary access.~~.

Figure 1-1. Project Overview

Caribou Plan

Table 1-1. Project Interaction with the Bistcho Caribou Range

Project Component	Abandonment Type/Activity	Length (km) in Caribou Range	Area (ha) in Caribou Range	Estimated Area of Project Disturbance (ha) During Abandonment in Caribou Range
North Shekilie Pipeline	In-place	15.~~2~~20	30.~~3~~33	15.~~9[a]~~92[a]
NS-1 Launcher	Removal of aboveground infrastructure Cut and cap belowground pipe	0.~~1~~09	1.~~5~~50	1.~~5~~50
NS-2 Watershed Boundary (cut and cap)	Cut and cap belowground pipe	0.~~1~~07	0.~~2~~16	0.~~2~~16
NS-3 Producer Tie-in	Removal of aboveground infrastructure Cut and cap belowground pipe	0.~~1~~05	0.~~1~~10	0.~~1~~10
South Shekilie Pipeline	In-place	12.~~5~~50	23.~~0~~05	6.~~3[a]~~32[a]
SS-2 Current Launcher	Removal of aboveground infrastructure Cut and cap belowground pipe	0.~~1~~07	1.~~2~~23	1.~~2~~23
SS-3 Producer Tap	Removal of aboveground infrastructure Cut and cap belowground pipe	0.~~1~~05	0.~~1~~10	0.~~1~~10
South Shekilie Extension Pipeline	In-place	9.~~2~~16	13.~~8~~76	0[a]
SSE-1	Removal of aboveground infrastructure Cut and cap belowground pipe	0	0.~~3~~30	0.~~3~~30
Total		**37.~~2[b]~~19**	**70.~~5~~53**	**25.~~6~~62**

~~Notes:~~

[a] Abandon in-place segments of the pipelines ~~will have~~had no disturbance except brushing of 10 m wide temporary access. Disturbance area of temporary access is calculated as a 10 m wide area over the length of temporary access. This metric ~~may be lower than the actual area brushed if~~is conservatively high because areas of taller vegetation ~~can be~~were avoided and areas of shorter vegetation ~~can be~~were walked down rather than brushed~~.~~, to the extent practical, during abandonment. No brushing for access ~~is~~was required for the South Shekilie Extension; therefore, there ~~is~~was no ~~expected~~ disturbance from abandonment activities on the right-of-way.

~~[b] The total area is summed based on areas to several decimal points, which is slightly different than adding the values in this table due to rounding.~~

Note:

ha = hectare(s)

The Bistcho caribou range is located within the southern extent of the Taiga Plain ecozone~~,~~ (Lower Boreal Highlands and Northern Mixedwood Natural Subregions of Alberta), where caribou critical habitat is broadly characterized by large areas of treed and shrubby lowlands (bogs and fens), mature forests of jack pine, spruce, and tamarack (100 years or older), and open coniferous habitat (ECCC 2020). Habitat types within the Project in caribou range are summarized in Table 1-2.

Table 1-2. Habitat Types Along the Project

Habitat Type		Area (ha)
Upland	Treed - Conifer	0.2
	Treed - Mixedwood	9.8
	Treed - Deciduous	1.7
	Upland total	***11.6***
Transitional	Treed - Conifer	0.3
	Treed - Mixedwood	0.6
	Transitional total	***0.9***
Lowland	Treed - Conifer	43.4
	Treed - Mixedwood	9.7
	Treed - Deciduous	0.5
	Shrub	3.1
	Graminoid	0.9
	Open Water	0.5
	Lowland total	***58.0***
Other	River	< 0.1

1.2 Scope and Change Log

Table 1-3 outlines where each requirement of Condition 3 is addressed in ~~the~~this revised CHRP~~.~~ and a log of key changes from the original CHRP filed in October 2021. The temporal scope of this CHRP is the abandonment phase of the Project and the 5-year post-construction environmental monitoring (PCEM) period. The spatial scope of this CHRP is the Project where it overlaps with the Bistcho caribou range, and ~~included~~includes the North Shekilie Pipeline, the South Shekilie Pipeline, the South Shekilie Extension Pipeline, as well as aboveground facilities and infrastructure associated with the Shekilie Pipelines and cathodic protection facilities.

Table 1-3. Caribou Habitat Restoration Plan Conditions

Condition 3 Requirement	CHRP Section Where Condition is Addressed	Change Log
Westcoast must file with the CER, for approval, **at least 60 days prior to commencing the abandonment activities**, a Caribou Habitat Restoration Plan (CHRP) which outlines the restoration measures that Westcoast will implement to accelerate the succession of vegetation regeneration, enhance caribou habitat attributes, and prevent access to the Project footprint located within the Bistcho caribou range. The CHRP must include the following:	Section 1 and subsection 5.4	~~This document comprises the CHRP~~The original CHRP was filed on October 4, 2021, more than 60 days before abandonment activities started. This revised CHRP provides an update on the proposed restoration measures and locations, and the rationale for the changes.
a) ~~goals~~Goals and measurable objectives of the CHRP~~;~~	Section 2 and 6	~~Section 2 and 6~~There are no changes to the goals and measurable objectives in Section 2. The performance measures and measurable targets outlined in Section 6 have been updated to reflect the revised restoration approach as described in Section 5. Rationale for the changes is included.
b) ~~the~~The decision-making framework that was used to identify the measures to be implemented, including a list of the potential measures considered, the scientific literature that supports their use and the criteria that was used to select the measures to be implemented~~;~~	Subsection 5.1	The decision frameworks have been updated to reflect the revised restoration approach.
c) ~~specification~~Specification drawings for the measures to be implemented~~;~~	Appendix A	~~Appendix A~~The specification drawings have been updated to reflect the revised restoration approach. New drawings include Tree Bending (Drawing 1 in Appendix B) and Site Preparation and Hummock Transplants (Drawing 2 in Appendix B). Drawings for large mounds and tree hinging have been removed, as they are no longer part of the restoration plan.
d) ~~maps~~Maps or environmental alignment sheets showing the locations of the caribou habitat restoration measures to be implemented, including the spatial extent of the measures~~;~~	Appendix B	The mapping has been updated to reflect the revised restoration plan.

Table 1-3. Caribou Habitat Restoration Plan Conditions

Condition 3 Requirement	CHRP Section Where Condition is Addressed	Change Log
e) ~~a~~A schedule indicating when the measures will be implemented~~;~~	Subsection 5.4	The schedule has been updated to reflect winter 2023 restoration work (tree bending, site preparation, hummock transplants) and the summer 2023 seedling planting schedule.
f) ~~the~~The quantifiable targets and performance measures that will be used to evaluate and determine success of the measures during the monitoring program, as required by Condition 7~~; and~~	Section 6	The performance measures and targets have been revised to reflect the revised restoration approach. Rationale for the changes is included.
g) ~~a~~A summary of consultation with Environment and Climate Change Canada and provincial authorities regarding the CHRP, including an explanation of how consultation feedback received was integrated into the CHRP~~.~~	Section 3	Table 3-2 was added to summarize feedback received from FNFN on the original CHRP, and how that feedback is incorporated into this revised CHRP. FNFN is a co-author of this revised CHRP.

2. Goal and Measurable Objectives

The goal of this CHRP is to accelerate the succession of vegetation regeneration within the Project such that the Project will, in time, contribute undisturbed habitat to the Bistcho caribou range. Specifically, this goal encompasses:

- ~~restoring~~Restoring caribou habitat in areas of the Project with limited natural regeneration~~; and~~
- ~~reducing~~Reducing predator and human access within caribou habitat~~.~~

Westcoast has identified the following three measurable objectives to achieve the goal of this CHRP:

1) Establish trees in disturbed caribou habitat in areas with limited natural regeneration
2) Limit line-of-sight within caribou habitat
3) Control access within caribou habitat

The performance measures and targets that will be used to measure these objectives are described in Section 6.

The purpose of this CHRP is to fulfill Condition 3 of the Order by describing the site-specific condition of current habitat restoration and the supplemental restoration measures that Westcoast will implement.

3. Consultation

Condition 3g requires consultation with ECCC and provincial regulatory authorities regarding the CHRP, including an explanation of how consultation feedback received was integrated into the CHRP. Table 3-1 summarizes consultation to date with Alberta Environment and Parks (AEP) and ECCC Canadian Wildlife Service (CWS). This revised CHRP will be provided to AEP and ECCC for review.

Table 3-1. Consultation Summary

Contact	Communication Date	Description
Natalka Melnyky, Senior Wildlife Biologist – AEP, Northwest Region	July 21, 2021 Phone call	A separate Caribou Protection Plan is not required. The Master Schedule of Standards and Conditions should be followed for abandonment activities. AEP requests opportunity to review the CHRP.
	September 23, 2021 Virtual meeting and follow-up emails	Westcoast provided an overview of the Project: locations, access, timing and what the abandonment activities entail. Field surveys conducted this summer found patchy regeneration of conifers; most of the regenerating vegetation is shrubby. Conifer germinants indicate good seed source from the adjacent forest. AEP noted that opening up line-of-sight with the brushing for access is a concern. Westcoast will be using existing winter roads and limit brushing to 10 m wide only where needed to access the site features where abandonment will occur. On the way out of the sites, equipment will mound the access and some other areas in wet lowlands to support tree establishment. This will mitigate some of the access concerns, but if there is a heavy snowfall, predators could still use the open areas for access. Access control points are being considered in the CHRP. Westcoast asked about permitting processes for tree felling/hinging and sourcing transplants for vegetation screens. AEP has no concerns with this approach and advised it could help with predator access as well as deterring bison from the restored areas. Bison have a tendency to browse and trample regenerating vegetation and can keep pipeline rights-of-way in a grassy vegetative state. Jeff Poekens, AEP Lands Management Specialist, may be able to advise on permitting. Constraints of planting in this remote wet area were discussed. There are limitations to how much can be practicably planted (approximately 40 percent of the pipeline rights-of-way). Natural regeneration will be the primary method of revegetation on about 60 percent of the rights-of-way; about 62 percent will have site preparation (ripping or mounding) to create microsites suitable for tree ingress and growth (planted and natural regeneration). AEP acknowledged the limitations of the area for planting. AEP advised that early in/early out planning is preferred; try to avoid activities extending into March (vulnerable time for caribou, higher predation risk). Westcoast is planning to freeze in access as early as weather conditions permit in December 2021, and work from east to west to be out of the caribou range as early as possible (plan to be out by end of February 2022).

Table 3-1. Consultation Summary

Contact	Communication Date	Description
		~~AEP asked about stockpiling seedling stock in winter during the abandonment activities. Westcoast will not have stock available at that time. The stock will be ready for summer planting in late summer 2022 (scheduling for after the July 15 timing window).~~ ~~AEP asked if monitoring would be a component of the CHRP. Westcoast is including a monitoring plan in the CHRP and will provide a draft to AEP for review and comment.~~ ~~Overall, AEP is supportive of abandonment projects and the habitat restoration approach. AEP also suggested contacting the Centre for Boreal Research to understand if they recommend certain practices to encourage tree regrowth on old pipeline rights-of-way, and whether standing water created by mounding inhibits tree growth.~~
Natalka Melnyky, Senior Wildlife Biologist – AEP, Northwest Region (cont'd)	See above	AEP asked about stockpiling seedling stock in winter during the abandonment activities. Westcoast will not have stock available at that time. The stock will be ready for summer planting in summer 2023 (scheduling for after the July 15 timing window). AEP asked if monitoring would be a component of the CHRP. Westcoast is including a monitoring plan in the CHRP and will provide a draft to AEP for review and comment. Overall, AEP is supportive of abandonment projects and the habitat restoration approach. AEP also suggested contacting the Centre for Boreal Research to understand if they recommend certain practices to encourage tree regrowth on old pipeline rights-of-way, and whether standing water created by mounding inhibits tree growth.
Paul Grégoire, Wildlife Biologist, Senior Environmental Assessment Officer, CWS Prairie Region, ECCC	September 23, 2021 Virtual meeting and follow-up emails	Westcoast provided an overview of the Project: locations, access, timing and what the abandonment activities entail. Photos of the site features where aboveground infrastructure would be removed were reviewed. Field surveys conducted this summer found patchy regeneration of conifers; most of the regenerating vegetation is shrubby. Conifer germinants observed indicate good seed source from the adjacent forest. CWS noted that opening up line-of-sight with the brushing for access is a concern and asked if the width of brushing could be narrowed and whether some smaller vegetation could be pushed down instead of brushed (allows the vegetation to spring back up after snow melts in spring). Westcoast will be using existing winter roads and limit brushing to 10 m wide only where needed to access the site features where abandonment will occur. Brushing crews will work to avoid areas that can be walked down and try to avoid the areas of taller/conifer regeneration as much as practical. On the way out of the abandonment sites, equipment will mound the access and some other areas in wet lowlands to support tree establishment. This will mitigate some of the access concerns. Access control points are being considered in the CHRP. Westcoast has been communicating with the Province about permitting processes for tree felling/hinging and sourcing transplants for vegetation screens. CWS advised this approach would be helpful.

Table 3-1. Consultation Summary

Contact	Communication Date	Description
		Constraints of planting in this remote wet area were discussed. There are limitations to how much can be practicably planted. Natural regeneration will be the primary method of revegetation where seedling planting is not practicable. Westcoast ~~will~~planned to complete site preparation (ripping or mounding) to create microsites suitable for tree ingress and growth (in both planted and natural regeneration areas). CWS advised Westcoast to try to avoid activities extending into the sensitive timing window after February 15. Westcoast is planning to freeze in access as early as weather conditions permit in December 2021, and work from east to west to be out of the caribou range as early as possible (plan to be out by the end of February 2022). ~~CWS asked if monitoring would be a component of the CHRP. Westcoast is including a monitoring plan in the CHRP, and will provide a draft to CWS for review and comment.~~ ~~CWS noted that the Bistcho caribou range is below the 65 percent undisturbed habitat threshold set by the Recovery Strategy, and offsets have often been a requirement for other pipeline projects regulated under the CER. Westcoast has had similar conditions; however, offsets were not conditioned for this Project. The removal of above-ground infrastructure and habitat restoration measures are expected to improve habitat conditions over time.~~
Paul Grégoire, Wildlife Biologist, Senior Environmental Assessment Officer, CWS Prairie Region, ECCC (cont'd)	See above	CWS asked if monitoring would be a component of the CHRP. Westcoast is including a monitoring plan in the CHRP and will provide a draft to CWS for review and comment. CWS noted that the Bistcho caribou range is below the 65 percent undisturbed habitat threshold set by the Recovery Strategy, and offsets have often been a requirement for other pipeline projects regulated under the CER. Westcoast has had similar conditions; however, offsets were not conditioned for this Project. The removal of aboveground infrastructure and habitat restoration measures are expected to improve habitat conditions over time.

In addition to consultation with ECCC and AEP, Westcoast engaged with Beaver First Nation, Dene Tha' First Nation (DTFN) and FNFN early in Project planning and has continued to engage Indigenous communities by way of phone/videoconference meetings and e-mail updates. Further engagement details are summarized in the Westcoast Response to CER Information Request 1.7 (CER Filing ID A7R9Y2). The original CHRP was shared with DTFN and FNFN in 2021. FNFN provided feedback on the original CHRP, which has been considered and incorporated into this revised CHRP as outlined in Table 3-2. Since that time, FNFN has been engaged to collaborate on this revised CHRP as noted in Section 1. Westcoast further intends to engage FNFN for the implementation of the restoration program.

Table 3-2. Fort Nelson First Nation Feedback Summary

Feedback Received	How Addressed in Revised CHRP
Requested clarification of the proportions of the footprint that will be planted.	The planting areas have been reconsidered given the change in site preparation methods and extent, accessibility, and the use of nursery seedling planting combined with hummock and seedling transplants.
Unless a site is truly upland no white spruce should be planted.	The treed ecosystems encountered along the Shekilie Pipelines are mostly dominated by black spruce; however, there are incursions of white spruce and jack pine in transitional and upland areas where soils are better drained. For simplicity in restoration implementation, the revised habitat restoration prescription is to use only black spruce nursery stock, as it is expected to establish and grow in suitable microsites along the Shekilie Pipelines. Other conifer species (e.g., white spruce, jack pine, tamarack) may be used in hummock transplants where source material is available adjacent to the restoration areas. Black spruce will not be planted in deciduous uplands.
Alder creates a better 'fence' than willows during all seasons and is lower palatability than willow.	Alder and conifer seedlings will be selected for vegetation screen transplants.
Do not bring offsite material in; can lead to invasive plant issues.	Rollback is not being considered as a suitable restoration option for access control. A combination of tree bending and vegetation screen planting will be used for access and line-of-sight management.
Recommendations were provided for tree hinging and bending. Bending in frozen conditions can cause tree stems to break. Bending is preferred over hinging because it keeps the tree alive for a period, which extends the timeframe when the live crown creates an effective visual barrier, and promotes direct seed deposition from cones.	Tree hinging has been replaced by tree bending in the revised CHRP.
Recommended light brushing access to promote a quicker recovery response from the vegetation.	Westcoast adopted the methods suggested to reduce vegetation disturbance during access preparation in winter 2021/2022 to the extent practical.
Recommended establishing ground monitoring plots and helipads for monitoring during the winter abandonment activities.	Helicopter access was reviewed by FNFN in summer 2022 to identify suitable sites for landing to conduct monitoring following restoration activities.

4. Status of Existing Revegetation and Access

The South Shekilie Extension Pipeline and a portion of the South Shekilie Pipeline were deactivated in 2007. The North Shekilie Pipeline and the remainder of the South Shekilie Pipeline were deactivated in 2011. Since then, there has been limited vegetation management on the rights-of-way, which has facilitated ingress and establishment of natural vegetation. There was a large wildfire in 2015 that burned portions of the South Shekilie Pipeline right-of-way.

Westcoast completed a field program in June 2021 to assess current levels of revegetation towards desired ecosystems. Desired ecosystems were defined as the adjacent undisturbed habitat types, which broadly include upland and lowland forests (coniferous, deciduous, and mixedwood), shrubby lowlands, and graminoid lowlands. The objectives of the June 2021 field program were to identify:

~~The objectives of the field program were to identify:~~

- ~~where~~Where the existing natural regeneration is meeting targets indicating the habitat is on trajectory towards the desired ecosystems~~; and~~
- ~~levels~~Levels of human and wildlife access along the Shekilie Pipelines~~.~~

A post-abandonment overflight was conducted in June 2022 by FNFN. The objectives of the June 2022 overflight were to assess:

- Current natural revegetation status and the extent of revegetation brushing on the Shekilie Pipelines for winter access
- Accessibility for the equipment needed to facilitate habitat restoration in the seasons following abandonment activities
- Suitability of the Shekilie Pipelines for alternate habitat restoration approaches including hummock transplants and tree bending, supplemented by nursery stock seedling

4.1 Revegetation Assessment Methods and Results

4.1.1 2021 Field Assessment

Both desktop and field surveys were used to assess the extent and species composition of vegetation on the pipeline rights-of-way. The vegetation communities on and within 100 m of the right-of-way were first identified using available landcover data, satellite imagery, and information collected for the Project in 2020, including vegetation characterization and wetland delineation and classifications. The delineations and habitat types were then verified in the field during helicopter overflights on June 22 and 23, 2021.

Locations for revegetation assessment plots in 2021 were selected based on stratification of habitat types, variation in levels of natural regeneration observed during the overflights, and accessibility. Revegetation assessment plots completed in 2021 adopted the protocols from the Draft Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (GoA 2018). Each plot consists of three evenly -spaced 10 square metre (m^2) circular sub-plots spread systematically across the line to account for light and temperature differences, plus a single belt transect (Figure 4-1). A total of 39 plots were sampled: 17 along the North Shekilie Pipeline; 16 along the South Shekilie Pipeline; and 6 along the South Shekilie Extension Pipeline (Figure 4-2). Plot locations were clumped due to a limited number of locations where the helicopter could safely land. Plots were located a minimum of 70 m apart as specified in the provincial framework (GoA 2018).

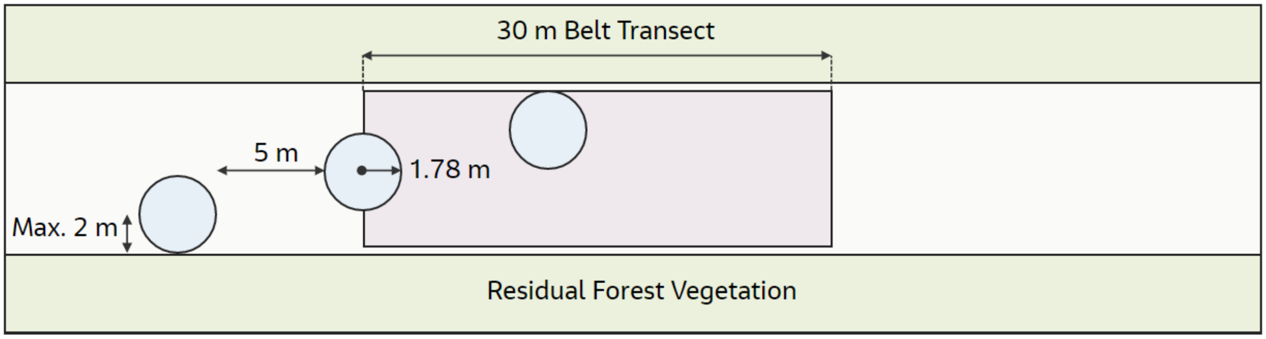


Figure 4-1. Revegetation Assessment Plot Layout

Figure 4-2. Revegetation Assessment Plot Locations

Figure 4-2a:

Caribou Plan

Figure 4-2b:

Caribou Plan

Figure 4-2c:

Caribou Plan

At each circular subplot, the following data were recorded:

- General information (plot ID; GPS location of each circular subplot centre; photos)
- Number of tree seedlings (germinants and multi-year trees)
- Seedling height
- Competition estimate:
  - Visual estimate of percent non-tree cover (including non-vegetated cover) within the circular subplot to the nearest 10 percent
  - Competing vegetation height category: overtop (O) the seedlings, is at the same level (L), or is below (B) the seedlings
- Adjacent habitat information including habitat type (upland/lowland, treed/shrubby/graminoid) and stand composition, viewed from the centre circular subplot:
  - Canopy structure (tree species and their estimated composition to the nearest 10 percent [e.g., Sw7Aw3 signifies 70 percent white spruce, and 30 percent trembling aspen])
  - Canopy height (to the nearest metre)
- At each belt transect, the following information was collected:
  - Visual estimate of overall stocking to the closest 10 percent
  - Stand height and structural stage of the adjacent stand
  - Coarse woody debris cover (low, moderate, high)

The Project location is remote and accessible by helicopter during non-frozen conditions. Given the saturated ground conditions and limited availability of adequately drained areas without tree cover, safe helicopter landing sites are also limited. As a result, field crews were unable to access large segments of the Shekilie Pipelines on foot~~.~~ during the 2021 field program. Best efforts were made to locate revegetation assessment plots in representative habitats, which included 16 plots located outside of caribou range.

Given the patchy nature of boreal ecosystems and regeneration, professional judgement was used to consider the plot data in combination with observations collected during the overflights and desktop review of the imagery and habitat classifications, to develop the site-specific habitat restoration prescriptions.

The 10 m^2 circle sub-plots are relatively small and discrete, resulting in sample locations that miss regenerating seedlings, or conversely, sites that have a dense patch of seedlings. In areas with more advance regeneration, self-thinning of germinants and multi-year seedlings has occurred. Therefore, low tree counts within the circle sub-plots were found to poorly represent the true levels of revegetation. However, the belt plots are larger and enable a contextual record of stocking.

Note that stocking is a metric commonly used in commercial reforestation. It combines measures of tree density, survival, and distribution. Refer to the Draft Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (GoA 2018) for a visual representation of stocking and its utility as a metric for linear restoration. During stocking assessments, acceptable tree species include species that are capable of reaching a minimum 5 m in height, and are compatible with and representative of the habitat, considering the adjacent undisturbed forest cover, site moisture, and nutrient regime.

Results of the revegetation assessment plots are summarized in Table 4-1, including the plots sampled both inside and outside the Bistcho caribou range. Overall, the limited vegetation management over the Shekilie Pipelines in recent years has allowed substantial vegetation regeneration. Site photos of the current state of revegetation at representative plots are provided in Appendix C.

Vegetation regeneration is lower over the approximately 10 m wide access within the pipeline rights-of-way. Graminoid and shrubby wetlands have regenerated well and there were no indicators of reduced wetland function evident during the overflights and ground surveys.

Although black spruce and tamarack germinants are common and even abundant in some of the treed lowlands within the Project footprint, these habitat types are predominantly revegetating with shrubs (e.g., green alder, willows, prickly rose) and there are few multi-year seedlings. Where raised microsites occur in treed lowlands and transitional habitats (e.g., where a pipeline roach occurs) deciduous tree seedlings and saplings are more common, however, the spatial extent is limited and does not result in adequate stocking.

Tree regeneration in the upland treed conifer, mixedwood and deciduous habitat types include primarily aspen and poplar, with lesser numbers of white and black spruce, and infrequent lodgepole pine seedlings limited to occasional raised microsites. While there are some relatively advanced aspen, poplar, and spruce seedlings, they tend to be in small patches or dispersed within predominantly shrub regeneration. As a result, the stocking percentages mostly do not meet the 70 percent stocking target for adequately regenerating sites.

There was a large wildfire in 2015 that burned portions of the South Shekilie Pipeline right-of-way. ~~Natural~~During the 2021 field assessment, the natural regeneration on the pipeline right-of-way in this area ~~is~~was observed to be consistent with the regeneration in the adjacent habitat.

Table 4-1. Revegetation Assessment Results

Project Component/ Route	Adjacent Habitat Type	Number of Plots	Multi-year Seedling Count in 10 m^2 Circular Sub-Plots		Multi-year Seedling Stems/ha		Stocking Percent		Multi-year Seedling Height on Right-of-Way (~~cm~~centimetres)		Germinant Stem Count in 10 m^2 Circular Sub-Plots		Germinant Stems/ha		Percent Shrub Cover on Right-of-Way		Average Cover Competing Vegetation on Right-of-Way Percent		
			Min/Max	Average	Min/Max	Average	Min/Max	Average	Min/Max	Average	Min/Max	Average	Min/Max	Average	Min/Max	Average	Overtopping Seedlings	Level with Seedlings	Below Seedlings
North Shekilie Pipeline	Upland Treed Deciduous	3	0 / 0	0	0 / 0	0	40 / 50	43	0 / 0	0	0 / 0	0	0 / 0	0	60 / 100	80	100	0	0
	Upland Treed Mixedwood	3	0 / 1	0	0 / 1,000	333	10 / 70	30	0 / 20	7	0 / 0	0	0 / 0	0	70 / 80	77	70	10	7
	Transitional Treed Conifer	1	10 / 10	10	10,000 / 10,000	10,000	80 / 80	80	10 / 18	14	1 / 1	1	1,000 / 1,000	1,000	40 / 40	40	60	20	20
	Lowland Treed Conifer	6	0 / 10	5	0 / 10,000	5,333	10 / 70	37	5 / 13	10	0 / 12	3	0 / 12,000	3,333	20 / 40	32	25	45	23
	Lowland Shrubby	4	0 / 33	11	0 / 33,000	10,750	10 / 50	38	0 / 15	10	0 / 8	3	0 / 8,000	2,750	40 / 80	60	55	23	20
South Shekilie Pipeline	Upland Treed Deciduous	1	0 / 0	0	0 / 0	0	40 / 40	40	0 / 0	0	0 / 0	0	0 / 0	0	60 / 60	60	100	0	0
	Upland Treed Mixedwood	2	0 / 0	0	0 / 0	0	60 / 70	65	0 / 0	0	0 / 0	0	0 / 0	0	60 / 80	70	100	0	0
	Transitional Treed Mixedwood	1	0 / 0	0	0 / 0	0	50 / 50	50	0 / 0	0	0 / 0	0	0 / 0	0	80 / 80	80	100	0	0
	Transitional Shrubby	1	0 / 0	0	0 / 0	0	30 / 30	30	0 / 0	0	0 / 0	0	0 / 0	0	20 / 20	20	100	0	0
	Lowland Treed Conifer	8	0 / 7	2	0 / 7,000	2,000	10 / 90	40	0 / 50	16	0 / 2	0	0 / 2,000	375	10 / 100	51	63	10	31
	Lowland Treed Mixedwood	2	0 / 0	0	0 / 0	0	20 / 30	25	0 / 0	0	0 / 0	0	0 / 0	0	40 / 80	60	100	0	0
	Lowland Open Water	1	0 / 0	0	0 / 0	0	0 / 0	0	0 / 0	0	0 / 0	0	0 / 0	0	20 / 20	20	100	0	0
South Shekilie Extension Pipeline	Transitional Treed Mixedwood	1	0 / 0	0	0 / 0	0	20 / 20	20	0 / 0	0	0 / 0	0	0 / 0	0	10 / 10	10	100	0	0
	Lowland Treed Conifer	3	7 / 16	11	7,000 / 16,000	11,000	40 / 70	60	14 / 30	25	0 / 13	7	0 / 13,000	7,333	20 / 80	53	20	30	17
	Lowland Graminoid	2	0 / 0	0	0 / 0	0	1 / 10	6	0 / 0	0	0 / 0	0	0 / 0	0	20 / 20	20	100	0	0

~~Note:~~

~~cm = centimetre(s)~~

4.1.2 2022 Field Assessment

FNFN's caribou habitat restoration specialist completed a helicopter overflight of the Shekilie Pipelines on May 31, 2022. The suitability for specific habitat restoration measures (i.e., hummock transplants, nursery conifer seedling planting and tree bending) using the specialized equipment that FNFN has been employing in recent caribou habitat restoration trials was documented. The level of naturally regenerating vegetation was assessed, considering the extent of brushing that was conducted on the Shekilie Pipelines for access during the 2021/2022 winter abandonment work. Segments of the Shekilie Pipelines were defined by preliminary restoration treatment recommendation and land cover class. The results were used to modify the restoration maps in Appendix B.

4.2 Access and Wildlife Use Evaluation Methods and Results

4.2.1 2021 Field Assessment

Current levels of human and wildlife access were evaluated qualitatively during helicopter overflights conducted on June 22 and 23, 2021, and while completing the revegetation assessment from June 23 to 27, 2021. Consistent with the remote location of the Project, signs of human access were limited to the existing winter roads used by the energy industry in the region. Winter roads intersected by the Project are shown on Figure 4-2. Given these roads are mostly used during winter, evidence of access is generally minimal, although there were minor ruts and tracks from industrial equipment and traffic observed.

There were no areas observed with broken seedlings or saplings ~~that~~, or cut logs, which might indicate well used snowmobile trails. During the assessment of revegetation, it was noted that sight lines were limited by the extensive shrub regeneration on the rights-of-way, outside of graminoid wetlands where sight lines are naturally open and along the travel lanes along the edges of the rights-of-way.

Evidence of wildlife use was also recorded during the overflights and ground plots. Black bears were observed during the overflight near the NS-4/SS-4 site feature at the junction of the North Shekilie and South Shekilie Pipelines (outside of the caribou range). Otherwise, there was no sign of predators observed during the field surveys in June 2021.

Ungulate browse levels were recorded during the revegetation assessment plots and documented as none, low, moderate, or high. Of the 39 plots surveyed, 35 plots had no or low browsing evident and four plots had medium browse levels. The plots with medium browse were located on the South Shekilie Extension Pipeline near the SSE-1 site feature (n=1), and the South Shekilie Pipeline near the SS-2 site feature (n=3).

4.2.2 2022 Field Assessment

During the May 31, 2022, overflight, the crew documented locations that would be inaccessible for restoration work due to extensive areas of open water caused by beaver impoundments. Potential alternative access routes were also evaluated. The South Shekilie Extension Pipeline is inaccessible for restoration work due to extensive beaver activity and lack of alternate access (Photographs 14 and 15 [Appendix C]). This segment of pipeline was abandoned in-place and access was not brushed along the right-of-way during winter 2021/2022. As a result, the naturally regenerating vegetation along this segment was undisturbed by abandonment activities (Photograph 16 [Appendix C]) and will be left for continued natural regeneration as shown on the maps in Appendix B.

Brushing of access was evident along most of the Shekilie North Pipeline and the southernmost 12 km of the Shekilie South Pipeline.

5. Habitat Restoration Measures

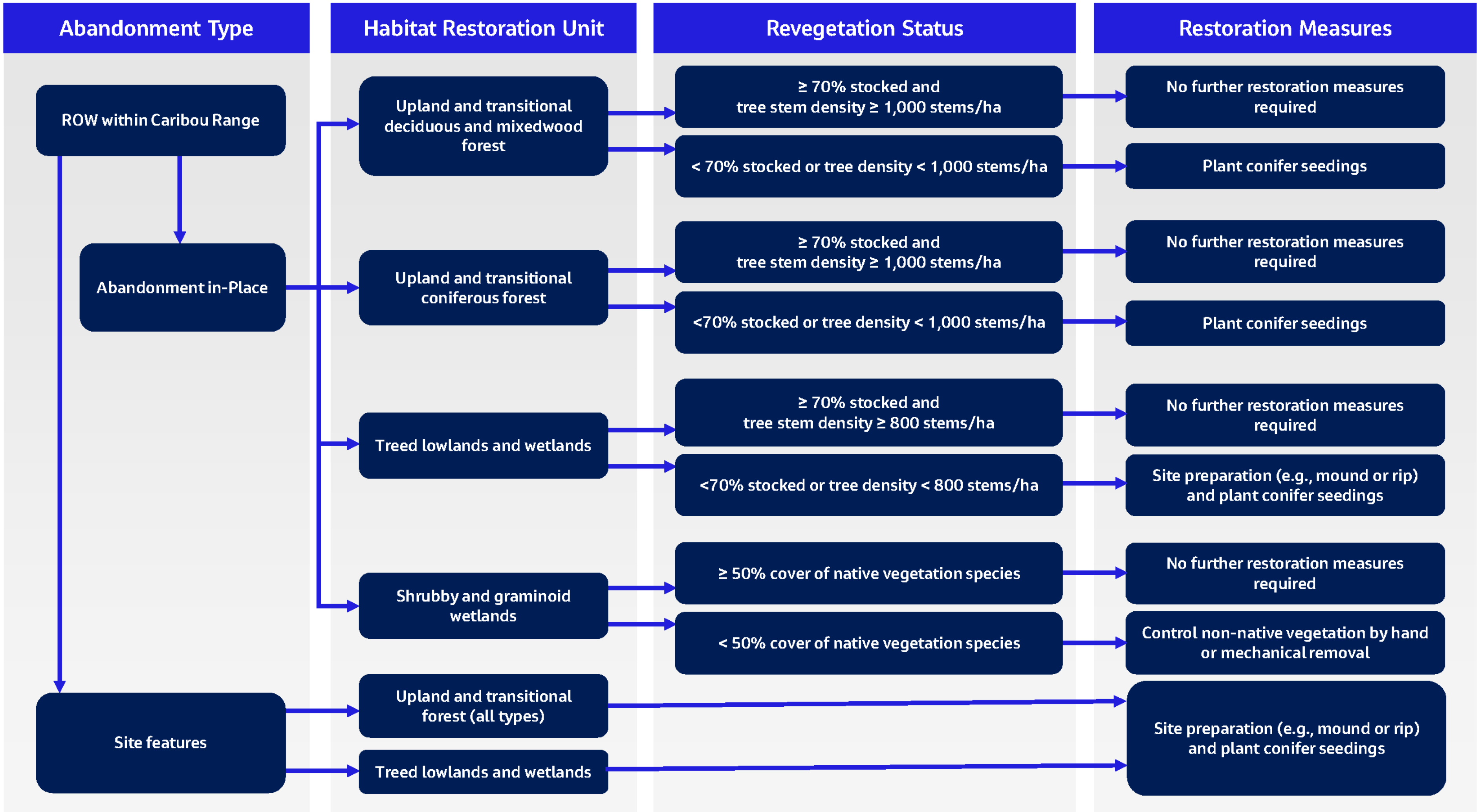
Westcoast will implement a combination of habitat restoration measures along the Shekilie Pipelines in the Bistcho caribou range to accelerate revegetation in forested habitats, limit line-of-sight, and control access. The following subsections describe the decision frameworks and criteria used to select restoration location and methods, challenges that affect restoration implementation and success, and the restoration measures that have been selected for the Project.

5.1 Decision Frameworks

~~The~~In the original CHRP for the Project, the establishment targets identified in the Draft Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (GoA 2018) were ~~used to define the criteria and targets for determining whether the existing natural regeneration is on trajectory towards the desired ecosystems.~~

~~The~~the basis for the Habitat Restoration Decision Framework ~~on~~ (Figure 5-1 ~~shows how those revegetation criteria and targets were used to determine where supplemental~~). This Decision Framework has been revised to reflect the updated habitat restoration ~~measures are not needed because the existing revegetation is on trajectory to desired ecosystems. As described in subsection 4.1, the stem count data derived from circle plots were not necessarily representative of revegetation. Therefore, the stocking data were relied on more heavily for the restoration decisions. The Decision Framework on Figure 5-1 also shows how~~methods and the additional information collected during the ~~restoration measures are selected~~May 31, 2022, overflight. Restoration methods will be determined based on site-specific habitat conditions~~.~~ including the existing regenerating vegetation, the extent of brushing for access to abandonment site features, and the habitat characteristics that influence the effectiveness of various restoration measures and accessibility for restoration implementation. Due to the high degree of variability in site conditions and extent of natural regeneration, there will be variability in site-specific application of restoration treatments. This revised CHRP provides flexibility to combine the most appropriate restoration techniques based on site-specific conditions.

A second Decision Framework (Figure 5-2) is provided to show the criteria used to determine when access control or line-of-sight measures will be implemented.



Abandonment Type
Habitat Restoration Unit
Revegetation Status
Restoration Measures
ROW within Caribou Range
Abandonment in-Place
Site features
Upland and transitional deciduous and mixedwood forest
Upland and transitional coniferous forest
Treed lowlands and wetlands
Shrubby and graminoid wetlands
Upland and transitional forest (all types)
Treed lowlands and wetlands
≥ 70% stocked and tree stem density ≥ 1,000 stems/ha
< 70% stocked or tree density < 1,000 stems/ha
≥ 70% stocked and tree stem density ≥ 1,000 stems/ha
<70% stocked or tree density < 1,000 stems/ha
≥ 70% stocked and tree stem density ≥ 800 stems/ha
<70% stocked or tree density < 800 stems/ha
≥ 50% cover of native vegetation species
< 50% cover of native vegetation species
No further restoration measures required
Plant conifer seedings
No further restoration measures required
Plant conifer seedings
No further restoration measures required
Site preparation (e.g., mound or rip) and plant conifer seedings
No further restoration measures required
Control non-native vegetation by hand or mechanical removal
Site preparation (e.g., mound or rip) and plant conifer seedings

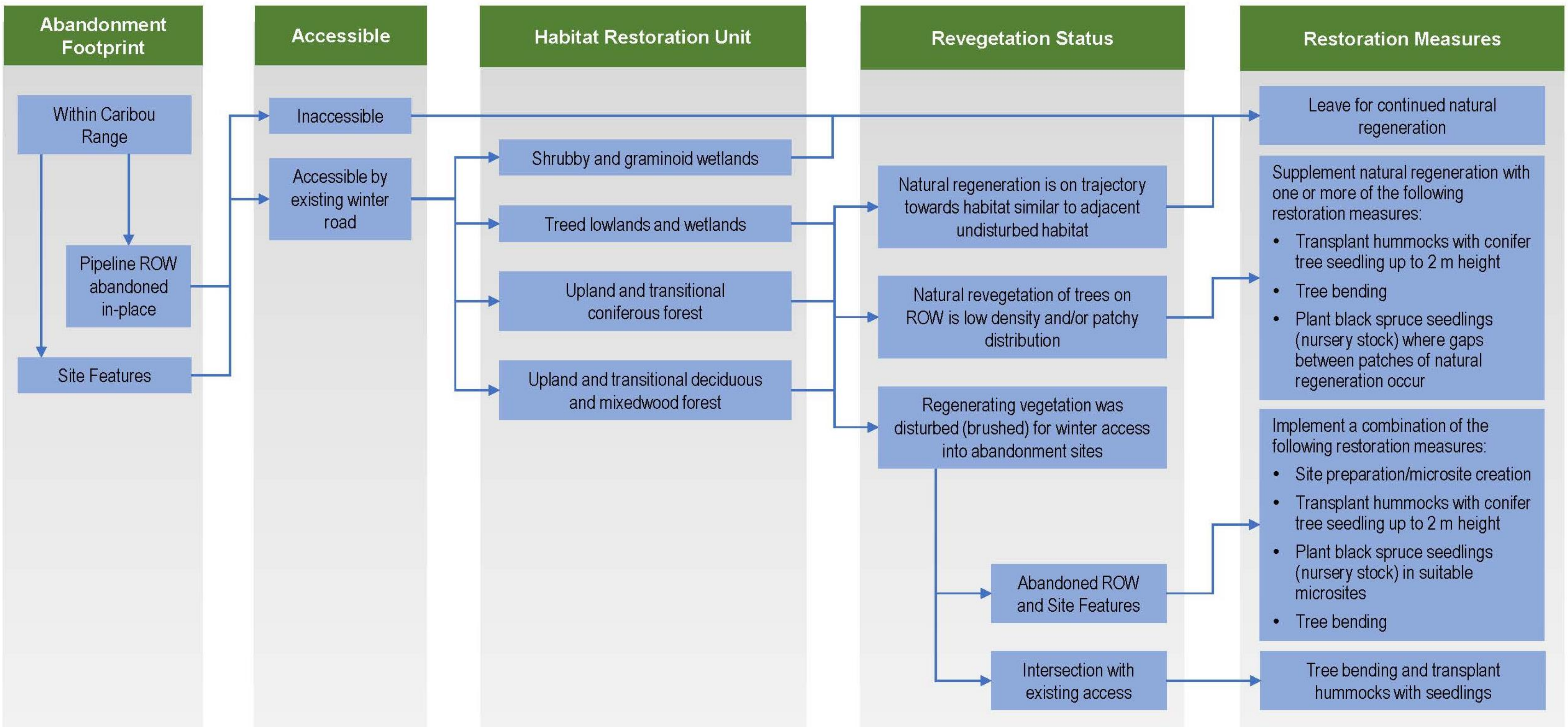
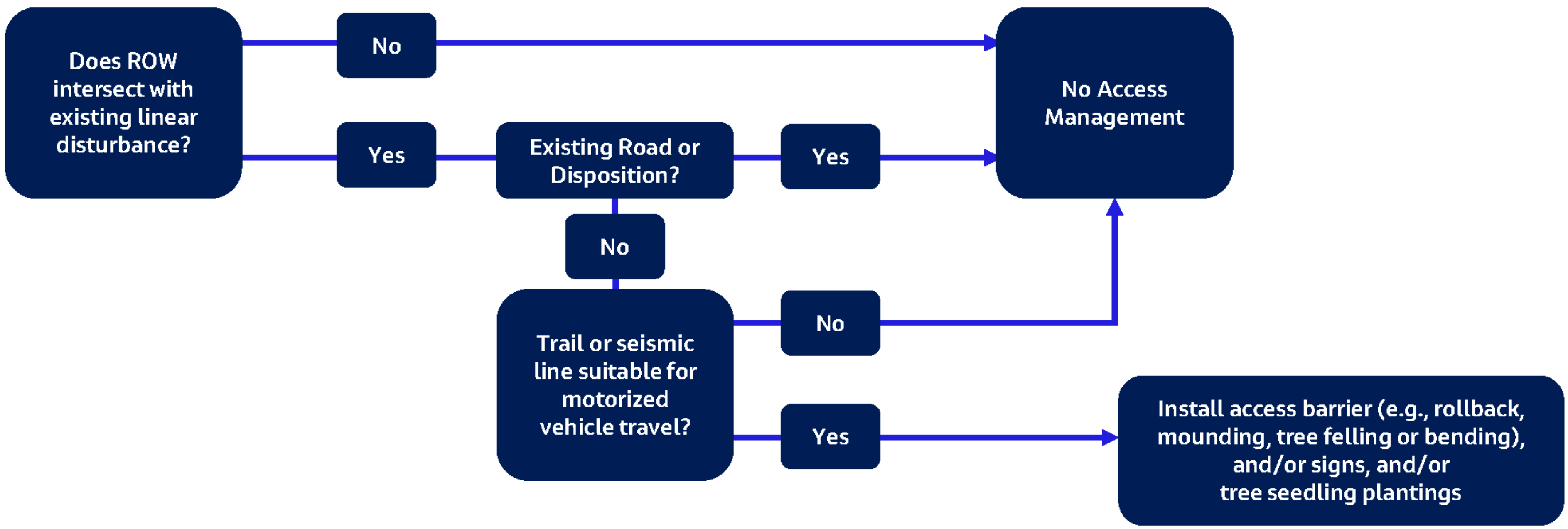


Figure 5-1. Habitat Restoration Decision Framework


Does ROW intersect with existing linear disturbance?
No
Yes
Existing Road or Disposition?
Yes
No
No Access Management
Trail or seismic line suitable for motorized vehicle travel?
No
Yes
Install access barrier (e.g., rollback, mounding, tree felling or bending), and/or signs, and/or tree seedling plantings

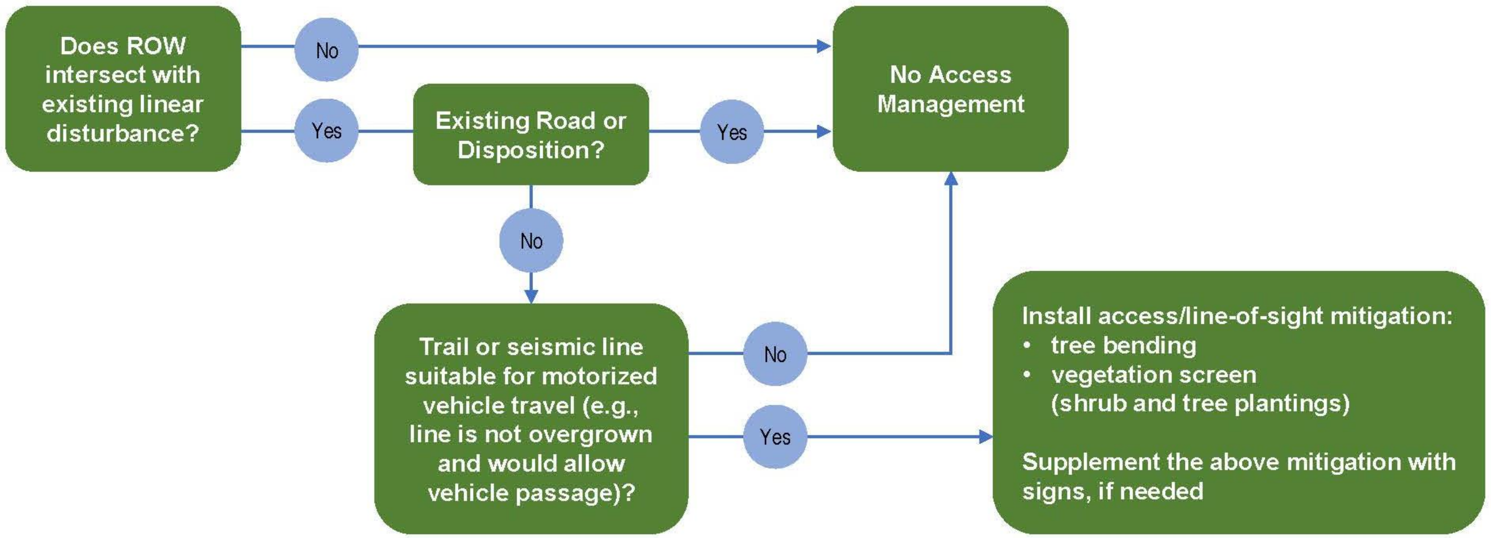


Figure 5-2. Access Control Decision Framework

5.2 Restoration Challenges

Project factors and site-specific conditions that influenced the selection of appropriate mitigation and habitat restoration methods, and are anticipated to affect restoration implementation, are described in the following points, along with an explanation of how Westcoast plans to manage these challenges.

- A substantial proportion of the Shekilie Pipelines are located within treed peatlands and shrubby or graminoid wetlands. High water tables and saturated soils in these habitats create challenges with access and tree establishment and growth, sometimes resulting in high seedling mortality. ~~Project abandonment activities are scheduled during frozen conditions to facilitate access for heavy machinery. Winter roads must be created by driving frost into the ground and packing down ice and snow that will support the machinery and construction vehicles. Site preparation by mounding will be conducted following abandonment activities in wet habitats to create suitable microsites for tree seedling establishment~~Site preparation (scraping surface soils to create shallow “hollows” and small mounds) will be conducted on the right-of-way and facility locations (as indicated on the maps in Appendix B), which will create microsites suitable for seedling planting and growth.
- ~~Site preparation (mounding or ripping) will also be conducted on facility locations where soils have been compacted, to create microsites suitable for seedling planting and growth. As noted above, the wet conditions will require driving frost into the temporary access along the rights-of-way to support construction equipment and vehicles, which can create a challenge when mounding soils as the frozen soils often result in large mounds. Multiple seedlings can be planted on these large mounds; however, it may result in reduced seedling densities. Therefore, ranges in target seedling densities are provided.~~
- Project abandonment activities were completed during frozen conditions to facilitate access for heavy machinery. The very wet conditions created challenges for sufficiently freezing access routes that would support the heavy equipment needed for the abandonment work. A very thick and heavily packed snow and ice road was required, which inhibited completion of site preparation (mounding and ripping) as originally planned. Westcoast has engaged FNFN to support habitat restoration with smaller, lighter equipment that will not require the same level of freezing in access as heavier equipment. This has delayed the implementation of restoration by 1 year.
- The field assessment completed in spring 2022 confirmed locations of large open water wetlands created by beaver impoundments near the north and south ends of the South Shekilie Extension Pipeline (Photographs 14 and 15 [Appendix C]). As a result, the South Shekilie Extension Pipeline is inaccessible for restoration work. This segment of pipeline was abandoned in-place and access was not brushed along the right-of-way during winter 2021/2022. Therefore, the naturally regenerating vegetation along this segment was undisturbed by abandonment activities (Photograph 16 [Appendix C]) and will be left for continued natural regeneration as shown on the maps in Appendix B.
- Site feature locations are expected to have compacted soils from construction and past operations of the Project, which can inhibit natural regeneration of woody vegetation, seedling planting and survival. These sites were also seeded with an agronomic reclamation mix in the past, which stabilizes soils to mitigate erosion, but can inhibit ingress of trees and outcompete tree germinants and young seedlings. Site preparation ~~using techniques such as mounding or ripping are proposed~~(hollows and small mounds) will help to address these factors and promote suitable growing conditions for tree seedlings.
- ~~The Project will require walking~~Walking down of low-growing vegetation and brushing of taller vegetation was necessary to establish winter access for Project activities on the North Shekilie and South Shekilie Pipelines. Wherever practical, brushing vegetation for access ~~will be~~was minimized by micro-routing to avoid areas of taller regenerating trees and walking down low shrubs and saplings to avoid cutting them. ~~Field observations reported that vegetation regeneration was generally lower along the travel lane used during operations of the Project. As such, the need for brushing is expected~~

~~to be minimal~~Areas where vegetation brushing was completed will be restored with a combination of treatment methods, as site conditions and access allow.

- Unlike new build pipeline construction projects, this Project ~~will~~did not require clearing of undisturbed forest. Therefore, there ~~will be few, if any, mature trees cut that could~~is no timber available to be used for rollback to manage access and create microsites that support tree establishment. Tree ~~hinging~~bending (described in subsection 5.3) is an alternate option to address access and line-of-sight ~~that Westcoast is investigating in consultation with AEP and the Forest Management Agreement (FMA) holders (Tolko Industries Ltd. and Footner Forest Products Ltd.).~~. Challenges with tree ~~hinging~~bending are related to permitting for ~~cutting~~modifying and transplanting of trees outside Westcoast's disposition~~.~~, and since the technique requires machinery to push over trees at the roots, it must be conducted during frozen conditions. Winter tree bending frequently results in the stem breaking (Pyper et al. 2014). Westcoast will mitigate the potential for stem breakage by digging to release the root mass on the forest side of the tree to be bent over the right-of-way so that the root ball pushes up when the tree is bent towards the right-of-way. This method has been used successfully in the KLRA and MRA to simulate natural wind-throw.
- The wet conditions and remote location with limited access ~~create~~creates logistical and safety challenges for tree seedling planting. The area is accessible only by helicopter during non-frozen conditions when seedlings will be planted, and there are limited locations suitable for helicopter landing due to the saturated soils and vegetation. This constrains the locations that can be planted during summer to areas in proximity to helicopter landing sites that can be safely accessed on foot. Winter planting was considered as an alternate option, however, there are a number of constraints that make this option impracticable. Winter planting would require helicopter-supported access (i.e., high sensory disturbance) during the February 15 to July 15 caribou timing window, and vegetation removal would be required to create safe helicopter landing sites, which is contrary to the objectives of the habitat restoration program. Further, the site is very remote and requires a lengthy transport time to ferry crews. With the short daylight hours combined with the transport time and lack of suitable openings for safe helicopter landings, winter planting is not a practical option. Therefore, the restoration plan will combine summer planting in areas that are safely accessible in ~~2022~~2023 (outside the caribou timing window), with hummock and seedling transplants, and natural regeneration. ~~Site preparation by mounding will be conducted during frozen ground conditions following abandonment activities in treed areas to enhance microsites for natural regeneration of trees and for planted seedlings.~~
- Transplanting hummocks with multi-year tree seedlings up to 2 m in height is a caribou habitat restoration method that has shown promising results in early small-scale trials (Hervieux et al. 2021). Progress is typically slow, which can be time-consuming and costly. Balancing the size of machinery against access limitations can be challenging. Larger, heavier equipment is capable of scooping larger hummocks that retain more of the tree seedling root mass, but requires additional preparation to build winter access. Conversely, small and light equipment can access wet areas with limited winter access preparation but is limited in the size of hummocks and proportion of the tree root mass that can be transplanted. Further, this approach requires sourcing transplant material from adjacent habitats, which requires permitting and must be done in a sustainable manner that does not adversely affect the habitat quality of the donor habitats.
- There are existing third-party developments adjacent to the Shekilie Pipelines that will create challenges for restoration implementation. Westcoast will obtain crossing agreements where necessary. Restoration crews will be provided with digital spatial information that shows the boundaries of the restoration area and where third-party dispositions are located. Where needed, Westcoast will flag the boundaries of third-party dispositions and locations where they may be aboveground or below-ground hazards that restoration crews need to be aware of for safety.

5.3 Restoration Measures Selected

The caribou habitat restoration measures selected for the Project include both ecological and functional restoration techniques. Ecological caribou habitat restoration refers to establishing growth and natural succession of forest vegetation, while functional restoration aims to return biological process to pre-disturbance conditions (DeMars and Benesh 2016). In a woodland caribou context, functional restoration reduces predator movement and hunting efficiency through access control and line-of-sight management (Pyper et al. 2014). In practice, restoration may be achieved through various targets or objectives, such as revegetation, rehabilitation, and reclamation, while the ultimate goal is generally returning a disturbance to original or pre-disturbance conditions (Ray 2014).

The Society for Ecological Restoration identifies nine attributes of restored ecosystems (SER 2004), and defines an ecosystem as recovered or restored once it “contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy.” Successful caribou habitat restoration may not necessarily achieve full expression of these attributes but should demonstrate an appropriate trajectory of ecosystem development towards the intended goals or reference condition (Ray 2014).

Table 5-1 outlines the ecological and functional habitat restoration measures selected for the Project, the objective of each measure, phase and details of implementation, and literature-supported context for the expected effectiveness of the measures. Further literature review is provided in Appendix D. The maps in Appendix B show the site-specific locations and restoration measures to be implemented. A summary of the restoration measures for the Shekilie Pipelines is provided in Table 5-2. The selected measures presented in Tables 5-1 and 5-2, and Appendices B and D have been updated in this revised CHRP and include:

- ~~A summary of the restoration measures~~Site preparation using relatively small, light equipment to scrape surface material and create shallow hollows and small mounds that provide suitable microsites for ~~the Shekilie Pipelines is provided in Table 5-2.~~ vegetation establishment and growth
- Transplanting whole hummocks, each including a conifer seedling up to 2 m in height
- Planting nursery-grown black spruce seedlings
- Tree bending
- Natural regeneration

Professional judgement ~~was~~ and experience, as well as the results of the field surveys completed during 2021 and 2022, were used ~~by~~in conjunction with the ~~Project reclamation specialists~~Decision Framework (Figure 5-1) to ~~adjust~~develop the restoration prescription ~~based on certain conditions. In particular,~~shown on the maps in Appendix B and summarized in Table 5-2. Accessibility, the degree of natural revegetation, and the extent of brushing that was completed for abandonment influenced the selection of restoration treatments. For example, portions of the South Shekilie Pipeline right-of-way within the area burned in 2015 ~~was~~are identified for natural regeneration because the revegetation on and off the Project is consistent~~.~~, and the South Shekilie Extension Pipeline right-of-way will also be left for natural regeneration due to lack of access. As the burned area on the South Shekilie Pipeline right-of-way is patchy~~, habitat polygons that~~ and some segments were ~~not burned retained their~~brushed for abandonment access, some areas have been identified for active restoration ~~prescriptions,~~treatments.

Site preparation and hummock transplants will be completed during frozen conditions using relatively light-weight equipment that requires limited access preparation (Appendix A, Drawing 2). Microtopographic complexity will be established by scraping surface materials to create a shallow hollow and small mound. This technique creates favourable microsite conditions for tree establishment and reduces competition from established vegetation.

Transplant hummocks will be sourced from adjacent forested areas and transplanted on the Project footprint to mimic the natural hummocks formed by sphagnum moss. Westcoast will acquire the necessary provincial permitting to collect the source material from the adjacent habitats outside of the pipeline rights-of-way. Each transplant hummock will be selected to include a multi-year conifer seedling up to 2 m in height, although additional germinants or smaller seedlings may also be moved with the hummock. An advantage to this method is that hummocks include a naturally occurring diversity of ecosystem components including mosses and vascular plants, and often much larger trees than standard nursery seedling stock. As a result, hummock transplanting has potential to speed recovery to intact and functional ecosystems consistent with the ~~Decision Framework (Figure 5-1).~~surrounding area.

Nursery-grown black spruce seedlings will be planted to supplement the hummock and seedling transplants (Appendix A, Drawing 3). Seedlings will be planted during non-frozen conditions, outside the sensitive timing window for caribou (i.e., late July to August 2023). Locations for nursery seedling planting have been selected based on the availability of safe helicopter landing sites in proximity to the Shekilie Pipelines~~ as well as~~, ground conditions or watercourses that limit the distance planting crews can safely access, and in consideration of safe extraction in the event of an emergency~~.~~

(Appendix B). Depending on site conditions at the time of planting, there may be adjustments ~~made~~ to the selected planting areas. ~~Within treed~~

Restoration areas that cannot be safely planted~~,~~ during summer conditions have restoration prescriptions including various combinations of site preparation (~~mounding) will be conducted following abandonment activities in winter 2022, which will enhance microsite conditions for tree establishment~~hollows and mounds), hummock with tree seedling transplants, tree bending, and natural regeneration. During field surveys in summer 2021, crews observed high numbers of conifer germinants, particularly in areas without dense shrub regeneration. This indicates that the surrounding forest is an adequate seed source. ~~Mounding~~The site preparation and hummock transplants will ~~not only~~ create suitable soil conditions ~~for tree germinants to establish, but it will also~~and temporarily reduce some of the competing vegetation~~.~~ to promote natural ingress of trees from natural seed sources including the adjacent forest stand and trees bent over the rights-of-way.

Tree bending will be implemented as shown on the maps in Appendix B, with the primary objective of creating line-of-sight and access barriers. Tree bending will be used in combination with other restoration treatments in locations where suitably sized trees are available adjacent to the restoration area. To mitigate the potential for stem breakage and simulate natural wind-throw, tree bending is done by digging to release the root mass on the forest side so that the root ball pushes up when the tree is bent towards the right-of-way. The objective is to minimize root disturbance, maintain root contact with the soil, and avoid breaking the stem so the tree is not killed and the crown of the tree creates a movement and line-of-sight barrier. As noted, tree bending may promote natural revegetation by increasing seed deposition onto the restoration area and create microsites through shading and dropped dead woody debris and protecting planted seedlings from extreme weather, wildlife trampling, and damage from access.

Overall, approximately ~~40~~21 percent of the Shekilie Pipelines will be planted with tree seedlings and ~~60~~70 percent will be natural regeneration; ~~62~~25 percent will have ~~site preparation (mounding or ripping)~~hummock transplants with seedlings up to 2 m in height, which will also create microsites to enhance growing conditions for seedlings and natural regeneration.

As described in subsection 4.2, there is very little human access in the Project area, and it is limited to the existing winter roads used by industry. ~~The proposed access control~~A combination of tree bending and

~~line-of-sight mitigation locations~~vegetation screen planting will be installed at selected intersections with existing access, and are shown on the maps in Appendix B.

Table 5-1. Selected Habitat Restoration Measures

Mitigation/Restoration Measure	~~Objective~~Objectives	Implementation Phase and Details	Literature-Supported Context for Expected Effectiveness of Restoration Measures
Site preparation – ~~mounding or ripping~~microsite creation	~~Establish trees in disturbed caribou habitat areas with limited natural regeneration:~~ ▪ Create suitable growing conditions for seedling establishment in lowlands and transitional habitats that are limited by high water tables, and where competing vegetation may be an inhibiting factor ▪ Alleviate soil compaction, reduce competition from agronomic grasses, and establish suitable growing conditions on site features	▪ Site preparation will be implemented during winter ~~2022 following completion of abandonment activities~~2023, as frozen ground conditions are necessary to access the Project. ▪ ~~Treed lowlands and transitional sites on the pipeline rights-of-way~~ Relatively small, light equipment will be ~~mounded where shown on the maps in Appendix B. The target mound density is 1,200 mounds/ha to 2,000 mounds/ha where practical, and no less than 700 mounds/ha where soil frost conditions~~ used to limit the ~~density. The target excavation depth is 0.75 m (approximate). Excavated material will be placed beside the excavation to create mound and hollow microterrain features. Refer to Drawing 3 in Appendix A.~~ ▪ ~~Alternate site~~ amount of winter access preparation ~~techniques (e.g., ripping) may be used at the site facilities where soil compaction and competition from agronomic grasses are likely to limit growing conditions. Where ripping is used to decompact soils on site features, target a depth of at least 0.7 m (NRCan 2016).~~needed. ▪ ~~Mounding~~Surface materials will be scraped to establish shallow hollows and small mounds that create microsite conditions favourable for tree establishment (e.g., reduced competing vegetation, improved drainage, or site moisture). Refer to Drawing 2 in Appendix A. ▪ The density and distribution of microsites will be variable. This technique allows for implementation decisions to be made at the microsite level to avoid areas with suitable natural regeneration, target areas with poor revegetation and limiting site factors, and adjust density and distribution to match the availability of transplant material. Areas of microsite creation are shown on the maps in Appendix B. ▪ Microsite locations will be created for hummock transplants and, where safe access is available, microsites will be planted with tree seedlings~~.~~ in summer 2023. Where safe access is not available mounded areas will be left to natural regeneration.	▪ Mounding has been found to discourage human access (i.e., trucks and all-terrain vehicles [ATVs~~)~~]) during snow-free periods and can create microsites that improve vegetation establishment (Macadam and Bedford 1998; MacIssac et al. 2004; Golder 2007; Roy et al. 1999). For access control purposes, mounds should be created using an excavator to 0.75 m deep, where site conditions allow (Golder 2012). The excavated material is placed beside the excavation to create a 'lump and hollow' terrain feature (Macadam and Bedford 1998). Mound height will generally be less than 0.75 m as the material will settle. The small hollows and mounds created with the small equipment on the Shekilie Pipelines will be too small to inhibit human access. Therefore, the primary objective for site preparation is to create conditions favourable to tree establishment. ▪ For the purposes of enhancing microsites for planted seedlings, mounding is commonly used in wet, low-lying areas to create better drained microsites to enhance seedling survival. Mounding treed wetlands (e.g., bogs, fens) can enhance a site to promote natural revegetation over time, as higher, drier spots are created that seed can eventually settle into and germinate (Macadam and Bedford 1998). Soil properties (e.g., substrate, drainage) affect the ability of mounds to retain their structure. ▪ ~~For access control purposes, mounds should be created using an excavator to approximately 0.75 m deep, where site conditions allow (Golder 2012). The excavated material is placed beside the excavation to create a 'lump and hollow' terrain feature (Macadam and Bedford 1998). Mound height will generally be less than 0.75 m as the material will settle.~~ ▪ Suggested densities of mounding for access control or microsite creation purposes vary from 1,200 mounds/ha to 2,000 mounds/ha (Alberta Environment 2010; Golder 2012). Mound density is affected by soil characteristics, amount of frost, and type of equipment used. In practice, achievable mound density on pipeline rights-of-way created during frozen conditions may varies from 700 mounds/ha to 1,400 mounds/ha (NGTL 2019). These mound densities are relevant to restoration programs that use heavy equipment. The microsite density and distribution implemented for the Shekilie Pipelines will be highly variable; therefore, these target densities are not applicable. ▪ Disc trenching can create similar microsite conditions, however with a trench pattern rather than small patches. In silvicultural applications, it may be used in natural regeneration or seedling planting sites, on a variety of site conditions with the exception of wet or steep sites (von der Gönna 1992). Discing is a method sometimes applied during pipeline construction, to alleviate compaction and create microsite conditions, however, its effectiveness for the Project may be limited by the high level of compaction and frozen ground conditions. Ripping (plowing) is another site preparation technique that is often used to alleviate soil compaction, which may be better suited to the site features. The equipment used on the Shekilie Pipelines will not have the capability for ripping or discing. Therefore, measures previously considered in the original CHRP are no longer applicable. Instead, small microsite creation (hollows and small mounds) will be used to alleviate areas of compaction. ▪ Results of monitoring at the KLRA showed that small mounds will settle over time and create drier microsites than the surrounding areas (Hervieux et al. 2021). Preliminary data from monitoring in 2022 indicates good survival and health of seedlings planted into suitable microsites on the mounds (Tigner pers. comm.).
Hummock transplants with tree seedlings	▪ Quickly establish trees in disturbed caribou habitat in areas with limited natural regeneration ▪ Transplant intact mounds of surface material with natural vascular plants and propagules to help re-establish natural vegetation community	▪ Transplant hummocks will be sourced from adjacent forested areas and transplanted on the Project footprint to mimic the natural hummocks formed by sphagnum moss. Mechanical equipment is necessary for hummock transplanting, which requires this measure to be completed during frozen conditions to facilitate access. ▪ Westcoast will acquire the necessary provincial permitting to collect the source material from the adjacent habitats outside pipeline rights-of-way. Adverse effects on the donor habitat will be limited by avoiding taking more than half of the available seedlings from a given area, and by limiting damage to the surrounding natural vegetation and surface soils as much as possible. ▪ Each transplant hummock will be selected to include a multi-year conifer seedling up to 2 m in height, although additional germinants or smaller seedlings may also be moved with the hummock. ▪ The hummock will be scraped off the surface to avoid scooping out large pits. The hummock will retain as much of the tree seedling root mass as practical, given limitations of the small equipment used. Hummocks will be placed into hollows created during site preparation on the Project footprint, attempting to avoid air pockets between the hummock material and surface soils.	▪ Results of 2-year monitoring of caribou habitat restoration at the KLRA in the Snake-Sahtaneh caribou range showed early success in hummock transplanting. Restoration at KLRA tested transplanting of hummocks directly onto unmodified surface soils (peat) and into shallow hollows prepared by scrapping off the surface soils. Both methods had successful integration and anchoring of hummock transplants indicated by live moss growth at the edges of the hummock transplants, and the moss, vascular plants and target trees in the hummock transplants showed persistence and new growth. (Hervieux et al. 2021) ▪ Monitoring at KLRA further indicated that terminal growth of the target trees on the transplanted hummocks was significantly better where moisture availability is higher. Site preparation to create hollows for transplanting increases hummock contact with water, thereby increasing available moisture. (Hervieux et al. 2021)

Table 5-1. Selected Habitat Restoration Measures

Mitigation/Restoration Measure	~~Objective~~Objectives	Implementation Phase and Details	Literature-Supported Context for Expected Effectiveness of Restoration Measures
Plant conifer seedlings	▪ Establish trajectory towards forested habitat with suitable tree seedlings	▪ ~~Conifer~~Nursery-grown black spruce seedlings will be planted to supplement the hummock and seedling transplants (Appendix A, Drawing 3). Black spruce seedlings will be procured in ~~2021~~2022 and planting will be implemented in summer ~~2022~~2023, after July 15 (outside the sensitive timing window for caribou). ▪ Planting locations are constrained by accessibility and safety considerations. Depending on site conditions at the time of planting, the areas planted may be adjusted during implementation. Where planting is not practical, the restoration method will be natural regeneration or a combination of site preparation (e.g., ~~mounding)~~microsite creation), tree bending and natural regeneration. ▪ Tree seedling species are determined based on the biophysical characteristics of the site, adjacent forest stand composition, and restoration objectives (e.g., low palatability for ungulates, such as moose and deer). ~~Black spruce is usually selected for lowland and transitional sites, although white spruce may be selected in some transitional sites where it occurs in the adjacent habitat. White spruce is selected for upland sites, as lodgepole pine is limited in occurrence in the Project area. Refer to the restoration maps in Appendix B for site-specific species recommendations.~~ The treed ecosystems encountered along the Shekilie Pipelines are mostly dominated by black spruce; however, there are incursions of white spruce and jack pine in transitional and upland areas where soils are better drained. For simplicity in restoration implementation, the revised habitat restoration prescription is to use only black spruce nursery stock, as it is expected to establish and grow in the lowland, transitional, and coniferous or mixedwood upland sites, where suitable microsites exist. Black spruce seedlings will not be planted in deciduous upland sites. Other conifer species (e.g., white spruce, jack pine, tamarack) may be used in hummock transplants where source material is available adjacent to the restoration areas. ▪ ~~The target planting density for mounded lowland and transitional sites is 1,400 mounds/ha to 2,000 stems/ha, which will vary depending on mound density. Large mounds may have two or three suitable microsites for seedling planting. The target planting density for upland sites is 1,600 mounds/ha to 2,000 stems/ha.~~ ▪ ~~Refer to Drawing 4 in Appendix A.~~ Planting nursery-grown black spruce will supplement hummock transplants with tree seedlings and natural regeneration that is already occurring. Therefore, the planting density and distribution will vary. The restoration approach using combined treatment methods allows for implementation decisions to be made at the microsite level to target areas with limited natural regeneration and suitable microsites (refer to Drawings 2 and 4 in Appendix A). Locations where nursery seedling planting will be incorporated into the restoration treatments are shown on the maps in Appendix B.	▪ Applied research of human and predator use of revegetating seismic lines in west central Alberta found (Finnegan et al. 2014; MacNearney et al. 2015; Pigeon et al. 2016, Dickie et al. 2017): – ~~clear~~Clear declines in movement rates of predators (grizzly bears and wolves) when vegetation is > 1.4 m to 1.5 m height~~;~~ – ~~considerable~~Considerable declines in human use at vegetation heights of 2 m, decreasing to no use when vegetation is > 5 m tall~~;~~ – ~~vegetation~~Vegetation cover > 50 to 75 percent and soil type (wet soils) were important indicators of lower human use~~.~~ Transplanting multi-year tree seedlings on hummocks and in placing transplants in suitable microsites with available moisture will achieve target vegetation heights faster than nursery-grown seedlings or natural revegetation. ▪ Mortality of planted seedlings may be as high as 5 to 20 percent, depending on site conditions (Golder 2015). However, seedling mortality 2 years after hummock transplants was 2 percent, with a single mortality due to a hinged tree that fell onto and damaged the seedling on the hummock transplant. ▪ Tree seedling survival and growth can be significantly influenced by human access on linear features. The potential for access issues limiting tree growth on the Shekilie Pipelines is low due to the remoteness and very wet terrain. Combining tree transplants and seedling planting with tree bending will help to mitigate the potential effects of human access on regenerating vegetation.
Vegetation screens	▪ Long-term management of access and line-of-sight	▪ During abandonment activities in winter 2022, vegetation screens will be retained where clearing of regenerating vegetation can be avoided or minimized, to the extent practical. ▪ Planted vegetation screens will be installed ~~in summer 2022~~ by planting conifer seedlings and/or by transplanting trees and tall shrubs from adjacent habitats~~.~~ (see hummock transplants with seedlings in this table). ▪ A combination of fast-growing shrubs with conifer seedlings is preferred to quickly establish vegetation screens that will have long-term effectiveness. ▪ Where combined plantings are used for vegetation screens, plant conifer and deciduous species suited to the ecosystem (consistent with adjacent vegetation). ~~Willow staking may be used rather than planting rooted stock where willows naturally occur on the adjacent habitat. However, species~~Species with lower palatability (e.g., green alder) are preferred over willow, red-osier dogwood and rose species, where appropriate to the ecosystem. ~~Rooted nursery stock or transplanted~~Transplanted alder shrubs from other areas of the right-of-way or off right-of-way will be used as alder does not root well from stakes~~.~~ and rooted nursery stock will not be available. ▪ Plantings should extend the full width of the right-of-way, and be a minimum of three rows of plantings, suitably spaced. The spacing of plantings for vegetated screens is reduced because the objective is to quickly establish a dense vegetated barrier to access and sight lines. The target spacing for vegetation screen rooted stock plantings sourced from a nursery or from staking is approximately one plant per m^2. If using transplants, increase the spacing to an approximate density of one plant per 3 m^2. ▪ Refer to Drawing 4 in Appendix A.	▪ Regenerating conifers provide visual barriers~~;~~; however, the faster growth rates of deciduous species ~~provides~~provide for effective results more quickly (DES 2004). Results of the OSLI Faster Forests project suggested that planting shrubs along with trees allows trees to grow healthier, faster, and with less competition for nutrients and water from fast-growing grasses (Golder 2012). It may also provide important habitat benefits for wildlife (compared to planting tree seedlings alone) by providing hiding cover (Bayne et al. 2011). ▪ As the pipeline is being abandoned (i.e., the entire width/length of the right-of-way are not cleared/stripped), the typical constraints with planting vegetation screens over the full width of the pipeline right-of-way are not applicable. Vegetation screens are less effective if placed where there is an adjacent operating right-of-way or road. ▪ Transplanting has the advantage of immediately establishing relatively large trees (saplings) and tall shrubs at functional height for access control and line-of-sight management (Osko and Glasgow 2010). Locally sourced transplants are suited to local site conditions. However, transplanting may be challenging and is not recommended for large scale application due to the difficulty in obtaining transplantable vegetation, the resulting degradation of areas where the transplants are taken from, and the difficulty in transporting and storing transplants (Golder 2012, 2015). Transplanting of willow and poplar species, which can attract primary prey ungulates, should be avoided and used only in areas where they would naturally occur in an undisturbed system. ▪ Alder species are less palatable shrubs (Fryer 2011; Uchytil 1989) to be used for caribou habitat restoration if consistent with the ecosystem vegetation community (Golder 2015). Alder has relatively low browse value for ungulates such as moose and deer (Poole and Stuart-Smith 2005; Uchytil, 1989); the palatability rating of alder is similar to conifers (CRRP 2007). Compacted sites that are difficult to treat using mechanical site preparation methods can benefit from inter-planting alder with conifers. When alder is interspersed with conifer plantings, line-of-sight and human access on linear features can be reduced relatively quickly, compared to conifers alone. The nitrogen-fixing characteristics of alder can provide soil enhancement (Sanborn et al. 2001), potentially promoting improved conifer growth over the long-term (Courtin and Brown 2001; Simard and Heineman 1996). The fast growth of alder can reduce growth rates of conifer plantings due to competition when alder densities are high (CRRP 2007; Simard and Heineman 1996). Alder does not readily establish from adventitious buds and generally requires seeding or planting rooted stock rather than live staking (Darris 2002).
~~Vegetation screens (cont'd)~~	~~As above~~	▪ ~~With prior authorization of the appropriate regulatory authority, trees and shrubs may be collected from the adjacent habitat and transplanted on the right-of-way to create visual screens. When collecting transplants, they will be selected from a dispersed area to avoid creating large clearings or openings.~~ ▪ ~~Plantings should extend the full width of the right-of-way, and be a minimum of three rows of plantings, suitably spaced. The spacing of plantings for vegetated screens is reduced because the objective is to quickly establish a dense vegetated barrier to access and sight lines. The target spacing for vegetation screen rooted~~	▪ ~~Alder species are less palatable shrubs (Fryer 2011; Uchytil 1989) to be used for caribou habitat restoration if consistent with the ecosystem vegetation community (Golder 2015). Alder has relatively low browse value for ungulates such as moose and deer (Poole and Stuart-Smith 2005; Uchytil, 1989); the palatability rating of alder is similar to conifers (CRRP 2007). Compacted sites that are difficult to treat using mechanical site preparation methods can benefit from inter-planting alder with conifers. When alder is interspersed with conifer plantings, line-of-sight and human access on linear features can be reduced relatively quickly, compared to conifers alone. The nitrogen-fixing characteristics of alder can provide soil enhancement~~

Table 5-1. Selected Habitat Restoration Measures

Mitigation/Restoration Measure	~~Objective~~Objectives	Implementation Phase and Details	Literature-Supported Context for Expected Effectiveness of Restoration Measures
		~~stock plantings sourced from a nursery or from staking is approximately one plant per m^2. If using transplants, increase the spacing to an approximate density of one plant per 3 m^2.~~ • ~~Refer to Drawing 5 in Appendix A.~~	~~(Sanborn et al. 2001), potentially promoting improved conifer growth over the long-term (Courtin and Brown 2001; Simard and Heineman 1996). The fast growth of alder can reduce growth rates of conifer plantings due to competition when alder densities are high (CRRP 2007; Simard and Heineman 1996). Alder does not readily establish from adventitious buds and generally requires seeding or planting rooted stock rather than live staking (Darris 2002).~~
~~Rollback or tree felling, hinging, or bending~~	~~Immediate management of access and line-of-sight~~	• ~~Vegetation screens may be supplemented by mounding (described above) or access and line-of-sight barriers (e.g., rollback or tree felling, hinging, or bending). The technique used will depend on the availability of materials and equipment, and logistical and safety constraints specific to the site and seasonal conditions. Refer to Drawings 1 and 2 in Appendix A.~~ • ~~Suitable woody debris of suitable size for rollback is not expected to be available from the Project. Unless Westcoast is able to source rollback material from offsite, this method will not be used. If offsite material is imported for use as access control, it will be spread over the full width of the right-of-way at the locations identified on the maps in Appendix B, for a length of 50 m to 100 m and target coverage of 200 m^3/ha to 300 m^3/ha (approximately 18 m^3 to 30 m^3 of material for a 50 m to 100 m segment of right-of-way).~~	• ~~Coarse woody debris rollback can be used for access management and to enhance restoration of natural habitat characteristics (e.g., conserve soil moisture, moderate soil temperatures, provide nutrients as debris decomposes, prevent soil erosion, provide microsites for seed germination, and protection for introduced tree seedlings) (Pyper and Vinge 2012; Vinge and Pyper 2012).~~ • ~~Coarse woody debris for access control should be spread evenly across the entire disturbance footprint width at a coverage/density that will not restrict ability to plant seedlings or limit planted or natural seedling growth. Recommended application rates of woody debris rollback for access control vary. Osko and Glasgow (2010) suggest woody debris to deter ATV use along a pipeline disturbance should not exceed 400 tonnes/ha. Where sufficient material is available, woody debris coverage of 150 m^3/ha to 250 m^3/ha along rights-of-way may be appropriate to manage human and wildlife access (Vinge and Pyper 2012). Preliminary results of recent research suggest that application of high densities rollback at linear feature intersections reduces use of the intersection by humans, wolves, and deer.~~ • ~~Where sufficient material is available, woody debris coverage can range from 60 m^3/ha to 100 m^3/ha on upland sites and 25 m^3/ha to 50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012).~~
Tree bending	▪ ~~As above~~Immediate management of access and line-of-sight ▪ Seed deposition to promote natural regeneration of trees	▪ ~~Felling, hinging, or~~Tree bending will be used to create access and line-of-sight barriers. Application of this technique will depend on the occurrence of an adjacent third-party right-of-way, availability of trees of suitable size along the edges of the Project footprint, and logistical and safety constraints specific to the site and seasonal conditions. Refer to Drawing 1 in Appendix A. ▪ Bending trees from outside the Project will require ~~authorization from the appropriate regulatory authority (i.e., AEP) and~~ Temporary Field Authorization and may require an agreement with relevant ~~FMA~~Forest Management Agreement holder(s) (i.e., Tolko Industries Ltd. within 117-11 W6M and 118-12 W6M and Footner Forest Products Ltd within 117-11 W6M and 118-12 W6M). If used, these techniques will be implemented in winter 2022 upon completion of abandonment activities. ▪ There is limited human access in the Project area and the advanced shrubby revegetation on the Project limits sight lines. The recommended locations for access control where ~~these techniques may be used on conjunction with vegetation screens~~tree bending can be used are limited to intersections with existing winter access routes, as shown on the maps in Appendix B. Existing advanced regenerating shrubs and trees ~~will be protected~~were avoided to the extent practical during abandonment activities~~,~~ and may be used strategically to support access and line-of-sight management objectives at the recommended locations. For example, tree bending alone may be required on the side of the right-of-way with temporary access if it is strategically placed at a location where natural regeneration effectively blocks the access and line-of-sight on the remainder of the right-of-way.	• ~~Coarse woody debris rollback can be effective immediately following implementation to deter access, provided adequate material is available and properly applied (Vinge and Pyper 2012). Long rollback segments are more effective at managing human access because ATV riders will be less inclined to try to ride through the debris or traverse around it in adjacent forest stands. Sections of rollback less than 100 m in length may not be effective at deterring motorized access (Vinge and Pyper 2012). An expert opinion survey cited 400 m long rollback segments as sufficient length (Golder 2007).~~ • ~~Fire risk is a consideration when using or storing materials for rollback. Fire risk can be minimized through proper storage and placement of materials (Pyper and Vinge 2012; Vinge and Pyper 2012). A 25 m rollback-free fuel break placed at 250 m intervals along long rollback segments is suggested (Pyper and Vinge 2012).~~ ▪ Mechanically bending ~~or hinging~~ live trees onto linear disturbances has been tested as a measure to restore habitat and manage access on seismic lines in caribou range (Pyper et al. 2014). Trees are typically bent ~~or felled~~ from both sides of the linear disturbance. ~~These measures are~~This technique is often used in conjunction with other restoration techniques (e.g., ~~mounding~~site preparation and conifer seedling planting) for restoration of seismic lines in boreal caribou ranges. ▪ Tree bending is completed by pushing over trees across the right-of-way with heavy equipment or by winching. The objective is to maintain root contact with the soil, so the tree is not killed, ~~however, to~~while still ~~create~~creating a movement and line-of-sight barrier (Pyper et al. 2014). This ~~relatively new~~ technique shows promising results, but winter applications frequently result in the stem breaking (Pyper et al. 2014). ▪ ~~Felling trees, especially conifers, across a linear disturbance feature can effectively block access and line-of-sight, although it typically results in rapid loss of needles (Pyper et al. 2014). Tree hinging involves cutting trees about 1 m up from the base so they fall over the linear disturbance. In addition to blocking access, the intact crown of the hinged tree creates an effective line-of-sight barrier. By leaving a small section of the trunk intact when hinging trees, the hinged tree may retain its leaves longer as nutrients and water are still able to flow to the crown. An alternate technique is to fell the tree and then lift the trunk back onto the stump. This can create logistical and safety challenges, particularly during winter conditions (Pyper et al.~~By avoiding stem breakage, the bent tree will retain its leaves longer (compared to felling or hinging) as nutrients and water are still able to flow to the crown (Pyper et al. 2014). ▪ Line blocking with tree felling or tree bending should be used in combination with other management actions, such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. ▪ Tree ~~felling/~~bending may promote natural revegetation by increasing cone deposition onto the Project, creating microsites through shading and dropped dead woody debris, and protecting planted seedlings from extreme weather, wildlife trampling, and damage from access.

Table 5-1. Selected Habitat Restoration Measures

Mitigation/Restoration Measure	~~Objective~~Objectives	Implementation Phase and Details	Literature-Supported Context for Expected Effectiveness of Restoration Measures
Natural regeneration	▪ Protect areas with advanced natural regeneration that meets specified targets	▪ Results of the field program completed in June 2021 indicate that the limited vegetation management over the Shekilie Pipelines in recent years has allowed substantial vegetation regeneration (~~subsection~~Section 4~~.1~~). ▪ Graminoid and shrubby wetlands have regenerated well and there were no indicators of reduced wetland function evident during the overflights and ground surveys. No further restoration measures are proposed within these habitat types. Winter access is expected to limit new disturbance to graminoid and shrubby wetlands. ▪ Where advanced regeneration of trees occurs (e.g., on raised microsites in treed lowlands and transitional habitats and some upland treed habitat types) efforts ~~will be~~were made to limit disturbance to the regenerating trees during abandonment activities~~ and site preparation for restoration~~, to the extent practical. ▪ In treed wetlands where planting is not practical, the restoration method will be natural regeneration or a combination of site preparation (e.g., ~~mounding)~~microsites), tree bending and natural regeneration.	▪ Soil moisture conditions are the predominant limiting factor for natural regeneration of seismic lines in boreal caribou habitat. Excessive soil moisture inhibits natural regeneration of treed habitat on seismic lines in boreal regions, while natural regeneration is most likely to occur on mesic sites (van Rensen et al. 2015). ▪ Re-establishment of woody vegetation can effectively inhibit motorized access and may also mitigate predator access and movement once vegetation reaches sufficient height and density. Construction methods that facilitate rapid regeneration of woody vegetation promote access management, as well as habitat restoration over the long-term. ▪ Winter roads ~~will be~~were used for accessing the Project for abandonment activities. Although brushing ~~will be~~was required, ~~the need for~~ soil ~~salvage~~ and ~~grading is not anticipated~~low vegetation disturbance was limited. Reduced disturbance to vegetation and root systems is achieved by cutting, mowing, or walking down and mulching shrubs and small diameter trees at ground level, and using a protective layer (e.g., snow, ramps, pads, or mats) to cover the vegetation and surface soils, preventing excessive damage from construction equipment and traffic. This leaves intact root systems and seed beds with little soil disturbance, which facilitates rapid regeneration of vegetation and reduces the need for costly site preparation and tree/shrub planting techniques (Bentham and Coupal 2015).

~~Notes:~~
~~ATV = all-terrain vehicle~~
~~m^3 = cubic metre(s)~~
~~m^3/ha = cubic metre(s) per hectare~~

Table 5-2. Summary of Habitat Restoration Measures

Project Component	Restoration Method	Area (ha)
North Shekilie Pipeline (including temporary access)	~~Natural regeneration~~Microsites, plant black spruce and tree bending	~~5.11~~1.39
	~~Mound~~Microsites, hummock transplants and plant black spruce	~~8.75~~7.91
	~~Mound and plant white spruce~~Microsites, hummock transplants and tree bending	~~0.06~~10.51
	~~Plant white spruce~~Tree bending	~~0.03~~6.63
	~~Mound and natural~~Natural regeneration	~~16.38~~15.97
NS-1 Launcher	~~Mound or rip~~Microsites, hummock transplants and plant black spruce	1.50
NS-2 Watershed Boundary (cut and cap)	~~Mound or rip and~~ Microsites, hummock transplants plant black spruce and tree bending	0.16
NS-3 Producer Tie-in	~~Mound or rip and plant black spruce~~Tree bending	0.10
South Shekilie Pipeline (including temporary access)	~~Mound and~~Microsites, plant black spruce and tree bending	~~2.29~~0.78
	~~Mound and plant white spruce~~Tree bending	~~<0.01~~15.87
	Natural regeneration	~~15.60~~21.53
	~~Plant white spruce~~Microsites, hummock transplants and plant black spruce	~~3.84~~2.02
	~~Mound and natural regeneration~~Microsites, hummock transplants, plant black spruce and tree bending	1.~~31~~37
	Hummock transplants and tree bending	1.79
SS-2 Current Launcher	~~Mound or rip~~Natural regeneration and ~~plant black spruce~~tree bending	1.23
SS-3 Producer Tap	~~Mound or rip~~Natural regeneration and ~~plant black spruce~~tree bending	0.10
South Shekilie Extension Pipeline	~~Mound and plant black spruce~~Natural regeneration	~~8.97~~19.71
	~~Mound and plant white spruce~~	~~0.14~~
	~~Mound or rip and plant black spruce~~	~~0.14~~

SSE-1	Natural regeneration	~~1.36~~0.30
	~~Plant black spruce~~	~~0.46~~
	~~Plant white spruce~~	~~0.19~~
	~~Mound and natural regeneration~~	~~2.50~~
~~SSE-1~~	~~Mound or rip and plant black spruce~~	~~0.30~~

5.4 Schedule

The ~~preliminary~~ schedule presented in Table 5-3 is subject to change pending ~~construction~~habitat restoration progress, which is influenced by seasonal weather conditions (e.g., suitably frozen ground). Project abandonment activities ~~are scheduled~~were completed during frozen conditions ~~to facilitate access for heavy machinery. Brushing and freezing~~ in ~~of~~ winter ~~access is planned to start in December~~ 2021 ~~and may extend into January~~ /2022.

~~Abandonment activities~~Site preparation, hummock transplants and tree bending are ~~expected~~planned to be completed in ~~February~~winter 2022~~. Westcoast plans to work from east to west to complete the abandonment activities within caribou range as early as possible.~~/2023. Westcoast will monitor the progress of ~~abandonment activities~~habitat restoration and if timelines indicate activities will extend into the February 15 to July 15 sensitive timing window for caribou, Westcoast will consider ~~increasing~~ options to increase productivity to limit the duration of activities during the timing window ~~by adding workforce resources or using alternate equipment that~~. Planting nursery-grown black spruce seedlings will ~~increase efficiency.~~ be completed after the July 15 timing window for caribou in 2023.

~~Habitat restoration measures that require heavy equipment, including mechanical site preparation (e.g., mounding or ripping) and placement of rollback (if material is available) are planned to be completed in February 2022 after abandonment activities. Planting to restore habitat will be completed after the July 15 timing window for caribou in 2022.~~

Table 5-3. Schedule of Project and Habitat Restoration Activities

Activity	Date of Initiation	Date of Completion
Establish winter access	Q4 2021	Q1 2022
Abandonment activities	~~Q1 2022~~Q4 2021	Q1 2022
~~Mechanical site preparation (mounding/ripping)~~ ~~Tree felling/bending[a] and rollback (if material is available) for access management~~	~~Q1 2022~~	~~Q1 2022~~
~~Tree felling/hinging for access management[1]~~ ~~Tree and shrub~~Nursery-grown black spruce planting	Q3 ~~2022~~2023	Q3 ~~2022~~2023
Monitoring	Monitoring Program: Summer ~~2023~~2024 (year 1)	Reporting Schedule: January ~~2024~~2025

Table 5-3. Schedule of Project and Habitat Restoration Activities

Activity	Date of Initiation	Date of Completion
	Summer ~~2025~~2026 (year 3) Summer ~~2027~~2028 (year 5)	January ~~2026~~2027 January ~~2028~~2029

~~Note:~~

~~[a] The use of heavy equipment to push over (bend) trees during mechanical site preparation in winter 2022 (after abandonment activities are complete) will be attempted. Frozen conditions often result in breakage of trees, making hinging impracticable. The EI will assess the extent of breakage and may advise that hand felling/hinging be completed during non-frozen conditions, in conjunction with tree planting in Q3 2022.~~

6. Performance Measures and Targets

The Draft Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (GoA 2018) identifies four indicators that caribou habitat is on trajectory to become effective habitat:

1) The location of restoration programs will contribute to restoration of large tracts of woodland caribou habitat.
2) Areas with advanced natural regeneration are protected.
3) Areas lacking advanced natural regeneration are treated to address site limiting factors and appropriate trees are established.
4) Treatments limit human and predator movement on the landscape.

This revised CHRP ~~has adopted the method outlined for~~uses a combination of qualitative assessments by an experienced caribou habitat restoration practitioner and establishment surveys ~~specified~~outlined in the Draft Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta (GoA 2018) to determine where advanced natural regeneration occurs, and restoration treatments are not necessary.

The CHRP originally used stocking ~~target~~targets consistent with those outlined in ~~the establishment targets are also adopted~~Government of Alberta (GoA) 2018 to monitor the effectiveness of habitat restoration over the PCEM period. However, these targets are better suited to the previous restoration approach, which used site preparation with heavy equipment to create relatively large, evenly distributed mounds that could be planted with tree seedlings at a relatively consistent density. The revised restoration strategy, as described in Section 5, will use a combination of hummock with seedling transplants, site preparation that creates small mounds for seedling microsites, and supplemental planting with nursery stock seedlings. These methods will be applied at varying distribution and density using small equipment and manual techniques to focus on areas that do not already have naturally regenerating woody vegetation. As a result, some of the performance measures and targets previously used in the original CHRP are no longer applicable. The literature summarized in Table 5-1 and Appendix D ~~is~~inform the ~~basis for the remaining~~ performance measures and targets. Table 6-1 outlines the revised performance measures to be monitored and targets against which effectiveness will be measured.

Table 6-1. Habitat Restoration Performance Measures and Targets

Habitat Restoration Approach	Objective	Performance Measures	Targets
Microsite creation through scraping a thin layer of surface material to create shallow hollows for hummock transplants and small mounds for seedling planting and natural ingress of native vegetation	Create suitable growing conditions for hummock transplants and tree seedlings	▪ Percent of raised microsites (small mounds created by scraping) with suitable microsites for seedling planting ▪ Occurrence of non-native invasive plants	▪ At least 90% of the small mounds created by scraping the surface soils for hummock transplants provide suitable microsites for planting black spruce seedlings (refer to nursery stock seedling survival for additional relevant targets) ▪ No non-native invasive plant occurrence in each PCEM year

Table 6-1. Habitat Restoration Performance Measures and Targets

Habitat Restoration Approach	Objective	Performance Measures	Targets
~~Mounding or ripping and planting in treed lowlands and transitional habitats~~Hummock transplants with tree seedlings	~~Create suitable growing conditions to~~Quickly establish trees in disturbed caribou habitat in areas with limited natural regeneration Transplant intact mounds of surface material with natural vascular plants and propagules to help re-establish natural vegetation community	▪ ~~Mound density and size~~ ▪ ~~Soil compaction at site features~~ ▪ ~~Planting microsite suitability~~ ▪ ~~Tree seedling stem density and stocking~~ ▪ Hummock intactness ▪ Percent of hummocks anchored to receiving soils ▪ Percent survival of ~~planted or naturally established~~mosses in transplanted hummocks ▪ Persistence of vascular plants on transplanted hummocks ▪ Percent survival of transplanted tree seedlings in hummocks ▪ Terminal growth of transplanted tree seedlings ▪ Evidence of chlorosis or other health issues in transplanted seedlings ▪ ~~Density of targeted vegetation (e.g., stems/ha of prescribed species planted)~~ ▪ ~~Occurrence of non-native invasive plants~~	▪ ~~Mound density is at least 700 mounds/ha and mounds are providing suitable microsite conditions for tree seedling establishment and growth in areas with high water tables (approximately 0.5 m to 0.75 m mound height in PCEM Year 1)~~ ▪ ~~Seedlings are planted in appropriate microsites with roots above the water table (based on visual estimate of root plug depth relative to standing water in mound excavations, without disturbing the planted seedlings)~~ ▪ ~~Stocking with live planted~~ Transplanted hummocks have not disintegrated and/or sunk below the level of surrounding surface material (peat mosses in lowlands, humus/mineral soils in uplands) ▪ Hummock transplants are at least 40% anchored by year 3 PCEM and at least 60% anchored by year 5 PCEM ▪ Percent of live moss on transplanted hummocks is not less than 80% ▪ Percent cover of live vascular plants on hummocks is not less than 85% of adjacent natural hummocks (excluding tree seedlings) ▪ At least 90% survival of tree seedlings ~~and naturally regenerating multi-year~~ on transplanted hummocks ▪ Tree seedlings ~~is ≥ 70 percent by PCEM Year 5~~transplanted with hummocks show new terminal growth each monitoring year ▪ ~~Live tree stem density (including planted/transplanted~~ Tree seedlings ~~and naturally regenerating multi-year seedlings) is ≥ 1,400 stems/ha by PCEM Year 5~~ ▪ ~~Planted seedlings~~transplanted with hummocks appear healthy (~~not chlorotic, leaders are healthy)~~ ▪ ~~No non-native invasive plant occurrence in each PCEM year~~no evidence of severe chlorosis or other health issues)
Planting ~~in treed upland habitats~~nursery stock black spruce seedlings	Establish trees in disturbed caribou habitat ~~in areas with~~where there is limited natural regeneration	▪ ~~Soil compaction at site features~~ ▪ ~~Tree seedling stem density and stocking~~	▪ ~~Upland site features decompacted with mounding have a mound density of at least 700 mounds/ha and mounds are providing suitable microsite conditions for tree seedling establishment and growth~~

Table 6-1. Habitat Restoration Performance Measures and Targets

Habitat Restoration Approach	Objective	Performance Measures	Targets
		▪ Seedlings are planted in suitable microsites ▪ Percent survival of planted ~~or naturally established~~seedlings ▪ Terminal growth of planted tree seedlings ▪ Evidence of chlorosis or other health issues in seedlings ▪ ~~Density of targeted vegetation (e.g., stems/ha of prescribed species planted)~~ ▪ ~~Occurrence of non-native invasive plants~~	~~(approximately 0.5 m to 0.75 m mound height in PCEM Year 1)~~ ▪ ~~Upland site features decompacted by soil ripping have been ripped to an approximate depth of at least 70 cm~~ ▪ ~~Stocking with live planted seedlings and naturally regenerating multi-year seedlings is ≥ 70 percent by PCEM Year 5~~ ▪ ~~Live tree stem density (including planted/transplanted seedlings and naturally regenerating multi-year seedlings) is ≥ 1,600 stems/ha by PCEM Year 5~~ ▪ Seedlings are properly planted in appropriate microsites with roots above the water table (based on visual estimate of root plug depth relative to standing water in mound excavations, without disturbing the planted seedlings) ▪ At least 70% survival of planted seedlings at year 5 PCEM ▪ Tree seedlings transplanted with hummocks show new terminal growth in PCEM year 3 and 5 (nursery grown seedlings often have very limited aboveground growth in the first years after planting, as the seedling puts most of its energy into root growth) ▪ Planted seedlings appear healthy (~~not chlorotic, leaders are healthy)~~ ▪ ~~No non-native invasive plant occurrence in each PCEM year~~no evidence of severe chlorosis or other health issues)

Table 6-1. Habitat Restoration Performance Measures and Targets

Habitat Restoration Approach	Objective	Performance Measures	Targets
Natural regeneration in graminoid and shrubby wetlands, and where advanced regeneration is protected during abandonment	Retain natural regeneration to support recovery of habitat	▪ Vegetation cover ▪ Vegetation species composition ▪ Occurrence of non-native invasive plants	▪ Vegetation cover (including moss cover) is at least 80 percent (< 20 percent bare soil) in PCEM Year 1 and increasing each subsequent PCEM year ▪ Vegetation species are consistent with the expected species based on adjacent ecosystems ▪ Advanced regeneration areas have not been cleared; or if clearing could not be avoided, have been ~~replanted (refer to planting~~restored with hummock transplants, nursery tree seedling planting, and/or tree bending (refer to the above targets) ▪ No non-native invasive plant occurrence in each PCEM year
Access and line-of-sight management	~~Limit human and predator use of the rights-of-way~~Limit human and predator use of the rights-of-way by retaining regenerating vegetation, bending trees, and/or planting vegetation screens using hummock with conifer seedling transplants and/or nursery tree seedlings; alder transplants may be used to supplement vegetation screen plantings if source material is available in the adjacent area	▪ Placement and extent of planted/transplanted vegetation screens ▪ Qualitative measures of access and sight line barriers where tree ~~felling/hinging/~~bending ~~are~~is used or where advanced regeneration was protected	▪ Access and line-of-sight are effectively blocked across the full width of the right-of-way at the identified intersections with existing winter roads ▪ Planted/transplanted vegetation screens are alive, healthy, and meet target spacing of one plant/m^2 for nursery stock or one plant/3 m^2 for transplants ▪ ~~Rollback, if used, extends the full width of the right-of-way for a distance of at least 50 m~~

7. Monitoring and Adaptive Management

During restoration activities, ~~including mechanical site preparation, access and line-of-sight measures and planting, Westcoast's Environmental Inspector~~FNFN will ~~be~~have an experienced caribou habitat restoration practitioner onsite to monitor and guide the proper implementation of restoration activities ~~and provide direction so that the measures are properly implemented to meet CHRP targets and specifications~~.

Following the completion of physical abandonment activities and habitat restoration, Westcoast will conduct PCEM for a period of 5 years ~~to ascertain if vegetation regrowth is on an appropriate trajectory (Years 1, 3, and 5 following completion of restoration). Monitoring will compare the habitat on the rights-of-way to adjacent habitat. Species composition, community structural stage, and soil assessments will be assessed, in addition to planted seedling density, health, and survival. Locations where access or line-of-sight management is implemented will be monitored for integrity.~~

(Years 1, 3, and 5 following completion of restoration). A combination of aerial and ground-based monitoring methods will be used to measure the performance measures described in Section 6. Aerial overflights will be completed to collect data on integrity and effectiveness of the implemented restoration measures. Observers will look for and record evidence of unauthorized access, surface contours and soil characteristics (e.g., stability, erosion, and compaction), surface hydrology, and debris or sediment within watercourses.

During ground-based monitoring, plant species composition, cover, and growth are the primary factors to be monitored in the vegetation assessment. In natural regeneration areas, establishing plant cover is evaluated based on emerging desirable vegetation (e.g., early successional species consistent with the surrounding vegetation community) and the presence or absence of non-native invasive plants. In wetlands, differences in percent cover between the physical work locations and the reference site are assessed more conservatively than in forested land, as decreases in vegetation cover are typically directly related to concurrent decreases in wetland function.

If issues are identified during monitoring, Westcoast will implement an adaptive management protocol to address identified issues and conduct further monitoring. If an analysis of monitoring data indicates that restoration measures are ineffective (i.e., targets are not being met), then adjustments may be necessary. The type of adjustment to be implemented would be informed through an assessment of why the original restoration measure was ineffective and, where appropriate, would include consultation with government agencies and engagement with Indigenous communities and groups to identify alternative restoration measures. Remedial restoration measures implemented will be monitored for effectiveness in relation to established targets.

Following ~~the~~ completion of ~~physical abandonment activities and~~the habitat restoration, long-term monitoring of the pipeline rights-of-way ~~by aerial flyovers~~ is planned to account for the remote possibility of issues arising ~~in~~beyond the ~~long-term following completion of the~~5-year PCEM program.

8. Reporting

Westcoast will file a Reclamation Report in January after the first, third, and fifth complete growing season following the ~~completion of abandonment activities and~~ implementation of the caribou habitat restoration measures, in accordance with Condition 7 of Order ZO-003-2021.

If equivalent land capability has not yet been achieved or there are issues identified regarding the caribou habitat restoration measures implemented by the fifth-year report, Westcoast will prepare a reporting schedule for monitoring progress towards those objectives.

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Appendix A
Caribou Habitat Restoration Drawings

Link:

Drawing 1 - Bending_v2.doc

Drawing 2 - Site Prep and Hummock Transplants_v2.doc

Drawing 3_SeedlingPlanting-Microsite.pdf

Drawing 4_VegScreens.pdf

Appendix B
Caribou Habitat Restoration Maps

AppB_Figures

Appendix C
Site Photos

AppendixC_Photos.pdf

Appendix D
Supplemental Literature Review

Appendix D. Caribou Habitat Restoration Literature Review

Habitat restoration may be achieved through various targets or objectives, such as revegetation, rehabilitation, and reclamation, while the ultimate goal is generally returning a disturbance to original or pre-disturbance conditions (Ray 2014). A review of restoration literature found that definitions of successful restoration projects typically focus on vegetation attributes (structure, composition, or diversity) to predict the direction and speed of succession. Recommended site or feature-scale criteria for measuring boreal caribou habitat restoration include: vegetation has established a trajectory towards appropriate ecosite conditions (measured by tree height, plant composition, ground cover, diameter, density, etc.); revegetation is not compromised by human access; native vegetation is compatible with adjacent areas (measured by vegetation structure and composition); and restored areas provide functional attributes of caribou habitat (Ray 2014).

Habitat restoration objectives in boreal caribou ranges have historically attempted to either create intact habitat areas for caribou or slow caribou predation rates as a result of disturbance footprints (Bentham and Coupal 2015). Boreal caribou habitat restoration has focused on silvicultural methods to speed recovery of conifer forests, management of human and wildlife access and movement, as well as limiting growth and establishment of plant species favourable to primary prey species such as moose and deer (CRRP 2007a,b; Osko and Glasgow 2010). Tree and shrub planting, site preparation (e.g., mounding) and coarse woody debris applications have shown positive results in revegetating seismic lines and pipeline rights-of-way (Bentham and Coupal 2015). These and other methods are discussed in the following.

D.1 Tree Seedling Planting and Hummock Transplanting

Silvicultural methods of regenerating forests, including planting nursery-grown seedlings or transplanting saplings, are used in ecological restoration to establish vegetation community composition and structure faster than could be accomplished with natural regeneration. These methods are also adapted for functional habitat restoration, such as high-density plantings in strips across a linear disturbance to create a vegetation screen or barrier.

The limitations of transplanting often make this method impractical for large-scale caribou habitat restoration programs. Limitations include inconsistent availability of vegetation suitable for transplant, potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands, transplanting programs often result in the storage of plant materials under less-than-ideal conditions due to uncontrollable factors (i.e., weather), and other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison (Golder 2012, 2015). However, recent trials of whole-hummock transplants with multi-year seedlings near Kotcho Lake in the Snake Sahtaneh caribou range has shown promising results (Hervieux et al. 2021). Hummock transplants achieve microsite creation and tree establishment in one step, and have the additional benefit of moving intact microsites from the adjacent habitat, complete with seed bank, propagules, live mosses, and vascular plants. As a result, successfully transplanted hummocks can support re-establishing a range of ecosystem components on a disturbance feature.

Species used for restoration are determined based on the biophysical characteristics of the site, adjacent forest stand composition, and restoration objectives (e.g., low palatability for ungulates, such as moose and deer). Regenerating conifers provide effective year-round visual barriers, but the faster growth rates of deciduous species provide for effective results more quickly (DES 2004). Recent research suggests that planting shrubs along with trees allows trees to grow healthier, faster and with less competition for nutrients and water from fast-growing grasses (Golder 2012). It may also provide important habitat benefits for wildlife, compared to only planting tree seedlings, by providing hiding cover (Bayne et al. 2011).

Planting densities for reclamation of forested areas in Canada have been based on forestry standards, ranging from 1,500 ~~stems/ha~~ to 2,500 stems~~/~~ per hectare (ha) (MacDonald et al. 2012). Target stocking densities for the forest industry vary by forest region and species and should be prescribed on a site-specific basis.

A high planting density of 2,000 stems/ha to 2,500 stems/ha has been recommended for restoration of linear disturbances in boreal caribou ranges to account for high anticipated mortality rates of planted seedlings (Golder 2015). Mortality of planted seedlings may be as high as 5 percent to 20 percent, depending on site conditions (Golder 2012). These planting densities are generally applied where there is very sparse or no existing natural regeneration, microsite creation is relatively uniform (such as large mounds created by heavy equipment), or nursery stock seedlings are planted and transplants are not used.

D.2 Bioengineering and Shrub Planting

Bioengineering is the use of live vegetation to stabilize and revegetate a site (e.g., transplants; installing cuttings) and is a technique often used on slopes or riparian banks (Polster 2002). Fast-growing species (willow, poplar) that are typically used for bioengineering are high value browse species for ungulates (e.g., moose and deer). Therefore, they are not preferable for use in caribou range.

Species and planting densities used for bioengineering are site dependent. Vegetation used (e.g., cuttings) is typically collected either from the disturbance site before or during clearing, or from the adjacent area. Vegetation may be planted during the growing season or during winter. Willow, red-osier dogwood, and cottonwood are fast-growing species that will regenerate from cuttings (Polster 2002), quickly establishing line-of-sight breaks and stabilizing soils. However, these are not preferred species for restoration projects in caribou range because of their palatability for ungulates such as moose and deer (Wall et al. 2011; Poole and Stuart-Smith 2005).

Alders are less palatable shrubs (Fryer 2011; Uchytil 1989) that may be used for bioengineering and caribou habitat restoration if consistent with the ecosystem vegetation community (Golder 2015). Alder has relatively low browse value for ungulates such as moose and deer (Poole and Stuart-Smith 2005; Uchytil 1989); the palatability rating of alder is similar to conifers (CRRP 2007a). Compacted sites that are difficult to treat using mechanical site preparation methods can benefit from inter-planting alder with conifers. When alder is interspersed with conifer plantings, line-of-sight, and human access on linear features can be reduced relatively quickly, compared to conifers alone.

The nitrogen-fixing characteristics of alder can provide soil enhancement, potentially promoting improved conifer growth over the long-term (Courtin and Brown 2001; Simard and Heineman 1996). The fast growth of alder can reduce growth rates of conifer plantings due to competition when alder densities are high (CRRP 2007a; Simard and Heineman 1996). Alder does not readily establish from adventitious buds and generally requires seeding or planting rooted stock rather than live staking (Darris 2002).

Nursery-grown shrub seedlings may be planted where staking of cuttings is not practical due to lack of available material, restrictions associated with collecting material offsite, or where a restoration prescription calls for shrub planting of species that do not readily regenerate through cuttings, such as alder and hardhack.

D.3 Natural Regeneration

Research has shown that natural regeneration is faster on mulched low-impact seismic lines compared to conventional seismic lines, particularly in upland ecosites, and when mulch cover is discontinuous and the lines are oriented in a north-south direction (DeMars and Benesh 2016). Shrub regeneration improved on wider seismic lines, where alder and willow stem counts and height measurements were more abundant on lines wider than 3 m, while black spruce growth was better on narrow lines (DeMars and Benesh 2016). Since a pipeline construction footprint is substantially wider than a low-impact seismic line, it could be inferred that conditions on a naturally regenerating pipeline footprint are likely to support shrub growth.

Reduced disturbance construction techniques for pipeline projects often use mulching to remove vegetation while leaving the surface soils and vegetation mat intact. Similar to mulching of low-impact seismic lines (DeMars and Benesh 2016), reduced ground disturbance ('minimum disturbance') pipeline construction encourages rapid natural regeneration of native vegetation. This approach reduces the need for costly site preparation and tree/shrub planting techniques (Bentham and Coupal 2015). Other components of reduced ground disturbance pipeline construction include minimizing the width of new clearing (e.g., overlapping with existing disturbance and keeping the workspace as narrow as possible), and using matting or snow (during frozen conditions) packed over the work/travel surface to minimize surface disturbance and compaction (Golder 2015).

Soil moisture conditions are the predominant limiting factor for natural regeneration of seismic lines in boreal caribou habitat. Excessive soil moisture inhibits natural regeneration of seismic lines in boreal regions, while natural regeneration is most likely to occur on mesic sites (van Rensen et al. 2015). Peatland habitats are a dominant feature of boreal caribou ranges, and as a result, habitat restoration measures have often involved mounding as a site preparation tool to create microsites where soil moisture conditions will support establishment and growth of trees and shrubs.

D.4 Human and Predator Movement

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

Additional research has demonstrated reduction in wolf movement during summer on regenerating seismic lines in boreal caribou ranges where vegetation heights are >1 m; however, vegetation did not decrease movement in winter until it exceeded 5 m (Dickie 2015). The author notes that results are limited by insufficient regeneration in the study area to detect wolf movement during winter, and although the study used vegetation height as a proxy to measure wolf movement, vegetation cover and stem density are more likely to influence wolf movement (Dickie 2015). Where packed trails from construction or recreational activity are not a factor, wolf movement may be impeded by snow on linear features where depths tend to be higher than in forest where the canopy intercepts snow (Fuller 1991).

Applied research of human and predator use of revegetating seismic lines in west central Alberta found (Finnegan et al. 2014; MacNearney et al. 2015; Pigeon et al. 2016):

- ~~clear~~Clear declines in movement rates of predators (grizzly bears and wolves) when vegetation is taller than 1.4 m to 1.5 m height~~;~~
- ~~considerable~~Considerable declines in human use at vegetation heights of 2 m, decreasing to no use when vegetation is more than 5 m tall~~; and~~
- ~~vegetation~~Vegetation cover above 50 percent to 75 percent and soil type (wet soils) were important indicators of lower human use~~.~~

This relationship is less clear for other predators. Tigner et al. (2014) found that black bears continue to use lines with substantial revegetation if game trails are established. These vegetation heights may be used to infer structural attributes of restored disturbances that contribute to lower predation risk for caribou.

Managing human access is an important component of habitat restoration when restoration objectives or targets involve establishment of woody vegetation. The ability of linear features to recover to a natural forested state is affected considerably by human use (Bentham and Coupal 2015). Restoration efforts have failed when all-terrain vehicles (ATVs) destroyed seedlings after planting (Enbridge 2010). Evidence of the effects of repeated motorized access on vegetation establishment and regrowth supports the use of access management tools to enhance restoration success. Seismic lines in boreal habitats in northeastern Alberta experience higher rates of regeneration when they are further from roads (van Rensen et al. 2015).

Dickie et al. (2016) suggest that relatively wide linear disturbances (i.e., conventional seismic lines and pipelines) should be prioritized for restoration to mitigate interactions between wolf travel and caribou risk, but note that intensive restoration activities in proximity to permanent linear features (e.g., roads, railways) may be suboptimal. Repeated motorized access is a key consideration for determining where access management will be effective, and as a result, where silvicultural methods of establishing vegetation are likely to be effective. Subjective expert ratings suggest that the effectiveness of most physical access management measures (e.g., berms, excavations, rollback, visual screening) varies considerably between negligible and high effectiveness in managing human access (Golder 2007; Eos 2009).

Effectiveness of access management measures depends on suitable placement (e.g., placed to prevent detouring around an access management point), enforcement, and public education of the intent of the access management (AXYS Environmental Consulting Ltd. 1995). Public education (e.g., signage) facilitates respect for the purpose of, and compliance with, access management measures. Once access has been used and is considered 'traditional' access, it becomes very difficult to subsequently block or manage (Eos 2009).

Given multiple confounding factors, it is difficult to clearly demonstrate how predator efficiency is affected by sight lines. Blocking line-of-sight is a common practice to mitigate the potential effects of caribou predation risk on linear features. Line-of-sight measures include line blocking, constructed berms and barriers, and revegetation (Golder 2015; BC MOE 2011). Relevant literature pertaining to each of these measures is reviewed and summarized in the other sections of this literature review. Terrain and bends in linear disturbances may also reduce line-of-sight.

Coarse woody debris rollback can be used for access management and to enhance restoration of natural habitat characteristics (e.g., conserve soil moisture, moderate soil temperatures, provide nutrients as debris decomposes, prevent soil erosion, provide microsites for seed germination and protection for introduced tree seedlings [Pyper and Vinge 2012; Vinge and Pyper 2012; Golder 2015; Pyper et al. 2014]). The composition and arrangement of coarse woody debris should be managed within acceptable levels of risk of wildfire, insect pest, and forest disease outbreaks. Potential for fuel loading is a concern when using coarse woody debris as a restoration tool for enhancing growing conditions or blocking access (Golder 2015).

Fire risk can be minimized through proper storage and placement of materials (Pyper and Vinge 2012; Vinge and Pyper 2012). A 25 m rollback-free fuel break placed at 250 m intervals along rollback segments is suggested (Pyper and Vinge 2012).

Recommended application rates of woody debris rollback for access control vary. Osko and Glasgow (2010) suggest woody debris to deter ATV use along a pipeline disturbance should not exceed 400 tonnes/ha. Where sufficient material is available, woody debris coverage of 150 ~~m^3/ha~~ to 250 ~~m^3~~cubic metres/ha along rights-of-way may be appropriate to manage human and wildlife access (Vinge and Pyper 2012). Coarse woody debris rollback can be effective immediately following implementation to deter access, provided adequate material is available and properly applied (Vinge and Pyper 2012).

Long rollback segments are more effective at managing human access because ATV riders will be less inclined to try to ride through the debris or traverse around it in adjacent forest stands. Sections of rollback less than 100 m in length may not be effective at deterring motorized access (Vinge and Pyper 2012).

An expert opinion survey cited 400 m long rollback segments as sufficient length (Golder 2007). Large root wads can provide coarse woody debris that emulates natural features (e.g., blow-down trees expose root wads) and may provide partial barriers to line-of-sight. However, storage of debris requires additional temporary workspace, which can increase the area of the disturbance footprint. The implementation and length of a rollback segment is dependent on sufficient quantities of coarse woody debris and the trade~~-~~-off between its use and the ability/space to store it during construction (Golder 2015; CRRP 2007a).

Woody debris rollback is unlikely to be effective for deterring snowmobile access. High volumes and irregular placement of rollback could pose a safety hazard for recreational snowmobilers if it is not visible under snow cover.

Line blocking refers to various methods of blocking or slowing predator movement or redirecting predators off of a linear disturbance into adjacent forest. It may also be used for deterring human access on linear features. Line blocking methods involving placement of trees or coarse woody debris across a linear disturbance also creates microsite conditions that enhance vegetation establishment and growth. In the case of tree felling or bending/hinging, seed deposition on the disturbance feature also enhances vegetation establishment. As noted previously, these techniques may be considered both functional restoration and ecological restoration.

Mechanically bending/hinging or felling live trees over a linear disturbance is one method of line blocking (DeMars and Benesh 2016), often used on seismic lines in conjunction with other treatments such as mounding in boreal caribou areas to manage predator or human access when snow depths are low. Trees are typically bent or felled from both sides of the linear disturbance. Tree felling entails cutting trees at the base from the edge of the linear disturbance and allowing them to fall across the linear disturbance. Tree bending requires mechanically bending trees from the base of the tree, partially exposing roots, so that the tree leans over the linear feature, close to the ground. Despite challenges to tree bending (expensive, time consuming, winter applications frequently result in stem breaking), its application continues to be tested in boreal caribou areas as a better alternative to tree felling. This is because tree felling results in rapid needle loss, while bending retains some root contact with soils, extending the life of the tree while still creating a line-of-sight and movement barrier (Pyper et al. 2014).

While line blocking treatments have been implemented fairly extensively in boreal caribou ranges in recent years, monitoring programs are in early stages and results are limited. A preliminary assessment of tree felling along seismic lines to block access was conducted in the Little Smoky herd range in Alberta during the summer and fall of 2004 (Neufeld 2006).

While results of that study showed no statistical significance between wolf use of blocked versus non-blocked seismic lines, there was an indication that wolves tended to use areas with unblocked seismic lines more often than areas with blocked seismic lines. Based on these results, it was concluded that if tree felling is to be used as a line blocking measure, it should be investigated more thoroughly, and not relied upon solely as a mitigation tool (Neufeld 2006).

More recently, monitoring of linear features with line blocking treatments at the Statoil Canada Ltd. Kai Kos Dehseh caribou pilot project in northeast Alberta found the treatments reduced human use to essentially zero, and reduced wolf use by more than 50 percent (Pyper et al. 2014). Monitoring of tree bending on seismic lines for the Cenovus Energy Linear Deactivation project has shown this method is immediately effective at deterring human access (Bentham and Coupal 2015), although the study area is in a relatively remote boreal region.

Limitations of tree felling or bending include increasing forest disturbance, limited availability of material (e.g., in open or sparsely treed areas), fire hazard (DeMars and Benesh 2016), risk of forest pest spread and safety risks, particularly where existing access has been open for a period of time and is considered a ‘traditional’ access route.

Ray (2014) emphasizes that even if functional restoration through line blocking reduces predator use or movement, this does little to address the numerical response of predators to deer and moose populations levels. Predation risk is strongly tied to the distribution and abundance of forage for early seral ungulates, and alleviating this risk requires a more comprehensive approach to habitat restoration than managing predator movement (Ray 2014). Preferably, line blocking should be used in combination with other management actions such as habitat restoration and continue to be evaluated for effectiveness using an adaptive management approach.

D.5 Mechanical Site Preparation

Mechanical site preparation is a common silvicultural tool used in the forest industry as well as ecological restoration of disturbed forested sites. It can be used to improve site conditions that might limit seedling survival and growth, by creating favourable microsite conditions for seed germination and seedling growth (von der Gönna 1992). Mounding, scalping, disc trenching, mixing, and ripping or plowing are site preparation options. Their use should be matched to the appropriate site conditions to avoid creating detrimental conditions. A matrix indicating the appropriate site preparation methods for soil conditions (coarse or fine textured), depth of surface organics (humus) and obstacles is provided in von der Gönna (1992).

For the purposes of enhancing microsites for planted seedlings, mounding is a well-researched and popular site preparation technique in the silviculture industry. It is commonly used in wet, low-lying areas to create better drained microsites to enhance seedling survival. The natural regeneration of conifer species, such as black spruce, on peatlands is increased by minor disturbance to substrates and elevated microtopography (Morris et. al. 2009), while natural regeneration of black spruce is often absent or sparse in areas without site preparation such as mounding (Lieffers et. al. 2017). Sites lacking micro-terrain variation often exhibit higher levels of vegetative competition, potentially hindering seedling establishment, as opposed to moderately altered sites (Morris et.al. 2009).

Mounding has been found to discourage human access (i.e., truck and ATV) during snow-free periods and can create microsites that improve vegetation establishment (von der Gönna 1992; Macadam and Bedford 1998; MacIssac et al. 2004; Golder 2007; Roy et al. 1999). Mounding treed wetlands (e.g., bogs, fens) can enhance a site to promote natural revegetation over time, as higher, drier spots are created that seed can eventually settle into and germinate (Macadam and Bedford 1998). Soil properties (e.g., substrate, drainage) affect the ability of mounds to retain their structure. For example, saturated peat mounds tend to lose their structure quickly compared to areas with some mineral soil content.

Mounding has been used as an access control measure on decommission roads, pipeline rights-of-way and seismic lines to discourage off-road vehicle activity (Golder 2015; Pyper et al. 2014; Bentham and Coupal 2015). It can be effective immediately following implementation; however, effectiveness to exclude snowmobile access is not demonstrated and unlikely in areas with high annual snowfall.

For access control purposes, mounds should be created using an excavator to approximately 0.75 m deep, where site conditions allow (Golder 2015). The excavated material is placed beside the excavation to create a 'lump and hollow' terrain feature (Macadam and Bedford 1998). Suggested densities of mounding for access control or microsite creation purposes vary from 600 mounds/ha to 2,000 mounds/ha, depending on mound size and obstacles or constraints such as avoiding a specified area over an operating pipeline (Alberta Environment 2010; Golder 2012). Implementation of this mound density may be suitable where specialized equipment is used, and where frost is not driven into the soils to allow heavy equipment access. The mound density that can realistically be achieved on pipeline rights-of-way is lower since mounding is completed in conjunction with final cleanup.

Scalping or scarification involves shallow scrapings to create small mounds of surface soils and exposed patches of mineral soil. It can be effective in dry sites where the surface soils are thin and soils are coarse, however should not be applied in fine textured soils or wet sites (von der Gönna 1992). Disc trenching can create similar microsite conditions, however with a trench pattern rather than small patches. In silvicultural applications, it may be used in natural regeneration or seedling planting sites, on a variety of site conditions with the exception of wet or steep sites (von der Gönna 1992). Discing is a method sometimes applied during pipeline construction, to alleviate compaction and create microsite conditions. Ripping (plowing) is another site preparation technique that is often used to alleviate soil compaction on pipeline construction rights-of-way. These techniques typically require heavy equipment.

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