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April 30, 2019

Filed Electronically

National Energy Board
Suite 210, 517 Tenth Avenue SW
Calgary, AB T2R 0A8

Attention: Ms. Sheri Young, Secretary of the Board

Dear Ms. Young:

Re: NOVA Gas Transmission Ltd. (NGTL)
North Montney Project (Project)
Certificate GC-125 (Certificate)
Certificate Condition 36
Board File OF-Fac-Gas-N081-2013-10 02

In accordance with Certificate Condition 36, NGTL encloses for filing with the National Energy Board the Preliminary Caribou Habitat Offset Measures Plan.

Should you require additional information, please contact me by phone at (403) 920-7816, or by email at crystal_begin@transcanada.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Crystal Begin
Regulatory Project Manager
Regulatory Facilities, Canadian Natural Gas Pipelines

Enclosure

cc: Kent Rowden, National Energy Board

North Montney Mainline Project Preliminary Caribou Habitat Offset Measures Plan

NOVA Gas Transmission Ltd.

April 2019

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1.0 INTRODUCTION AND ORGANIZATION

This section introduces the rationale, context, and scope for the caribou habitat preliminary Offset Measures Plan (preliminary OMP) for the North Montney Mainline Project and outlines the organization of the key components of the preliminary OMP.

1.1 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada PipeLines Limited (TransCanada), is required by Condition 36 of Certificate GC-125(Certificate) to prepare an OMP for residual impacts to caribou habitat resulting from the North Montney Mainline Project (Project), Aitken Creek Section 52 facilities. Condition 36 of the Certificate reads as follows:

NGTL shall file with the Board for approval, a plan to offset all residual effects of the Aitken Creek Section 52 Facilities resulting from directly and indirectly disturbed critical habitat for caribou, after taking into account the implementation of the EPP and CHRP measures (Offset Measures Plan). NGTL shall provide a copy of the Offset Measures Plan to Environment Canada and the appropriate provincial authorities. The Offset Measures Plan for the Section 52 Facilities shall include:

a) a preliminary version, to be filed with the Board for approval at least 90 days prior to requesting Leave to Open for the Aitken Creek section of the Section 52 Facilities, including, but not limited to, a discussion of:

i) an initial quantification of the area of critical habitat for caribou directly and indirectly disturbed;

ii) a list of the potential on-the-ground offset measures available, the expected effectiveness of each, including a discussion of uncertainty, and how the measures align with criteria specified in the scientific literature specific to conservation offsets;

iii) the relative quantitative and qualitative value of each measure towards achieving the offset;

iv) the proposed offset ratios for each potential measure, based on consultation with expert agencies and on a review of the literature on conservation offsets; and

v) decision framework that will be used to select which specific offset measures and accompanying offset ratios would be used under what circumstances; and *b) a final version, to be filed with the Board for approval on or before 1 February after the second complete growing season following the commencement of operation for the Aitken Creek section of the Section 52 Facilities, including:*

i) the contents of the preliminary version, with any updates identified in a revision log that includes the rationale for any changes to decision making criteria;

ii) a complete table listing the offset measures and offset ratios to be implemented or already underway, including site-specific details and map locations, and an explanation of how they meet criteria in the scientific literature for offsets;

iii) a description of factors considered when determining the location for offset measures, including consideration of how the measures could maximize benefits to landscape variables;

iv) a schedule indicating when offset measures will be initiated and the estimated date when implementation will be complete; and

v) an assessment of the predicted effectiveness of the measures, including a discussion of uncertainty, and a quantitative compilation showing how the offset measures have offset the previously calculated residual effects;

c) Both the preliminary and final versions of the plan shall also include:

i) evidence of how consultation feedback from Environment Canada, provincial authorities and any potentially affected Aboriginal groups is integrated into the plan; and

ii) any updates to applicable Recovery Strategy, Range and Action Plans, as well as range boundaries and identified critical habitat made prior and up to the date on which LTO is granted.

This preliminary OMP was prepared to satisfy the specific elements of Condition 36(a) and 36(c). Table 1-1 provides concordance between those specific elements and the section(s) of this preliminary OMP that address them. This preliminary OMP includes consideration of the Project Environmental Protection Plan (EPP)[1] and the preliminary Caribou Habitat Restoration Plan (CHRP)[2] measures, specifically in relation to on-site habitat restoration measures and residual project effects calculations. Other sections of this preliminary OMP are provided for context as it links to the preliminary CHRP (Section 2.0), and to Condition 37

[1] NEB Filing ID: A92423
[2] NEB Filing ID: A72289 and A72374

(Section 5.1) and Condition 38 (Section 5.3) of NEB Order XG-N081-10-2015 (Order).

Table 1-1 Concordance between Certificate Conditions 36(a) and 36(c) and Preliminary OMP

Condition Number	Condition Element	Section of the OMP
36(a)i	An initial quantification of the area of critical habitat for caribou directly and indirectly disturbed	Section 3.2 Appendix A
36(a)ii	A list of the potential on-the-ground offset measures available, the expected effectiveness of each, including a discussion of uncertainty, and how the measures align with criteria specified in the scientific literature specific to conservation offsets	Appendix B
36(a)iii	The relative quantitative and qualitative value of each measure towards achieving the offset	Section 4.2 Appendix B
36(a)iv	The proposed offset ratios for each potential measure, based on consultation with expert agencies and on a review of the literature on conservation offsets	Section 2.0 Section 4.2 Section 4.3 Section 4.5 Section 6.6 Appendix B Appendix C
36(a)v	Decision framework that will be used to select which specific offset measures and accompanying offset ratios would be used under what circumstances	Section 4.4 Section 4.5
36(c)i	Evidence of how consultation feedback from Environment Canada, provincial authorities and any potentially affected Aboriginal groups is integrated into the plan	Section 2.0
36(c)ii	Any updates to applicable Recovery Strategy, Range and Action Plans, as well as range boundaries and identified critical habitat made prior and up to the date on which LTO is granted.	Section 6.2

The temporal scope of this preliminary OMP is the post-construction phase. Offsets are expected to be implemented, or already underway, within the first or second growing season following commencement of operation.

The spatial scope of this preliminary OMP is partially defined. The amount of area to be offset will be based on direct and indirect residual Project effects on Crown land within the Graham Local Population Unit (LPU). The area(s) where offsets will be implemented will include consideration of consultation outcomes with Environment and Climate Change Canada (ECCC), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC MFLNRORD), the BC Oil and Gas Commission (BC OGC), and affected Aboriginal groups. Offset areas are expected to satisfy the general principle of "like-for-like" relative to affected areas (see Section 6.4). Offsets are expected to be implemented within the Graham LPU.

Previous to filing this preliminary OMP, and in accordance with Certificate Condition 15, NGTL filed a preliminary Caribou Habitat Restoration Plan (preliminary CHRP) for the Project on August 21, 2015[3] and filed supporting Errata on August 31, 2015.[4] The Board approved the preliminary CHRP on October 22, 2015.[5]

This preliminary OMP outlines NGTL's strategy to offset the Project's residual effects on caribou habitat that are predicted to remain after mitigation and planned on-site habitat restoration have been accounted for. Since filing the preliminary CHRP in August 2015, estimated residual effects from the Project have been updated in this preliminary OMP using the current Project footprint, the current extent of baseline disturbance (to July 2018), and the latest provincial and federal caribou range and habitat mapping (to July 2018). The estimated residual effects will be carried forward into a final CHRP and final OMP.

This preliminary OMP describes the methods for quantifying direct and indirect residual effects on caribou habitat and takes into account existing and Project-related disturbances, the temporal nature of those disturbances (i.e., temporary or permanent), and habitat restoration measures planned for implementation on the Project footprint. Once estimated, residual effects will be used to calculate an Initial Offset Value (IOV), which will be used to identify and select suitable off-site habitat restoration measures and locations in consultation with regulatory agencies and Aboriginal groups. This process, along with the determination of a Final Offset Value (FOV) will be described in the final OMP.

This preliminary OMP was developed in consideration of the federal recovery strategy, provincial caribou implementation and range plans, engagement with ECCC and BC FLNRORD, engagement and feedback from Aboriginal groups, NGTL and industry experience, emerging applied research, and monitoring outcomes from caribou-focussed habitat restoration and offset measures monitoring programs currently underway.

1.2 ORGANIZATION OF THE PRELIMINARY OMP

The key components of the preliminary OMP are:

Consultation (Section 2.0): a summary of consultation and engagement dates, regulatory agencies and Aboriginal groups consulted or engaged, and evidence of how feedback is integrated into the preliminary OMP

Residual Project Effects and Caribou Habitat Restoration (Section 3.0): residual project effects and caribou habitat restoration, including updating the residual direct

[3] NEB Filing ID: A72289.
[4] NEB Filing ID: A72374.
[5] NEB Filing ID: A73379.

and indirect project effects and summarizing habitat restoration measures planned for on-site implementation

Offsetting (Section 4.0): offsetting, including offset strategy and framework, offset multipliers, calculation of the initial offset value, offset decision planning, potential offset measures, offset decision framework, and calculation of a hypothetical final offset value

Monitoring, Adaptive Management, and Reporting (Section 5.0): monitoring, adaptive management, and reporting

Literature Review (Section 6.0): methods, regulatory and policy framework updates, offset definitions, potential offset measures (direct and indirect), offset challenges, offset risks and uncertainty, and knowledge gaps and limitations

References (Section 7.0): a list of references that are linked to citations used throughout the preliminary OMP

The organization of these key components reflects the process logic of NGTL caribou offset planning, and experience from past NEB conditions regarding caribou for NGTL and similar, related projects.

2.0 CONSULTATION

The following sections summarize feedback received on a draft version of this preliminary OMP, and how that feedback is integrated into this preliminary OMP. NGTL is committed to ongoing consultation with regulatory agencies, and engagement with Aboriginal groups, on the development and implementation of habitat restoration and offsetting measures. The final OMP will include updated consultation and engagement records.

2.1 REGULATORY CONSULTATION

NGTL has continued to build upon its history of consultation with federal and provincial agencies from project to project. NGTL is committed to continuing consultation specific to this preliminary OMP through the Project's planning and implementation stages.

NGTL has met with ECCC and BC MFLNRORD several times on other projects to discuss offsetting options for implementation.

Key outcomes of those discussions have been incorporated into this preliminary OMP through the following:

- ECCC and BC MFLNRORD have agreed with NGTL that access control will generally be ineffective on contiguous portions of the ROW when the access measure does not span the full width of the ROW and the adjacent disposition. Access control can be effective on contiguous and new cut portions of the ROW when it spans with full width of the ROW. In this preliminary OMP, 'discontinuous' application of access control measures has been excluded as an offset measure option.
- ECCC and BC MFLNRORD encourage restoration of existing pipeline disturbances as offsets. NGTL is currently investigating opportunities to use tree planting as an offset measure on existing NGTL ROWs.
- ECCC encouraged the implementation of offsets within the caribou range affected by the Project, and BC MFLNRORD encouraged prioritizing offsets so that they align with emerging provincial restoration, range, and implementation plans. NGTL's priority will be to implement offsets within Type 1 Matrix range of the Graham LPU.

NGTL is committed to ongoing consultation with ECCC and BC MFLNRORD on the development of the final CHRP, final OMP, and Caribou Habitat Restoration and Offset Measures Monitoring Plan (CHROMMP). The following sections provide a summary of consultation with federal and provincial agencies.

2.1.1 Federal

NGTL met with ECCC on November 7, 2018 to discuss the preliminary OMP. Key points of discussion were:

- NGTL updated ECCC on the discussion between NGTL and BC MFLNRORD on October 12, 2018
- NGTL confirmed that changes to the recovery strategy, range boundaries, and critical habitat would be incorporated into the OMP if available before the in-service date, as required by Condition 36 of the Certificate
- ECCC asked for clarification about monitoring effectiveness; NGTL provided the following:
  - Monitoring will be implemented prior to February 2021
  - Monitoring will continue for a minimum of 10 years, with potential to extend the program as it may take 12 to 14 years for trees to reach ‘free to grow’
  - Monitoring the effectiveness of planted vegetation as an offset measure will be addressed in the CHROMMP
  - Monitoring will be used to evaluate whether goals are being met; monitoring results will then be reviewed under an adaptive management framework and a plan will be developed and implemented if remedial measures are needed.
- ECCC asked for clarification about addressing the time lag between habitat disturbance and habitat restoration; NGTL has incorporated time lag considerations as a temporal multiplier in the offset calculation (see Section 4.2). Specifically, the temporal multiplier accounts for:
  - 2 - 3 year gap between habitat clearing and restoration implementation (i.e., planting)
  - Age of tree seedlings (i.e., 2 - 3 year old seedlings are likely to be planted)
  - 7 - 14 years to reach ‘free to grow’ depending on site conditions and species
  - Potential for adjustment based on how the Project and restoration activities progress. Updates will be provided in the final OMP.
- ECCC asked for clarification about monitoring predator-prey interactions; NGTL is not planning to monitor predators and prey specifically in caribou range because of the small Project interaction, but remote cameras are being used to monitor access management effectiveness, primarily to deter human access, along the Project ROW. NGTL will report on the results of human and wildlife detections from the camera monitoring work as part of the Access Management Plan (Certificate Condition 16).
- ECCC asked for clarification about the inherent effect multiplier of 0.2 (Table-4-3); NGTL confirmed this value was derived from a survey that was undertaken by Northern Resource Analysts (2016) with input from caribou

experts representing government, industry, academia and consulting professionals and that the multiplier is applied only once to direct effects associated with portions of the Project that are contiguous alignment.

- ECCC remarked that, according to the federal Recovery Strategy, the 500 m buffer is meant to be used to determine overall disturbance relative to recovery thresholds in each LPU, not as a measure of indirect impacts to caribou from projects. ECCC recognizes that reaching an agreement on what buffer distance to use for calculating indirect disturbance is challenging and likely not possible soon. ECCC requested that NGTL remove from Section 2.2 of the preliminary OMP the wording indicating that the use of a 500 m for calculating indirect disturbance from the Project is "consistent with the federal recovery strategy". NGTL maintains that the approach used to calculate residual Project effects (Section 2.2), including use of the 500 m buffer, is consistent with the definition of 'disturbed habitat' in the federal recovery strategy in terms of delineating and describing impacts on critical habitat. As this approach is consistent with previous NEB-approved OMPs for other projects, NGTL informed ECCC that this statement should remain in the preliminary OMP.

Based on the discussion with ECCC on November 7, 2018, no revisions to the preliminary OMP were necessary.

2.1.2 Provincial

NGTL met with BC MFLNRORD on October 12, 2018 to discuss the preliminary OMP. Key points of discussion were:

- BC MFLNRORD mentioned a draft provincial offset calculator that is not yet final but is going through testing
- NGTL explained how the offset calculator used for the preliminary OMP was developed and explained how the multipliers were chosen. BC MFLNRORD considered NGTL's approach to offset calculation to have merit and noted that some of the principles would be taken back for discussion with the provincial offset calculator development team.
- NGTL will consult with BC MFLNRORD on the selection of offset areas to align with the Province's range plan for the Graham herd; BC MFLNRORD advised NGTL that the inter-agency group on caribou recovery in BC is developing a 5-Year Prioritization Plan for restoration, and a preliminary plan is expected to be available in January 2019[6].

[6] British Columbia updated its BC Habitat Offset Decision Support Tool in February 2019 and developed a 9-month trial version of the Offset Tool in December 2018. Both the Decision Support Tool and the Offset Tool are expected to be further revised as a result of the newly released Draft Partnership Agreement between Canada and British Columbia such that the tools align with actions identified in the Partnership Agreement when it is finalized. In the recently released Section 11 Conservation Agreement, a key action is to develop a habitat mitigation and offset program for the Central Group (not inclusive of the Graham LPU) of Southern Mountain Caribou between winter 2019 and winter 2021.

- BC MFLNRORD advised NGTL of three caribou funding programs that can accept financial offset contributions; NGTL noted that on-the-ground habitat restoration measures were being pursued as an offset based on suggestions from the NEB
- Based on the discussion with BC MFLNRORD on October 12, 2018, no revisions to the preliminary OMP were necessary.

2.2 ABORIGINAL CONSULTATION

This section provides an overview of the engagement activities carried out with each Aboriginal group from February 14, 2019 to April 15, 2019.

On February 14, 2019 NGTL sent the preliminary OMP by email to the following Aboriginal groups for review and comment:

- Blueberry River First Nations
- Doig River First Nation
- Halfway River First Nation
- McLeod Lake Indian Band
- Saulteau First Nations
- West Moberly First Nations

In the email, NGTL explained that NGTL is seeking input on the Project's preliminary OMP, which is required as part of Condition 36 of the Certificate. NGTL offered to meet with each community to discuss the preliminary OMP and address additional comments, and requested that if the community was interested in meeting or providing comments on the preliminary OMP to respond by Friday, March 1, 2019.

NGTL did not receive comments from the Aboriginal groups by Friday, March 1, 2019 and therefore, on March 19, 2019, NGTL sent an email to the Aboriginal groups advising that the deadline to receive feedback had been extended to March 29, 2019.

Since providing the March 19, 2019 email, NGTL did not receive feedback from Blueberry River First Nations, McLeod Lake Indian Band, Saulteau First Nations, or West Moberly First Nations.

On April 15, 2019 NGTL sent an email to the above listed four communities advising that NGTL was proceeding with filing the preliminary OMP with the Board to comply with the filing deadline stated in Condition 36. However, NGTL advised that it will continue to engage with Aboriginal groups and offer to meet throughout the finalization of the OMP, to further discuss their comments and to seek their feedback in identifying high-value areas for suitable offset habitat restoration as outlined in the

OMP.

Where engagement has occurred in addition to the notifications listed above, summaries of these activities with the respective Aboriginal groups are provided below.

Doig River First Nation (DRFN)

On March 4, 2019 NGTL received an email from DRFN advising DRFN has retained a consultant for caribou matters. On the same day, NGTL acknowledged DRFN's email and provided a copy of the preliminary OMP and offered to meet or have a conference call.

On March 19, 2019 NGTL received an email from DRFN acknowledging NGTL's email notification from the same day.

On March 29, 2019 NGTL received an email from DRFN advising DRFN's comments would be provided the week of April 1, 2019.

On April 8, 2019 NGTL sent an email to DRFN requesting an update regarding DRFN's comments on the preliminary OMP.

On April 12, 2019 NGTL received an email from DRFN providing comments and inquiring if NGTL was available the following week to discuss next steps. DRFN's comments on the preliminary OMP included:

- Problems replicating the offset calculations
- Suggestion to use BC's provincial offset calculator
- Request for further conversations with NGTL for additional OMP planning

NGTL replied the same day acknowledging receipt of DRFN's comments and advised that it would review and provide a response. NGTL also agreed to discuss next steps and requested DRFN provide available dates.

On April 15, 2019 NGTL sent an email to DRFN providing NGTL's responses to DRFN's initial comments on the preliminary OMP. NGTL offered to meet with DRFN to review with their consultant how offsets were calculated and acknowledged that the offset calculation formula did not appear in the preliminary OMP as a result of an administrative error. As such, NGTL provided the offset calculation formula and updated the preliminary OMP. NGTL provided a rationale for the offset calculator that was used, indicating that the calculator that was used to derive an offset value for the Project is grounded in the principles of offsetting within British Columbia and Canada but draw on examples that have been used elsewhere for completeness. A meeting was proposed to further discuss NGTL's response and future offset planning.

Halfway River First Nation (HRFN)

On March 21, 2019 NGTL received an email from HRFN advising that comments on the preliminary OMP would be submitted by March 29, 2019.

On March 29, 2019 NGTL received HRFN's preliminary comments and advised the additional comments would be forthcoming. HRFN's comments included:

- Suggestion that the habitat offset ratio should be 4:1
- Request that restoration of temporary Project disturbances not be included as habitat offsets
- Request that NGTL work closely with HRFN to identify areas for offset prioritization

On the same day, NGTL responded acknowledging receipt of HRFN's preliminary comments and advised that NGTL would review and provide a response.

On April 15, 2019 NGTL sent an email to HRFN providing NGTL's responses to HFRN's preliminary comments. NGTL explained how the offset ratio in the OMP is supported and that the value of on-site restoration is subject to modifiers. NGTL inquired if HRFN would still be submitting additional comments. NGTL offered to meet further to discuss NGTL's responses to HRFN's draft comments on the preliminary OMP and future offset planning. To date, NGTL has not received additional comments from HRFN.

3.0 RESIDUAL PROJECT EFFECTS AND CARIBOU HABITAT RESTORATION

This section of the preliminary OMP describes and updates effects of the Project on caribou habitat in the Graham caribou range since the approved preliminary CHRP was filed in August 2015. The residual effects calculations provided in this section are used to estimate the IOV in consideration of habitat restoration measures that are planned for implementation on the Project footprint.

3.1 PROJECT IMPACTS TO CARIBOU HABITAT

The Aitken Creek Section of the Project overlaps the Graham caribou range for approximately 8.1 km between KP 84+700 to KP 92+800 (Table 3-1; Figure 3-1). Within this area, the Project overlaps with private land for approximately 2.0 km. NGTL will engage with the landowner to determine the type of restoration that will occur on this portion of the Project footprint. However, because NGTL has no control over land use on private lands, Project effects on private land are not included in this preliminary OMP.

On Crown land, the Project is contiguous with an existing ROW for approximately 4.6 km, and non-contiguous (i.e., new cut) for approximately 1.5 km (Table 3-1). The Project footprint on Crown land within the Graham LPU is 27.2 ha, and the estimated direct effect (i.e., new disturbance) is 5.6 ha (Table 3-2). During operations, a width of up to 10 m over the ditchline of the pipeline will be subject to periodic vegetation management. All other areas in the Graham caribou range (i.e., non-maintained portions of the ROW and temporary workspace) are planned for habitat restoration. There are no access roads or permanent above-ground facilities associated with the Project within the Graham caribou range.

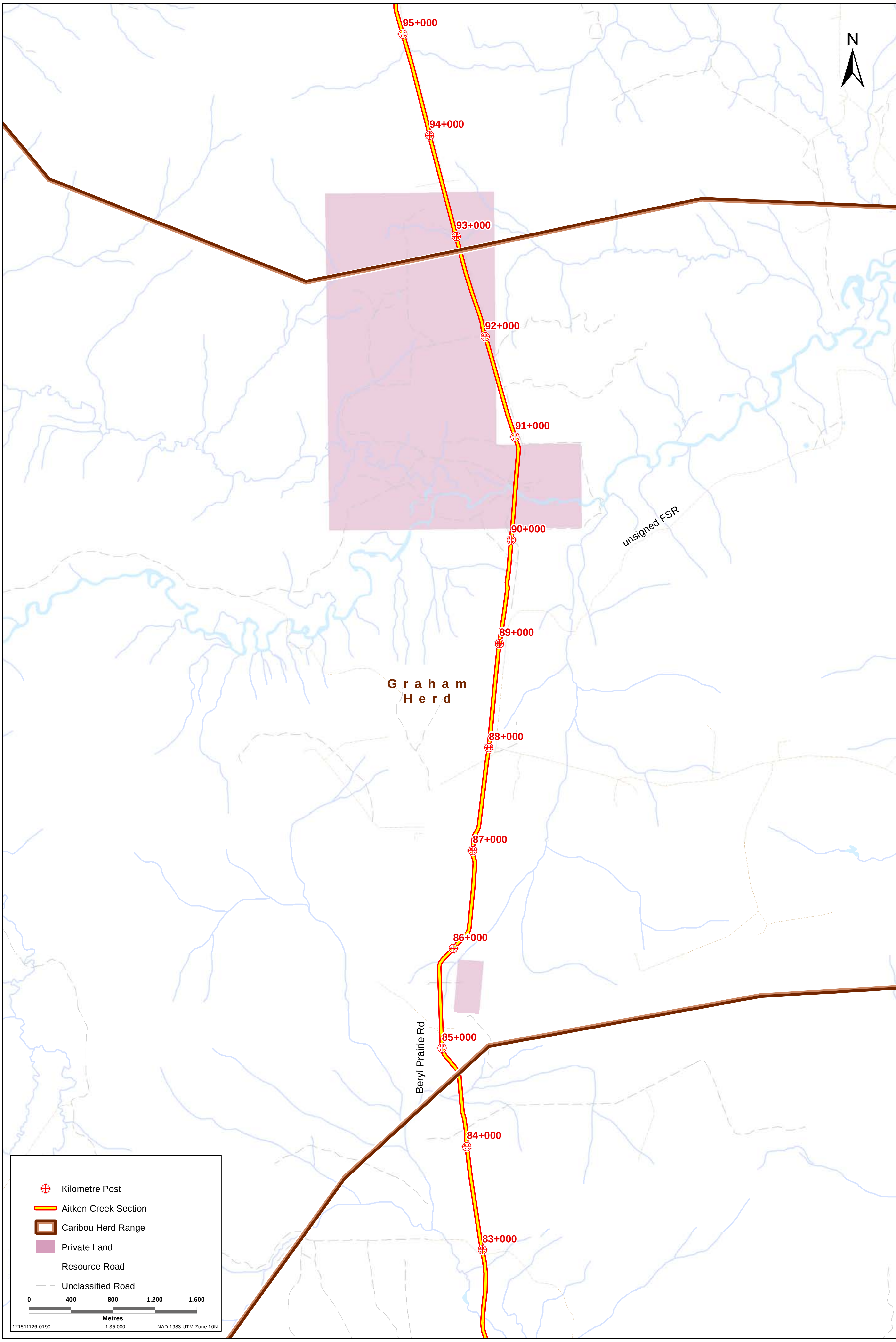
Table 3-1 Project Interaction with the Graham Caribou Range

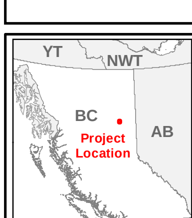
Project Linear Disturbance in Caribou Range (approximate; km)				
	Contiguous Alignment		Non-contiguous Alignment	
Total Length	Private Land	Crown Land	Private Land	Crown Land
8.1	2.0	4.6	0.0	1.5

Table 3-2 Project Interaction with Caribou Habitat on Crown Land in the Graham Local Population Unit

Caribou LPU / Range	Habitat Type	Land Cover Classification	Footprint Area (approximate; ha)	Direct Effect [1] (approximate; ha)
Graham / Type 1 Matrix Range	Forest	Lowland	3.8	0.9
		Upland/Transitional	19.0	4.7
	Anthropogenic	Oil and Gas	3.8	0.0
		Road/Trail	0.6	0.0
		Total Area in Type 1 Matrix Range	**27.2**	**5.6**

NOTE:
[1] Area directly affected by the Project footprint minus existing permanent disturbance.





NORTH MONTNEY MAINLINE PROJECT

Project Overlap with the Graham Caribou Range

PREPARED BY Stantec

PREPARED FOR TransCanada

FIGURE NO. 3-1

Sources: Base data: Canvec, GeoBase & Province of British Columbia
Note: 1 - Environment Canada, 2011. Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada: 2011 Update. Ottawa, Ontario, Canada. 102 pp. plus appendices.

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

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Last Modified: 1/29/2019 By: opeleshchyshyn

3.2 QUANTIFICATION OF RESIDUAL PROJECT EFFECTS BEFORE IMPLEMENTATION OF HABITAT RESTORATION

Quantification of residual Project effects is required to estimate an offset value. The approach used to calculate residual Project effects is consistent with the federal Recovery Strategy for Southern Mountain Caribou in terms of delineating and describing disturbances. Specifically, the baseline disturbance layer used to quantify residual Project effects was created using recent imagery (orthophotos 2011 to 2012, Microsoft Bing (date unavailable) and available spatial data from public sources (i.e., CanVec v.12, DataBC, British Columbia Oil & Gas Commission). The baseline disturbance mapping covers an area delineated by a 1 km buffer applied to the Project footprint, including applicable adjacent areas outside of the Graham LPU (see Appendix A). This buffer allows for the quantification of indirect effects that result from applying a 500 m buffer to anthropogenic disturbance features that could affect the offset value.

To calculate residual Project effects, disturbance types were classed as either temporary or permanent as a means for parametrizing disturbance longevity and assumed effects on caribou habitat. Temporary disturbances are those that can reasonably recover in the short term (i.e., 40 years or less per the definition of disturbed habitat in the Recovery Strategy), and permanent disturbances are those that are not likely to recover within 40 years. Temporary disturbances include forest cut blocks, low-impact seismic lines, and burned areas, and permanent disturbances include the pipelines, transmission lines, roads, railways, conventional seismic lines, recreational areas and trails, well sites, quarries, agriculture/cropland, buildings, airports, and settlements. For the Project, the maintained ROW that is approximately 10 m wide is considered permanent, and the remaining workspace that is planned for restoration is considered temporary.

Effects associated with temporary and permanent disturbances are partitioned into direct and indirect effects. Direct effects are based on the areal representation of disturbance footprints, and indirect effects are based on the areal representation of a 500 m buffer around those footprints, less permanent effects. Burned areas that are 40 years old or less are included as a temporary disturbance feature, but these areas are not buffered by 500 m, consistent with methods used in the Federal Recovery Strategy. Baseline and Project disturbances are organized hierarchically by effect duration (i.e., permanent or temporary) and effect type (i.e., direct or indirect), as illustrated in the ‘standard disturbance hierarchy’ (Figure 3-2).

The disturbance hierarchy functions to provide an accurate accounting of residual Project effects on caribou habitat when the Project footprint and its 500-m buffer area are overlaid on existing disturbance footprints and their associated buffer areas. An example illustration of the steps taken to quantify residual direct and indirect Project effects is provided in Figure 3-3.

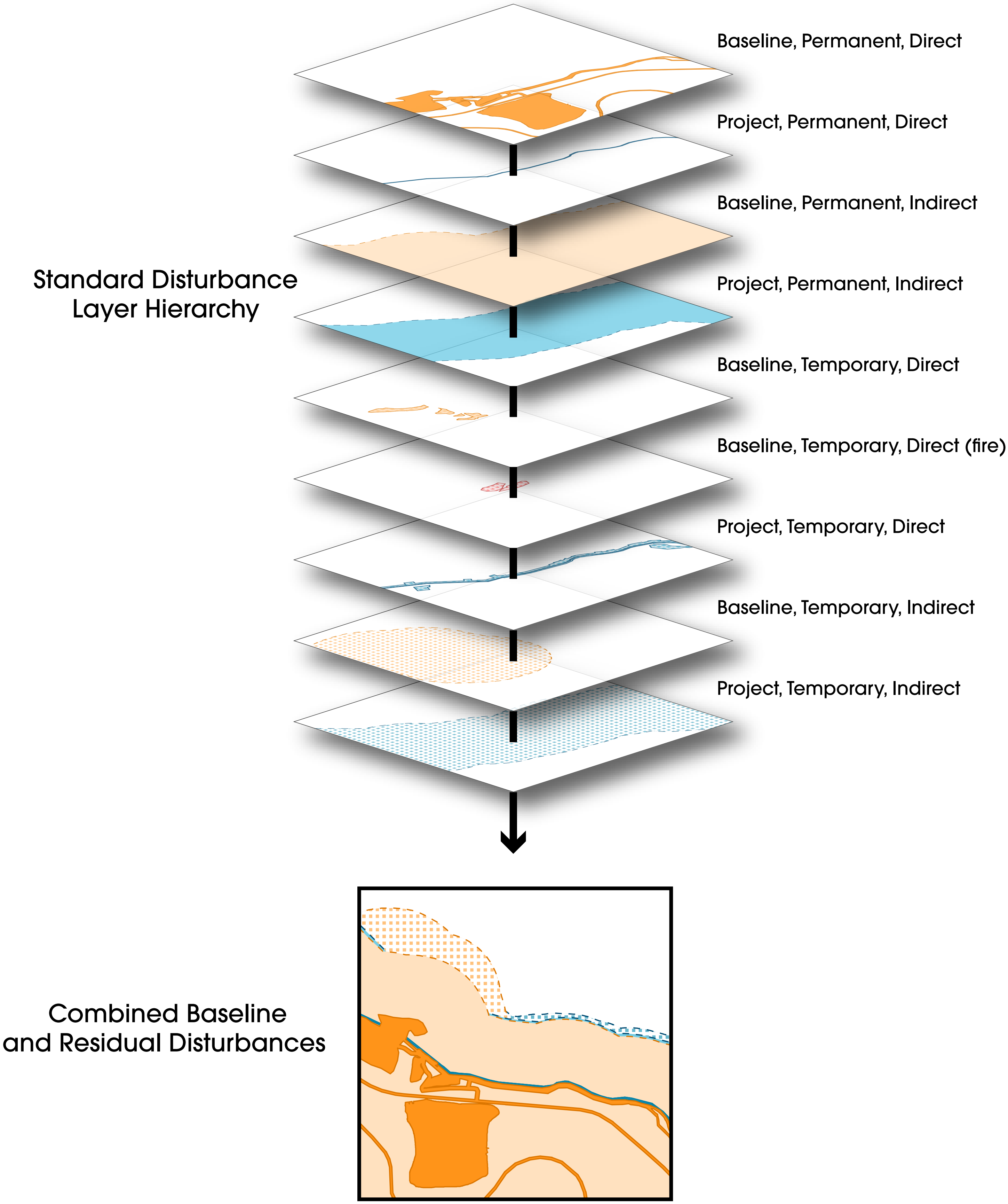

Figure 3-2 Standard Disturbance Hierarchy Process Used to Quantify Residual Effects

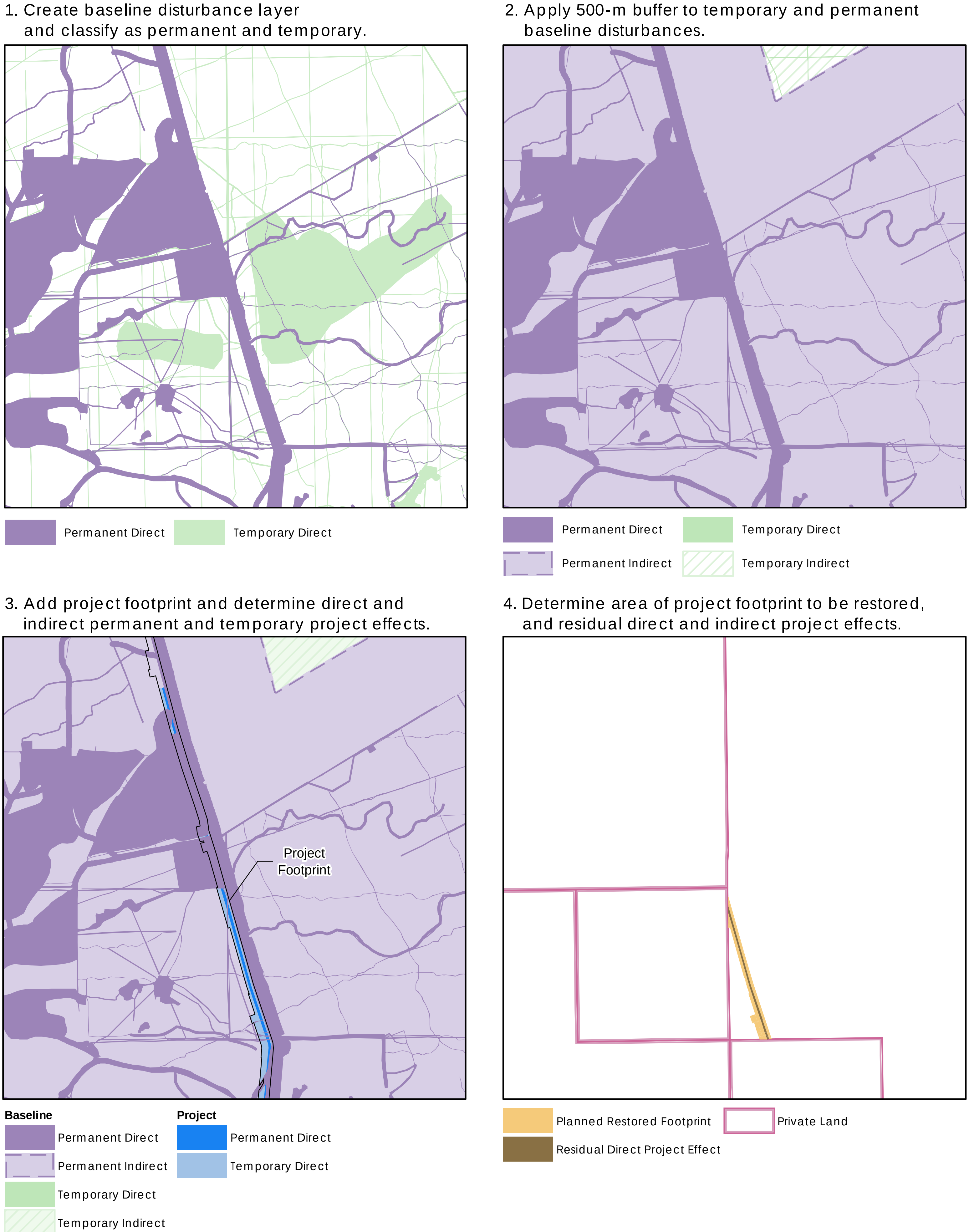

Figure **3-3** Step-wise Approach for Quantifying Residual Project Effects

3.3 HABITAT RESTORATION MEASURES

Habitat restoration measures will be implemented on the Project footprint in caribou range to reduce residual effects of the Project on caribou and caribou habitat. However, residual effects after implementation of habitat restoration measures will remain because:

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

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

Tree seedling planting is the primary habitat restoration measure planned for on-site habitat restoration, and will occur in lowland, transitional, and upland habitat types. In lowland areas, mounding (or another suitable technique such as discing) may be used to improve seedling survival. The operational ROW will be left for natural regeneration and periodically maintained as required for safe operation. For areas of existing permanent disturbance that need to be maintained following construction of the Project, such as existing dispositions, those areas will not be included in the offset determination.

Access management is not planned for the contiguous section of the Project footprint as access management is considered ineffective when not applied across the full width of a linear feature (see Section 2.1.1, 2.1.2, and 4.2). For the new cut section, the Project footprint is 200 m or less from two existing, parallel, and permanent linear features (i.e., road and pipeline), and is crossed by two other permanent linear features (i.e. roads). The resulting new cut segments are therefore relatively short (< 500 m each) and within the disturbance buffers of existing permanent access. Subsequently, access management for the Project is not planned for the new cut section as it is not expected to provide functional value in the context of managing access along the existing contiguous ROW.

Table 3-3 summarizes the preliminary direct and indirect Project effects in the context of existing disturbance, before risk multipliers are applied to determine offset values. Final direct and indirect effects will be based on the as-built footprint. The preliminary metrics are defined as:

- **Planned Restored Footprint:** area of the Project footprint that is planned for restoration (i.e., temporary workspace and portions of the non-maintained ROW). Risk multipliers will be applied to these areas in the IOV calculation to account for temporal risk and delivery risk.
- **Unrestored Existing Maintained Disturbance:** area of the Project footprint that is disturbed at baseline (e.g., an existing disposition) and will not be restored following Project construction.

- **Residual Direct Project Effect:** unrestored area of the Project footprint (i.e., maintained ROW). This area will be calculated as the length of the maintained ROW in the Graham LPU multiplied by 10 m wide.
- **Residual Indirect Project Effect:** area represented by a 500-m permanent disturbance buffer applied to the unrestored project footprint (i.e., maintained ROW), less areas of existing direct or indirect permanent anthropogenic disturbance.
- **Residual Project Effects:** the sum of the area of Residual Direct Project Effect and Residual Indirect Project Effect.

Table 3-3 Residual Project Effects on Caribou Habitat on Crown Land

Spatial Boundary	Area (ha)				
	Planned Restored Footprint	**Unrestored Existing Maintained Disturbance**	**Residual Direct Project Effect**	**Residual Indirect Project Effect**	**Residual Project Effects**
Project Footprint (27.2 ha)	20.3	0.8	6.1	n/a	6.1
Within 500 m of the maintained ROW	n/a	n/a	n/a	0.0	0.0
Total					**6.1**

4.0 OFFSETTING

Consistent with the provincial and federal mitigation hierarchy, NGTL plans to avoid, reduce, and restore areas impacted by construction of the Project to the extent feasible. However, as identified in Section 3.3, residual Project effects on caribou habitat are predicted to remain following construction and during operation. This preliminary OMP was developed with the express purpose of offsetting "*all residual effects of the Aitken Creek Section 52 Facilities resulting from directly and indirectly disturbed critical habitat for caribou*", as required by Condition 36. Therefore, the overarching goal of this preliminary OMP is to achieve no net loss of caribou habitat as a result of the Project.

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

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

4.1 OFFSET STRATEGY AND FRAMEWORK

Supported by a literature review (see Section 6.0), this preliminary OMP uses a strategy consistent with conservation offset development, focusing on the specific conservation needs of the Northern and Central groups of the Southern Mountain Caribou Population.[7] This preliminary OMP follows a like-for-like habitat restoration framework, where offsets are directed toward physical habitat restoration measures rather than indirect measures such as contributions to research programs or other financial mechanisms. This approach is consistent with other recent NEB-approved

[7] The Graham caribou range is in the Northern Group, and immediately adjacent to Central Group (Environment Canada 2014). However, the Graham caribou range is often included in provincial South Peace Northern Caribou planning documents which includes caribou herds from the Central Group. For these reasons, relevant conservation needs for both the Central and Northern groups are included in this preliminary OMP.

OMPs (e.g. High Pine Pipeline Expansion Project (Stantec 2018a) and Wyndwood Pipeline Expansion Project (Stantec 2018c)).

NGTL anticipates implementing direct offset measures that are consistent with priorities identified in the Federal Recovery Strategy (Environment Canada 2014), and in provincial recovery plans (e.g., Government of British Columbia 2018).

4.2 RISK MULTIPLIERS

Risk multipliers[8] are a component of offset determination that take into account challenges and uncertainties associated with habitat restoration time lags (temporal), effectiveness (delivery), and spatial relevance (spatial). NGTL surveyed subject matter experts in industry, government, and academia through a questionnaire to quantitatively evaluate the expected effectiveness and acceptance of caribou habitat restoration practices (Northern Resource Analysts 2014). In addition to the results of the questionnaire, NGTL has also reviewed peer-reviewed and technical literature, national and international offsetting practices, recent caribou habitat offsetting plans filed with the NEB (e.g., Stantec 2018b), and recent results from ongoing monitoring programs (e.g., NGTL 2018) to inform and refine the risk multipliers. NGTL has also considered consultation feedback received from government agencies and Aboriginal groups both on past projects, and on this Project, to inform the risk multipliers.

The delivery and temporal risk multipliers used in this preliminary OMP are provided in Table 4-1, and spatial risk multipliers are provided in Table 4-2. These risk multipliers are consistent with those used in approved caribou habitat OMPs for other NEB-regulated projects (e.g. High Pine Pipeline Expansion Project (Stantec 2018a), and Wyndwood Pipeline Expansion Project (Stantec 2018c)), and where appropriate have been adjusted to reflect new or updated information as described in the literature review (see Section 6.6). One notable change is the removal of differential multipliers for 'continuous' versus 'discontinuous' application of access or line-of-sight measures. If access or line-of-sight measures cannot be applied across the full width of a ROW (new cut or contiguous with another ROW), then the measure is not likely to be effective and the objective unachievable (i.e., in most instances, discontinuous application is not a viable measure). Another notable change is that the temporal risk multiplier to be used in the offset calculation will be based on multiple criteria (see notes in Table 4-1).

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

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

- delivery risks associated with the effectiveness and achievability of each measure (i.e., challenges and uncertainty of the restoration technique)
- temporal risks associated with the ability of each measure to achieve functional effectiveness, and be on a trajectory to achieve ecological effectiveness
- spatial risks associated with the proximity of each measure to the caribou habitat affected by the Project (i.e., spatial relevance in respect of Project effects on Type 1 Matrix range in the Graham LPU)

Table 4-1 Temporal and Delivery Risk Multipliers[1,2]

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

Habitat Restoration Measure	Restoration Application[1]	Temporal Risk Multiplier	Delivery Risk Multiplier[2,3]
Tree Planting to Accelerate Reforested State	At or above required stocking density (includes areas where Minimum Surface Disturbance construction is applied)	No delay = 1.0 5-year delay = 1.2 10-year delay = 1.4 15-year delay = 1.7 20-year delay = 2.0 25-year delay = 2.4 30-year delay = 2.8 35-year delay = 3.0 40-year delay = 3.3	1.25
Seeding, Shrub Planting, and/or Left for Natural Revegetation	Temporary workspace (high intensity)	40-50-year delay = 4.0	2.5

NOTES:

Adapted from Northern Resource Analysts (2014, 2016)

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

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

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

Table 4-2 Spatial Risk Multiplier

Notation	Offset Location	Spatial Risk Multiplier
A	Within the affected habitat type (i.e., Type 1 Matrix range) of the affected LPU (i.e., Graham)	1.0
B	Outside the affected habitat type, but within the affected LPU (i.e., Graham)	1.5
C	Outside the affected LPU, but within one or more other LPUs in the affected group[1]	2.0
D	Outside the affected group, but within one or more other LPUs, within the Southern Mountain caribou population range	2.5
E	Outside of the Southern Mountain caribou population range	3.0

NOTE:

Adapted from DEFRA (2011, 2012)

[1] There are three groups in the Southern Mountain population: Northern Group, Central Group, and Southern Group (Environment Canada 2014). The Graham LPU is in the Northern Group.

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

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

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

4.3 CALCULATING THE INITIAL OFFSET VALUE

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

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

1. **Initial Offset Value (IOV):** based on the approved project footprint and the areas and measures planned for on-site habitat restoration.

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

To calculate the IOV, the following steps are completed:

1. Along the length of the route, the project footprint is considered either new cut alignment (i.e., the ROW will create a new linear feature) or contiguous alignment (i.e., the ROW is immediately adjacent to, and shares the space of, an existing ROW). Contiguous alignment is assumed to have a lesser effect on caribou habitat compared to new cut alignment, both from a functional (i.e., predator and human access) and ecological (i.e., less forest cover is removed on contiguous alignment) perspective. The contiguous alignment approach is also consistent with the mitigation hierarchy, whereby the contiguous alignment avoids (i.e., no new linear feature) and reduces (i.e., less forest cover removal) project effects to the extent feasible. An inherent effect multiplier is applied in the following way (Northern Resource Analysts 2014):

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

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

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

2. For each footprint element and alignment class (i.e., new cut or contiguous) combination, identify the planned habitat restoration measures and applications (see Table 4-1) and assign the appropriate delivery and temporal risk multipliers.

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

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

$$IOV\ [ha]=(RPRV+RIDV)$$

$$RPRV=(RDDV \times (1-(1 \div delivery\ risk \times temporal\ risk))$$

$$RDDV=contiguous\ [ha] \times 0.2+(new\ cut\ [ha] \times 1.0)$$

$$RIDV=(500\ m\ indirect\ buffer\ [ha]-all\ other\ permanent\ indirect\ buffers\ [ha])$$

The IOV represents the area to be offset and takes into account direct and indirect effects and the planned implementation of on-site habitat restoration measures. Table 4-3 summarizes the restoration units, residual effects (for restored and unrestored footprint elements), risk multipliers, and the IOV.

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

The corresponding areas related to footprint element, planned habitat restoration measures, and ROW alignment described in Table 4-3 are illustrated in a series of maps in Appendix C[9]. All areas of the project footprint that are directly affected and are planned for on-site habitat restoration measures are subject to risk multipliers (Table 4-3). The area of planned on-site habitat restoration is 20.3 ha, and after accounting for inherent effects, and delivery and temporal risk, the IOV for this area is 4.0 ha. The maintained ROW is 6.1 ha, and after accounting for inherent effects the IOV for this area is 2.4 ha. There are no incremental indirect effects associated with the Project, and 0.8 ha will remain unrestored as an existing maintained disturbance. The total IOV is 6.4 ha.

[9] Indirect Project effects are illustrated in Appendix A

Table 4-3 Quantification of the Initial Offset Value for Residual Project Effects on Crown Land

Restoration Unit (Project ROW)			RPRV = (RDDV x Inherent Effect) x (1-(1/(Delivery x Temporal)))				
Footprint Element	**Planned Habitat Restoration Measure[1]**	**ROW Alignment**	**RDDV (ha)**	**Inherent Effect**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Residual Effect (RPRV & RIDV) (ha)**
Temporary workspace or unmaintained ROW	Tree seedling planting in upland or transitional areas	Contiguous	12.1	0.2	1.25	1.4	1.0
		New cut	4.7	1	1.25	1.4	2.0
Temporary workspace or unmaintained ROW	Tree seedling planting with mounding in lowland area	Contiguous	2.7	0.2	1.25	3.3	0.4
		New cut	0.8	1	1.25	3.3	0.6
Planned Habitat Restoration Area (ha)			**20.3**	**Subtotal RPRV (ha)**			**4.0**
Temporary workspace or unmaintained ROW	Unrestored (existing maintained disturbance) in upland, transitional, or lowland areas	N/A	0.8	N/A	N/A	N/A	N/A
Unrestored Existing Maintained Disturbance (ha)			**0.8**				N/A
Operational ROW (10 m centered on ditch line)	Natural regeneration and maintained	Contiguous	4.6	0.2	N/A	N/A	0.9
		New cut	1.5	1	N/A	N/A	1.5
Maintained Operation Access (ha)			**6.1**	**Subtotal RPRV (ha)**			**2.4**
Total RPRV (ha)							**6.4**
Total RIDV (ha)							**0.0**
Preliminary Initial Offset Value (ha) (RPRV + RIDV)							**6.4**

NOTE:
[1] These measures are planned, and not final. Final restoration measures and corresponding updates to area and IOV calculations will be provided in the final OMP.

4.4 OFFSET DECISION PLANNING AND FRAMEWORK

NGTL's offset decision planning criteria are consistent with the approach outlined in the Business and Biodiversity Offsets Programme (2012a), where the preferred approach to implementing offsets considers the regulatory policies and frameworks under which offsets might be structured. NGTL has also taken into consideration general guidance provided in the federal Conservation Allowances Framework (Environment Canada 2012a). NGTL will consult with appropriate regulatory agencies and affected Aboriginal groups on potentially suitable locations for offset implementation. However, NGTL does anticipate some challenges as a result of:

- an absence of an established offset policy or other regulatory mechanism for developing offsets for caribou and caribou habitat
- limited detail and availability of provincial range plans, directives, or preliminary guidance for priority caribou management/conservation pertaining to the Graham LPU, and other Southern Mountain Caribou population ranges in British Columbia
- potentially limited availability of suitable offset locations within Type 1 Matrix range of the Graham LPU that can offer long-term protection

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

- range planning considerations specific to southern mountain caribou recovery efforts and management informed by discussions and consultation with provincial and federal regulators and available caribou location data (i.e., telemetry)
- areas with reduced or limited active traditional, recreational, or industrial use needs
- areas adjacent, or in proximity, to monitoring programs or other wildlife/landscape management objectives
- areas that fall in provincial parks, ecological reserves, or other designated areas that can afford long-term protection from future development. The potential for offsetting in such sites will be identified through consultation with the Province of BC to determine whether opportunities to support provincial planning priorities and caribou restoration priorities in these areas is available

NGTL will give preference to locating offsets within Type 1 Matrix range of the Graham LPU. However, final offset placement will result from consideration of priorities of the provincial regulators, available and appropriate offset areas, and feedback received from affected Aboriginal groups. If the offset location is outside of Type 1 Matrix range of the Graham LPU (where the Project effect occurs), a corresponding spatial risk multiplier, as described in Table 4-2, will be included in the FOV calculation.

After identifying and securing an offset location at the landscape scale, the site-specific scale will be evaluated for restoration potential. Once this area has been investigated and caribou habitat considerations such as connectivity of caribou habitat and overall patch size have been accounted for, habitat restoration units will be identified and characterized, and appropriate restoration treatments will be implemented.

Figure 4-1 illustrates the decision framework for determining and implementing caribou habitat offset measures. Figure 4-1 is divided into two main components:

1. The upper component relates to milestones and key processes

2. The lower component relates to specific decision options and pathways

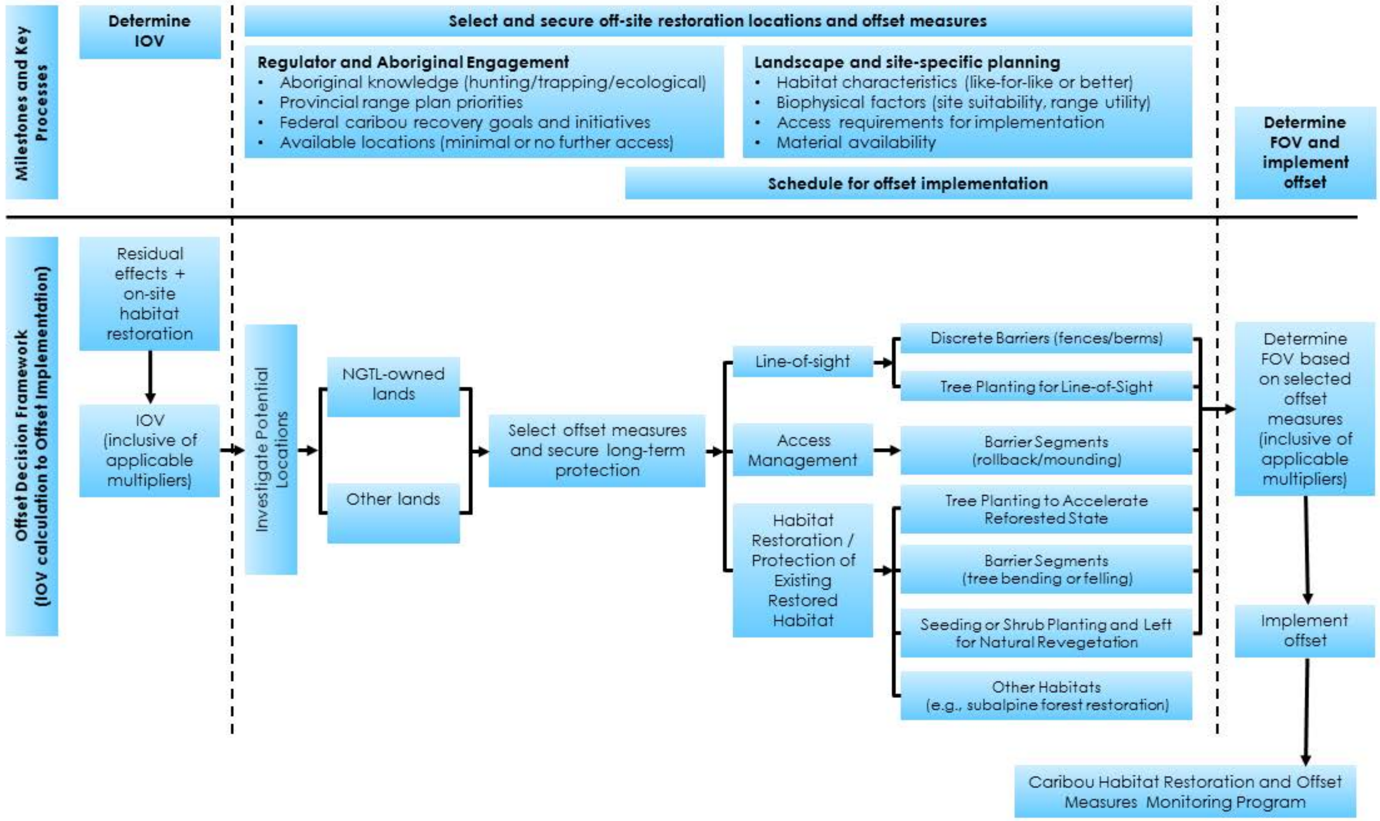

Figure 4-1 Offset Decision Framework

Once the Updated IOV has been calculated (i.e., as built, post-restoration on-site), a process of investigating, selecting, and securing offset locations and measures will be undertaken. This includes identifying available lands (i.e., NGTL-owned or other lands) and engaging with applicable regulatory agencies and Aboriginal groups on the selection process to determine whether offset locations are viable (i.e., access and land use constraints are not limiting, and long-term effectiveness can be achieved).

Once candidate offset locations are selected, appropriate offset measures for those locations will be considered in consultation with regulatory agencies and Aboriginal groups. For this Project, NGTL expects the suite of offset measures available for selection to be consistent with those identified for on-site restoration (i.e., measures related to access management, line-of-sight, and habitat restoration). Considerations for site-specific planning will include like-for-like criteria (i.e., quantity and quality), and other values such as connectivity and patch size (i.e. habitat intactness), access requirements necessary to implement the measures, and material availability.

Following the selection of suitable offset locations and offset measures, the FOV will be calculated (Section 4.5) to confirm that the locations selected are of sufficient size (i.e., quantity) and the measures selected are of sufficient value (i.e., quality) to achieve the goal of no net loss of caribou habitat. While the decision framework illustrates the selection process and the determination of the IOV and FOV as discrete steps, NGTL anticipates using an iterative process to balance constraints, make good use of opportunities, and achieve a high offset value relative to the cost of implementation. The effectiveness of the offset measures selected and implemented will be monitored as part of the CHROMMP (see Section 3.1).

4.5 CALCULATING THE FINAL OFFSET VALUE

The FOV is dependent on the IOV, and on the selection of offset locations and offset measures. Therefore, before the FOV can be calculated, it is first necessary to know what the spatial boundaries of the as-built project footprint are, and to what extent the planned habitat restoration measures are implemented (i.e., area treated and type of restoration measure). Subsequently, the IOV will be updated and then used to calculate the FOV based on planned offset measures and associated risk multipliers. The FOV includes multipliers for delivery risk, temporal risk, and spatial risk, but does not include an inherent effect multiplier.

The FOV is calculated as follows:

FOV [ha] = Updated IOV x (Delivery Risk x Temporal Risk x Spatial Risk)

The FOV will be quantified in the final OMP. In the interim, a hypothetical quantification of the FOV is provided in Table 4-4. The hypothetical FOV assumes that on-site restoration measures are applied as planned, and offset measures will take the form of tree planting in Type 1 Matrix range of the Graham LPU, tree seedlings will take 10 years to reach a functional restoration height of 3 m and be on a trajectory to achieve ecological restoration. Applying these assumptions, the hypothetical FOV is 15.0 ha, which equates to an offset ratio of 2.5:1 for residual Project effects (i.e., 6.1 ha).

Table 4-4 Hypothetical Quantification of the Final Offset Value

Restoration Unit Description			FOV = Updated IOV x (Delivery Risk x Temporal Risk x Spatial Risk)				
Habitat Type	**Restoration Measure**	**Offset Location [1]**	**Updated IOV [2,3] (ha)**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Spatial Risk Multiplier**	**FOV [3] (ha)**
Upland/Transitional	Tree seedling planting	A	4.8	1.25	1.4	1.0	8.4
Lowland	Tree seedling planting with mounding	A	1.6	1.25	3.3	1.0	6.6
						Final Offset Value (ha)	**15.0**

NOTES
[1] Offset location corresponds with the offset location notation descriptions in Table 4-2
[2] In this hypothetical quantification, the 'Updated IOV' is the same as the calculated IOV provided in Table 4-3
[3] IOV and FOV are rounded to one decimal place

5.0 MONITORING, ADAPTIVE MANAGEMENT, AND REPORTING

Monitoring, adaptive management, and reporting are important elements to inform whether restoration investments (i.e., on-site habitat restoration and offset measures) are contributing meaningfully to the desired strategic outcome of the conservation and recovery of woodland caribou. To this end, NGTL will develop a CHROMMP for the Project to monitor the effectiveness of the habitat restoration and offset measures implemented. The CHROMMP will be designed to identify and manage issues requiring supplemental or remedial action to achieve restoration and offsetting goals. An adaptive management framework will be used to respond to monitoring results as they pertain to achieving monitoring targets; reporting of monitoring results will be completed for compliance and transparency.

5.1 MONITORING

In accordance with NEB Condition 37, a CHROMMP will be submitted to the NEB on or before 1 February after the first complete growing season following the commencement of operation of the Aitken Creek section. Monitoring will be undertaken for a minimum of 10 years and will describe:

- The scientific methods for short-term and long-term monitoring of the habitat restoration and offset measures, and the effectiveness of the measures
- Frequency, timing, locations, and rationale for each monitoring method
- Protocols for how habitat restoration and offset measures will be adapted, as required, based on monitoring results from the implementation of either Aitken Creek plans or other NGTL CHRPs or OMPs
- A schedule for filing reports of monitoring results and the adaptive management responses to the Board, Environment and Climate Change Canada, and provincial authorities

5.2 ADAPTIVE MANAGEMENT

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

- Evaluating habitat restoration monitoring results (i.e., targets and performance measures)
- Identifying the cause of underperforming measures (i.e., microsite conditions that are either not conducive or suitable for establishment of target vegetation)

- Addressing underperforming measures with supplemental or remedial action(s)

The habitat restoration and offset measures are considered successful when monitoring results indicate restoration has achieved, or is on a trajectory to achieve, the performance indicators and, thereby, the monitoring plan targets. If, prior to reaching the targets, results indicate that restoration and offset measures are not on trajectory to success, corrective action will be taken, and monitoring will continue until a positive trajectory is achieved. The extent of additional monitoring required for adaptive management actions will be site-specific.

5.3 REPORTING

In accordance with Condition 38 of the Order, NGTL will file with the Board, based on a schedule to be provided in the CHROMMP, reports outlining the results of the monitoring program.

6.0 LITERATURE REVIEW

An overview of the regulatory framework pertaining to Southern Mountain Caribou (Northern and Central groups), and a comprehensive review of habitat restoration methods and measures, is provided in the preliminary CHRP for the Project (see Section 8.0). The literature review provided in the preliminary CHRP was used to identify project-specific habitat restoration measures (see Section 3.0 of the preliminary CHRP) in consideration of historical and current restoration initiatives at that time (see Appendix C of the preliminary CHRP).

This literature review is specific to the development of this preliminary OMP, and therefore focusses predominantly on offsetting methods and measures. Accordingly, however, new or updated information pertaining to the regulatory framework for Southern Mountain Caribou, and new or updated information on habitat restoration methods and measures as an offsetting tool, has become available since the preliminary CHRP was filed and approved. Subsequently, the regulatory framework is updated in this preliminary OMP, and as appropriate new or updated information on habitat restoration measures has been included for the purpose of informing offset measures selection and implementation.

6.1 METHODS

The literature review methods for this preliminary OMP included a systematic search of key words using Google, Google Scholar, EBSCOhost Online Research Databases, ScienceDirect (sciencedirect.com), JSTOR (jstor.org), ISI Web of Science (https://isiknowledge.com/), and ELSEVIER (elsevier.com). The literature review also included searches of:

- the Cumulative Environmental Management Association (CEMA) database, including Oil Sands Leadership Initiative (OSLI) historic filings
- provincial, state, and federal government agency websites for established or emerging offset policies and frameworks (countries included: Australia, Canada, New Zealand, South Africa, United Kingdom, and the United States of America)
- expert agency websites that provide scientific review and best practice guidance and frameworks for established and emerging offset programs (organizations included: Alberta Conservation Association, Business Biodiversity Offset Programme, Commonwealth Scientific and Industrial Research Organization, International Union for Conservation of Nature, Pembina Institute and the United Nations Convention on Biological Diversity, and Alberta Association for Conservation Offsets)
- expert individual websites (author-specific, where available) for published articles and associated links or documents related to the aforementioned sources

References included in other similar caribou OMPs[10] that have been accepted by the Board were also reviewed as appropriate; in some cases, newer versions of those references were available and either updated or replaced for this preliminary OMP. The literature review was completed in September 2018; where relevant it was supported by the literature review that was completed for the preliminary CHRP.

Where key word searches were completed using the following key words or combinations of key words:

- Caribou; woodland caribou; southern mountain caribou; boreal caribou; mountain caribou; *Rangifer tarandus*
- Habitat offset; habitat restoration; habitat reclamation; caribou offset; biodiversity offset; environment offset; conservation offset; compensation; conservation allowance; habitat banking; bio-banking; like-for-like, offset multiplier; offset discount; offset ratio; offset effectiveness; inherent effect
- Linear features; seismic lines; pipelines; oil and gas; roads; linear feature removal; linear feature deactivation; facilities
- Prioritization; ecological restoration; functional restoration; landscape factors; landscape variables
- Offset and associated modifiers, such as environmental, conservation, biodiversity, allowance, compensatory, mitigation, bio-banking, direct, indirect, in-kind, out-of-kind, like for like, multiplier and ratio

Several technical sessions related to habitat restoration for caribou were presented at both the 15th and 16th North American Caribou Workshops (2014; 2016). Where relevant, information pertaining to the effectiveness of caribou habitat restoration measures were included in the evaluation of restoration effectiveness; this information was also used to support ascribing offset multiplier values for delivery risk.

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10 These include the NGTL Northwest Mainline Expansion Project: Preliminary Offset Measures Plan for Residual Effects on Caribou Habitat (NGTL 2013), the NGTL Chinchaga Lateral Loop No. 3, Final Offset Measures Plan for Residual Project Effects to Caribou Habitat (Northern Resource Analysts 2016), the 2017 NGTL System Expansion Project, Revised Caribou Habitat Restoration and Offset Measures Plan (NGTL 2015), and offsetting plans for the Westcoast Energy Ltd. High Pine Expansion Project (Stantec 2018a), the Westcoast Energy Ltd. Pine River Aerial Crossing and 2BL Crossover Projects (Stantec 2017b), the Westcoast Energy Ltd. Wyndwood Pipeline Expansion Project (Stantec 2018c), and the Westcoast Energy Ltd. Spruce Ridge Program (Stantec 2018b).

6.2 REGULATORY AND POLICY FRAMEWORK UPDATE

Section 8.2 of the preliminary CHRP for the Project provides an overview of the regulatory and policy framework pertaining to caribou habitat restoration. There have been no updates to the provincial or federal regulatory framework since filing the preliminary CHRP on August 21, 2015. However, two relevant pieces of literature available on the Species at Risk Public Registry (www.registrelep-sararegistry.gc.ca) do indicate that legislation could be updated, revised, or created as part of affording adequate protection for the Southern Mountain Caribou population.

The first document is the Canada-British Columbia Southern Mountain Caribou (Central Group) Protection Study (SRPR 2017a). As indicated in Section 4.1, the Graham herd is in the Northern Group of Southern Mountain caribou. However, the Graham caribou range was included in the Protection Study because the Province includes the Graham caribou range in its South Peace Northern Caribou reports (along with Central Group caribou ranges). At the time of writing, no changes or additions to regulations or policies affecting the Graham caribou range have occurred since the Protection Study was produced.

The second document is a draft Section 11 Conservation Agreement for the Conservation of Southern Mountain Caribou (SRPR 2017b). This document does not include the Graham herd range but is relevant for understanding current regulatory thinking about caribou ranges that are immediately adjacent to the Graham caribou range. This agreement, in part, seeks to resolve information gaps or disagreements on mapping and defining critical habitat, and the appropriate geographic area for setting recovery targets and the definition of self-sustaining populations. Prior to the commencement of operations, NGTL will review and incorporate into the OMP, as appropriate, new or updated information on critical habitat mapping or definitions published in final or amended Recovery, Range, or Action Plans that pertain to the Graham caribou range, or adjacent ranges where offsets could be located.

This preliminary OMP was prepared in consideration of British Columbia's *Policy for Mitigating Impacts on Environmental Values* (BC MOE 2014a), the federal *Operational Framework for Use of Conservation Allowances* (Environment Canada 2012a), and recent filings with the Board for other pipeline projects occurring within caribou range.

6.3 OFFSET DEFINITIONS

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

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

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

6.4 OFFSET MEASURES

In referenced literature, including Environment Canada (2012a), existing offset programs commonly use the design elements and frameworks recommended by BBOP (2012c) as the standard best practice, and therefore, this approach was applied to this preliminary OMP. Under BBOP, initial planning stages first consider the legal framework and/or policy requirement for an offset. Currently, there is little guidance or policy specific to caribou offsets in British Columbia, with current guidance pertaining only to direct impacts in high elevation winter range (BC MOE 2013). In the absence of caribou range plans, and where disturbance exceeds 35%, Environment and Climate Change Canada considers all existing habitat to be critical habitat (Corcoran and Eyre 2017). Offsets may be relevant, if, after applying avoidance and mitigation measures, the project will have residual effects. In considering proposed offsets, Environment and Climate Change Canada will assess whether the offset is consistent with the range plan (Corcoran and Eyre 2017). Notwithstanding, offset criteria, guidelines, and frameworks referenced in the development of this preliminary OMP includes examples and applications presented in the primary literature, as well as currently available but emerging science to address the unique conservation needs of caribou and their habitat.

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

6.4.1 Direct Offsets

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

Direct offsets for loss of caribou habitat have been used in British Columbia mining projects, such as Roman Coal Mine (Stantec 2012) and Sukunka Coal Mine (Stantec 2015). In these instances, habitat securement of like-for-like high elevation habitat within the proponent's tenure area was determined at a ratio of 4:1, following provincial policy guidance (BC MOE 2013). Glencore's proposed Sukunka Coal Mine is also planning for additional direct offsets in the form of off-site habitat restoration at a ratio of 1:1 (Stantec 2017a). The direct (i.e., on-the-ground) offset approach is better at taking specific ecological features into account in terms of ecological and geographical equivalency, compared to, for example, financial offsets (Calvet et al. 2015). Direct offsets can contribute to the goal of net loss under certain circumstances, such as where gains of sufficient magnitude will compensate for losses, and when the offsets are in place for at least the same duration as the impact (Gibbons and Lindenmayer 2007).

Direct offsets in the form of land securement for habitat have also been used recently by proponents of other industrial projects, including the Joslyn North Mine Project (Total E&P Canada Ltd.), the Roman Coal Mine (Peace River Coal Inc.), the True North Forest (Shell Canada), Trans Mountain Pipeline (Kinder Morgan Canada), and a recent Canadian Boreal Forest Agreement (CBFA 2012; Poulton 2015).

6.4.2 Indirect Offsets

Indirect offsets are typically comprised of financial contributions (i.e. offset funding) that would be transferred from a proponent to a trust fund or the Province of British Columbia, or to research and monitoring programs, in advance of development (i.e., financial offsets). Offset funding for loss of caribou habitat has been used in British Columbia for the Roman Coal Mine (Stantec 2012) and is proposed for other mining projects such as Sukunka Coal Mine (Stantec 2015) and the Quintette Coal Mine Restart (Teck Coal Ltd. 2013). Offset funding is also planned, but not yet developed, for pipeline projects (e.g., Coastal GasLink Ltd. 2016). The effectiveness of offset funding for caribou habitat in British Columbia is currently untested. However, with respect to no net loss of biodiversity, studies show that, in most cases, offset funding programs do not provide sufficient guarantees that this can be achieved (Calvet et al. 2015). Offset banking, by which individual proponents contribute funds to a large restoration project ahead of impacts, can yield better ecological and effectiveness outcomes than offset funding (Calvet et al. 2015). However, Calvet et al. (2015) notes limitations of the offset banking approach which include incomplete and imprecise scientific knowledge regarding biodiversity and conservation issues, and conceptual limitations stemming from the inherent difficulty of applying the most recent advances in ecology and conservation biology.

NGTL's approach to offsetting will be to use on-the-ground restoration measures, and to not use financial offsets (i.e., funding or banking) as a mechanism for compensating for loss of caribou habitat.

6.4.3 Offset Challenges

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

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

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

6.5 OFFSET DESIGN ELEMENTS

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

Proponents advocate offsets as an effective and operationally efficient mechanism for enhancing environmental values and achieving important conservation objectives (McKenney 2005; Dyer et al. 2008; Bovarnick et al. 2010; McKenney and Kiesecker 2010; Croft et al. 2011; BBOP 2013; Pickett et al. 2013; Sustainable Prosperity 2014). Offsets in their various forms (e.g., like for like mitigation, banking or trading programs, land securement) provide flexibility for stakeholders, industry, and regulatory authorities to exercise a number of measures where legislative frameworks and policy exist. However, a large amount of effort is required for successful outcomes (Pickett et al. 2013). The reasons why offsets are undertaken vary. Offsets can be undertaken voluntarily or can be a regulatory requirement imposed as a condition of approval before receiving a permit for a specific project (Doswald et al. 2012; Calvet et al. 2015; Poulton 2015; Sustainable Prosperity 2014). A key benefit of offsets is that they allow both offset purchasers and offset creators flexibility. Under ideal circumstances, developers will look at the cost of complying with offset requirements and factor the associated cost into the overall project cost to decide ultimately whether or not to proceed with the proposed project or whether to redesign the project to lessen impacts on environmental values (Sustainable Prosperity 2014). However, there are potentially dozens of ecological, cultural, social, economic, and resource location factors that could affect project design and costs, and only a few reasonable options might be considered. Conversely, offsets may come into force under policy or as a condition of project approval after most project design considerations have been finalized.

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

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

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

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

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

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

6.6 OFFSET RISK AND UNCERTAINTY

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

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

A method for defining and including multipliers for determining an offset has been developed for NEB-regulated projects that affect caribou habitat. Northern Resource Analysts (2014; 2016) developed the method by undertaking an expert-based survey and integrating principles and best practices for determining biodiversity offsets (e.g., DEFRA 2011, 2012; BBOP 2012c). The method has been applied to NEB-regulated projects on multiple NGTL projects, including the Northwest Mainline Expansion Project (NGTL 2013; Northern Resource Analysts 2014), the Chinchaga Lateral Loop No.3 Project (Northern Resource Analysts 2016), the 2017 NGTL System Expansion Project (NGTL 2015), and the Smoky Lateral Loop (NGTL 2017). The method has also been reviewed and used on other NEB-regulated projects, including the High Pine Expansion Project (Stantec 2018), the Pine River Aerial Crossing and 2BL Crossover Projects (Stantec 2017b), the Wyndwood Pipeline Expansion Project (Stantec 2018c), and the Spruce Ridge Program (Stantec 2018b).

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

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

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

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

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

The preliminary CHRP for the Project provides information on habitat restoration measures, but information on the effectiveness of those measures at the time was limited. Since the preliminary CHRP was filed in 2014, much more information has become available on the effectiveness of various habitat restoration measures. This information is summarized in Appendix B and has been taken into consideration in this preliminary OMP. NGTL's approach to the selection of offset measures is to focus on those measures that have moderate to high expected effectiveness and low to moderate delivery risk; avoiding measures with high delivery risk is the driver for this approach.

6.6.1 Delivery Risk

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

A theoretical analysis of offset multipliers that used a probabilistic model to account for delivery risk was developed by Moilanen et al. (2009). The model predicted that offset multipliers could be as low as 2, or greater than 100 when the predicted probability was greater than 50% and the degree of uncertainty of the habitat restoration measure was moderate to high (Moilanen et al. 2009). DEFRA (2012) based its offsetting program on the principles of Moilanen et al. (2009), and so too did Northern Resource Analysts (2016) when developing a caribou OMP. Both DEFRA (2012) and Northern Resource Analysts (2016) acknowledged that as offset delivery risk multipliers became excessively large for a given restoration measure that there was likely little value in pursuing the measure at all. For example, partial blocking of access across a ROW is unlikely to deliver on the intended function.

The delivery risk multipliers used by DEFRA (2012) are provided in Table 6-1. DEFRA (2012) asked experts to assign a delivery risk category to several broad habitat types (i.e., exclusive of knowledge of site-specific habitat substrates, nutrient levels, and existing state) throughout England as a starting point. Values assigned to the recreation of habitats ranged from “low” to “impossible”, and values assigned to restoration of habitats ranged from “low” (1.0 multiplier) to “high” (3.0 multiplier).

Table 6-1 Delivery Risk Multipliers used by DEFRA (2012)

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

Northern Resource Analysts (2016) used the results of its questionnaire to support assigning delivery risk multipliers to a suite of caribou habitat restoration measures (Table 6-2). These values were based on respondents’ answers to specific questions[11]. Discontinuous measures such as fences, berms, rollback, mounding, and tree planting that did not span the full width of a project ROW (or the full width of a project ROW and an existing contiguous ROW) were viewed as having less value (i.e., higher uncertainty) than the same measure when applied continuously across the full width of the ROW. Among access control measures, 60% of respondents indicated that continuous application of rollback would have the lowest delivery risk; rollback is also identified as effective in other literature when applied at specific volumes and lengths (e.g., CLMA and FPAC 2007; EOS 2009; AER 2013). For tree planting, 54% of survey respondents indicated that continuous application of this measure would result in 100% reduction of an effect in the long term, whereas 38% of survey

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

respondents indicated that discontinuous application would result in a 50% reduction of effect in the long term.

Table 6-2 Delivery Risk Multipliers used by Northern Resource Analysts (2016)

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

NOTES

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

2 Delivery risk multiplier values vary depending on the application of the habitat restoration measure and the intensity of the application. See Section 4.2 for project-specific details on these risk multipliers.

6.6.2 Temporal Risk

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

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

One target for achieving functional restoration of forested stands in boreal caribou ranges in British Columbia is to achieve an average tree height of at least 3 m (BC MOE and BC MFLNRORD 2017). This vegetation target height is within the range of values reported elsewhere, whereby vegetation height ranging from 1.2 to 5 m tall have been shown to reduce wolf, grizzly bear, and human use and movement rates along linear features (Finnegan et al. 2014; Dickie et al. 2017). In northern Alberta, Dickie et al. (2017) compared wolf movement rates in relation to vegetation height on linear features with wolf movement rates in forests without linear features. They found that movement rates were similar in summer when vegetation height was 4.1 m tall, and similar in winter when vegetation height was 2.4 m. They also noted that wolf movement rates on linear features began to drop substantially when vegetation height exceeded 0.5 m, and in particular in both summer and winter when more than 34% of the linear feature had vegetation that exceeded 4.9 m.

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

DEFRA (2011; 2012) developed a range of temporal multiplier values based on the theoretical work of Moilanen et al. (2009). The multiplier values range from 1.2 to 3.0 for 5 year to 32 year time periods (Table 6-3), which were applicable to the recovery of a variety of broad habitat types (excluding those classed as impossible to recreate or restore). Northern Resource Analysts (2016) adopted the temporal risk multipliers developed by DEFRA (2011)[12], but applied generally the lower (1.2) and upper (2.8) values based on respondent's answers to questions[13] relating to temporal delay and different restoration measures (Table 6-4). Measures that were considered effective immediately were assigned a temporal risk multiplier of 1.0.

Table 6-3 Temporal Risk Multipliers used by DEFRA (2012)

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

[12] In DEFRA (2012), a 3.0 target multiplier was used for 32 years; this was not included in DEFRA (2011)

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

Table 6-4 Temporal Risk Multipliers used by Northern Resource Analysts (2016)

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

NOTES

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

[2] Temporal risk multiplier values vary depending on the application of the habitat restoration measure and the intensity of the application. See Section 4.2 for project-specific details on these multipliers.

Regionally, tree height-growth curves can be informative for determining an appropriate temporal risk multiplier when planting tree seedlings as a habitat restoration measure. Research on height-growth curves is available for BC but limited with respect to the suite of tree species and biogeoclimatic zones addressed. The information most applicable to this preliminary OMP is based on research on interior spruce[14] and lodgepole pine in the Sub-boreal Spruce biogeoclimatic zone. For interior spruce on moderately productive sites, a model developed by Hu and García (2010) estimated that an average tree height of 2.5 to 5.0 m would be achieved in 6 to 11 years. For lodgepole pine on moderately productive sites, a model developed by Batho and García (2014) estimated that an average tree height of 2.5 to 5.0 m will be achieved in 5 to 9 years.

6.6.3 Spatial Risk

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

Spatial risk multipliers in the context of offsetting for wetland losses are relatively well-developed. For permanent wetland losses in Canada, Cox and Grose (2000) found that spatial risk multipliers for replacement wetlands ranged from 1.0 to 4.5. More recently however, in Alberta, spatial risk multipliers for wetlands can range from 1.0 to 8.0, with the multiplier value depending on the value of the wetland lost versus the value of the wetland replaced (Alberta Government 2013). In the United States, the average multiplier for wetlands was 1.36 when a banking scheme was used, and 1.41 when a trading scheme of spatial wetland area was used (Brown and

[14] A complex of white spruce, Engelmann spruce, and their hybrids (Hu and García 2010)

Lant 1999). In Ohio and Michigan, a 1.0 multiplier is used when the offset meets like-for-like criteria, whereas in New Jersey a 2.0 multiplier is used for like-for-like offsets (Environmental Law Institute 2002). In Australia, land-based offset risk multipliers range from 1.0 to 4.0, and take into consideration offset area, area of impact, and ecological equivalency (Queensland Government 2017).

The approach used by DEFRA (2012) to identify spatial risk multipliers is summarized in Table 6-5. In this approach, location parameters are tied to specific offsetting strategies that identify the preferred area(s) for an offset, such as within a particular ecosystem type, species' range, or management area. When an offset is planned for implementation in a location identified within the offsetting strategy, no spatial multiplier is required. If the location identified for offsetting buffers, links, restores, or expands a habitat area outside of an area identified in the offsetting strategy, a spatial risk multiplier of 2.0 is used. Lastly, if the offset is not expected to contribute to the offsetting strategy, a spatial risk multiplier of 3.0 is used.

Table 6-5 Spatial Risk Multipliers used by DEFRA (2012)

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

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

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

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

6.6.4 Inherent Effect

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

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

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

6.7 KNOWLEDGE GAPS AND LIMITATIONS OF THE LITERATURE REVIEW

The literature review provided the opportunity to identify the following knowledge gaps:

- restoration criteria (e.g., defined guidelines or quantifiable objectives) for restoration of boreal ecosystems for wildlife habitat values, in particular habitats that do not support merchantable timber (e.g., treed bogs and fens)
- although research programs have begun on understanding the functional responses of caribou, wolves and primary prey (e.g., moose, deer) to restoration treatments, understanding movements and habitat use to reclaimed habitats in various stages of successional progression, as well as to access and line-of-sight management continues to be a knowledge gap
- long-term monitoring of vegetation recovery on linear disturbances and of predator response to access management measures
- uncertainty risk for specific circumstances where offset response cannot be adequately predicted or does not achieve gains

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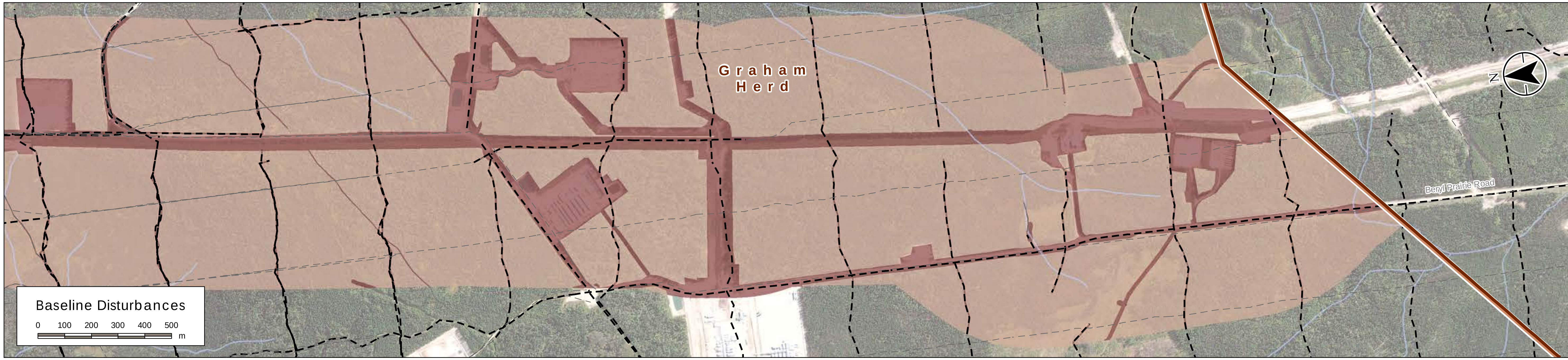
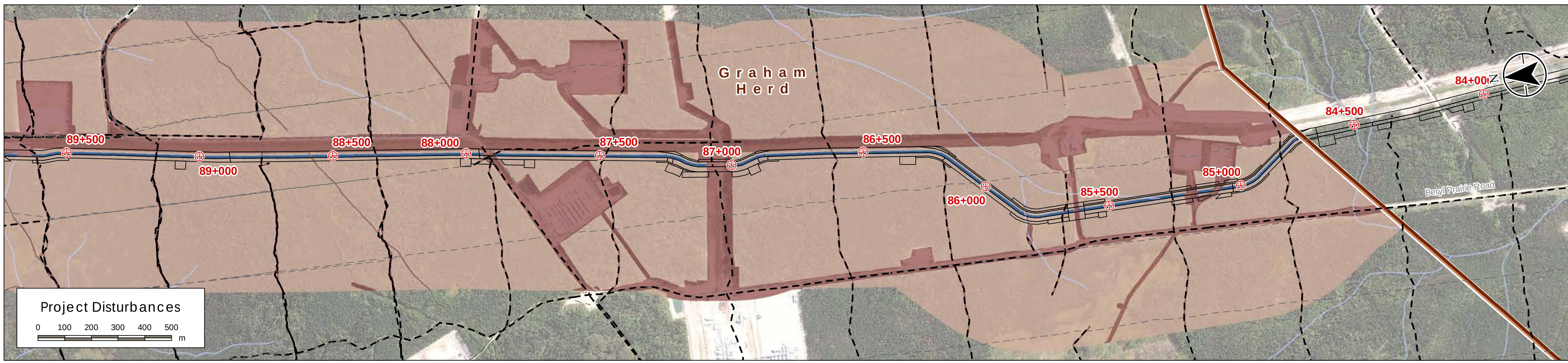
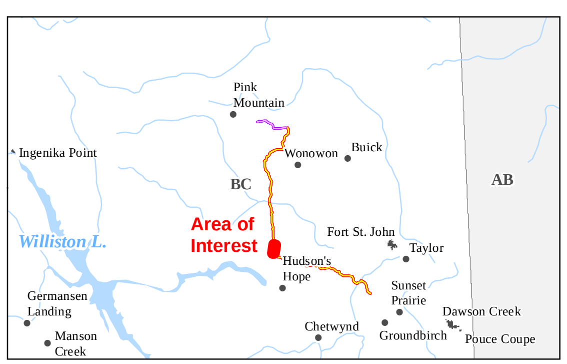
Appendix A
Extent of Baseline and Incremental Project Disturbance within Caribou Range







Kilometre Post
Project Footprint
Caribou Herd Range

Hydrology
River
Water Body
Railway
Road
Major Road
Minor Road
Low-impact Seismic Line
Conventional Seismic Line

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

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

Notes
1. Coordinate System: NAD 1983 UTM Zone 10N
2. Data Source: Government of British Columbia, Government of Canada
3. Not all features may be present on each page and some features may not be visible because of the disturbance hierarchy (i.e., baseline temporary direct disturbance is not visible because it is hierarchically below baseline permanent direct and indirect disturbances).

Stantec TransCanada

Project Location
NTS 094A13
BCGS 094A081

121511126-0XXX
Prepared by LT on 2018-06-19
Technical Review by MP on 2018-06-20
Quality Review by XX on 2018-XX-XX

Client/Project
NOVA Gas Transmission Ltd.
North Montney Mainline Project
Caribou Habitat Restoration Offsets Measures Plan

Figure No. Appendix A
Rev. 1

Title
EXTENT OF BASELINE AND INCREMENTAL PROJECT DISTURBANCE WITHIN CARIBOU RANGE

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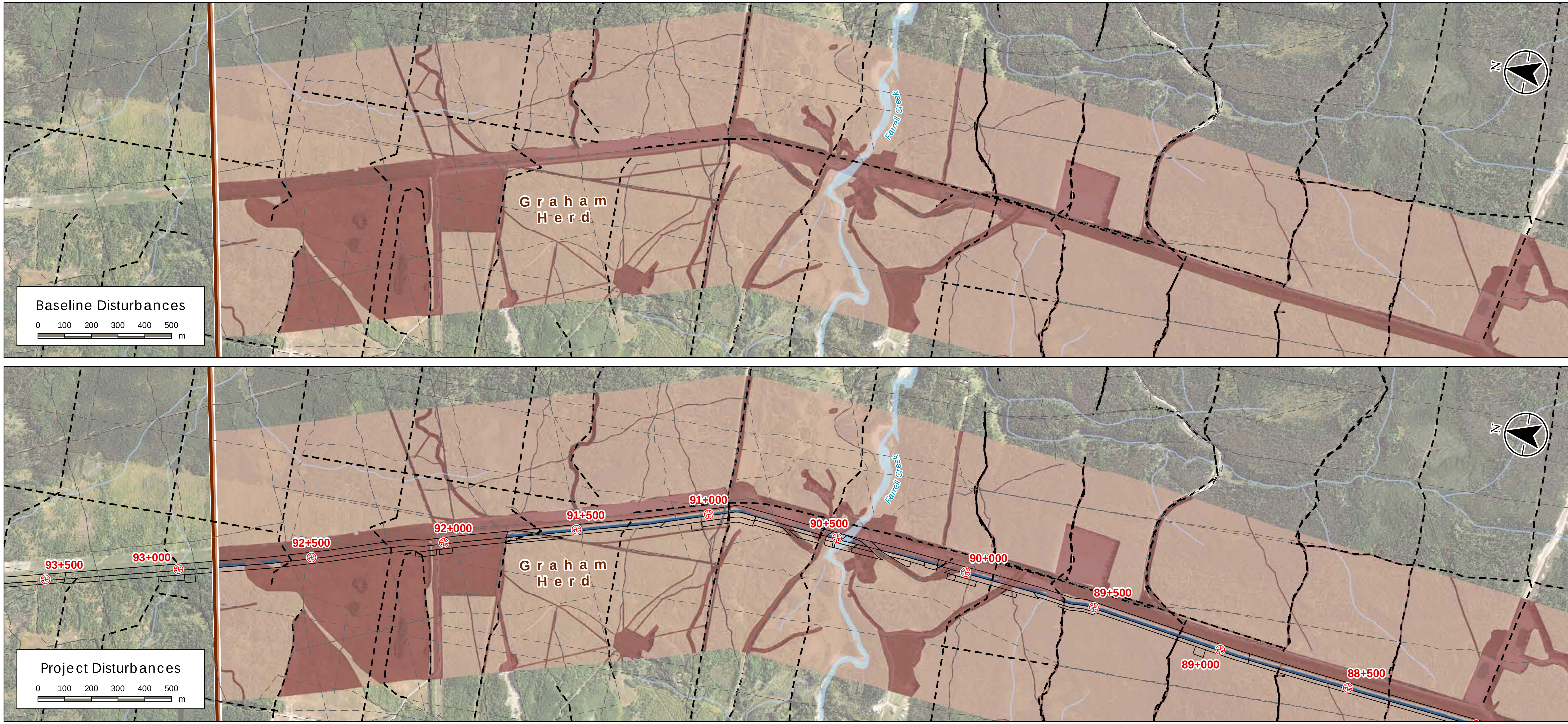

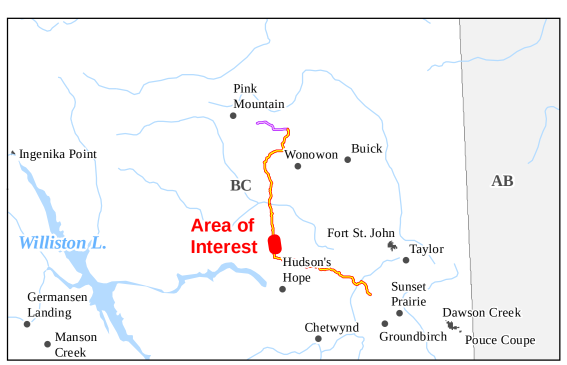

Legend	
Kilometre Post	
Project Footprint	
Caribou Herd Range	

Hydrology
- River
- Water Body
- Railway

Road
- Major Road
- Minor Road
- Low-impact Seismic Line
- Conventional Seismic Line

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

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

Notes
1. Coordinate System: NAD 1983 UTM Zone 10N
2. Data Source: Government of British Columbia, Government of Canada
3. Not all features may be present on each page and some features may not be visible because of the disturbance hierarchy (i.e., baseline temporary direct disturbance is not visible because it is hierarchically below baseline permanent direct and indirect disturbances).

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Client/Project
NOVA Gas Transmission Ltd.
North Montney Mainline Project
Caribou Habitat Restoration Offsets Measures Plan

Figure No. Appendix A
Rev. 1

Title
EXTENT OF BASELINE AND INCREMENTAL PROJECT DISTURBANCE WITHIN CARIBOU RANGE

Appendix B
Summary of Potential Offset Measures Available and Expected Effectiveness

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

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

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

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

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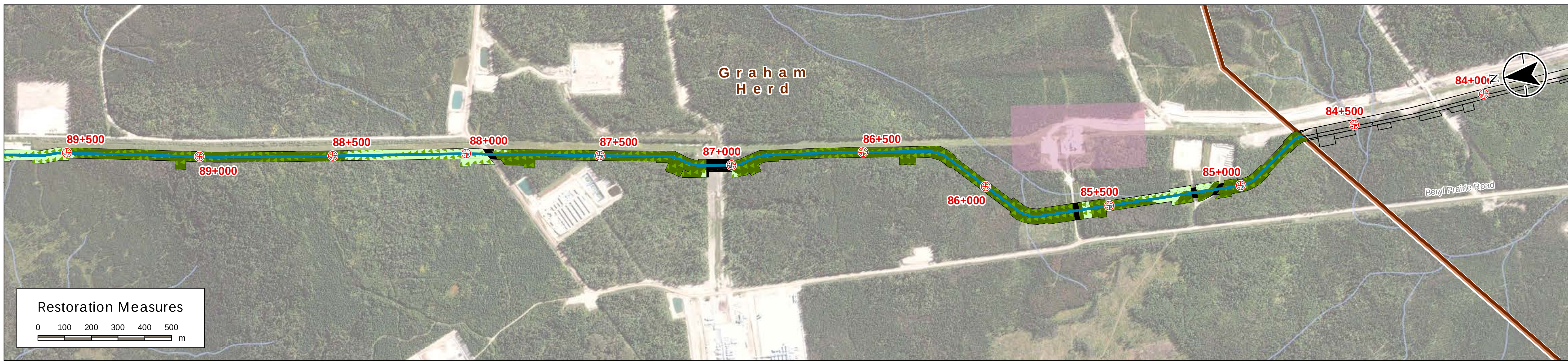
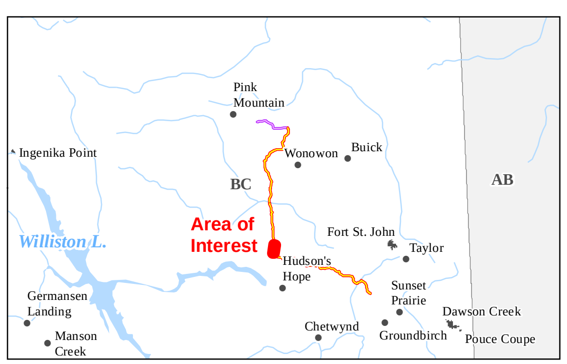
Appendix C
Footprint Elements and Planned Habitat Restoration Measures





Kilometre Post
Project Footprint
Contiguous
New cut
Caribou Herd Range
Private Land

Hydrology
River
Water Body

Road
Major Road
Minor Road

Footprint Elements
Operational Access
Non-maintained ROW
Temporary Workspace

Restoration Measures

Restored
Tree seeding planting
Tree seeding planting with mounding

Unrestored
Natural Regeneration
Unrestored (existing maintained disturbance)

Notes
1. Coordinate System: NAD 1983 UTM Zone 10N
2. Data Source: Government of British Columbia, Government of Canada

Project Location
NTS 094A13
BCGS 094A081

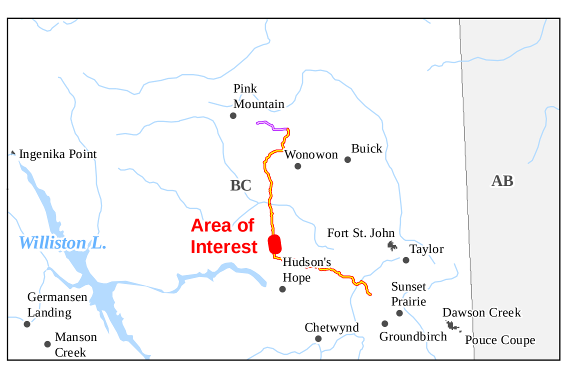
121511126-0XXX
Prepared by LT on 2018-06-19
Technical Review by MP on 2018-06-20
Quality Review by XX on 2018-XX-XX

Client/Project
NOVA Gas Transmission Ltd.
North Montney Mainline Project
Caribou Habitat Restoration Offsets Measures Plan

Figure No.
Appendix C

Rev.
1

Title
FOOTPRINT ELEMENTS AND PLANNED HABITAT RESTORATION MEASURES



Kilometre Post
Project Footprint
Contiguous
New cut
Caribou Herd Range
Private Land

Hydrology
River
Water Body

Road
Major Road
Minor Road

Footprint Elements
Operational Access
Non-maintained ROW
Temporary Workspace

Restoration Measures

Restored
Tree seeding planting
Tree seeding planting with mounding

Unrestored
Natural Regeneration
Unrestored (existing maintained disturbance)

Stantec TransCanada

Project Location
NTS 094A13
BCGS 094A081

121511126-0XXX
Prepared by LT on 2018-06-19
Technical Review by MP on 2018-06-20
Quality Review by XX on 2018-XX-XX

Client/Project
NOVA Gas Transmission Ltd.
North Montney Mainline Project
Caribou Habitat Restoration Offsets Measures Plan

Figure No. Appendix B
Rev. 1

Title
FOOTPRINT ELEMENTS AND PLANNED HABITAT RESTORATION MEASURES

Notes
1. Coordinate System: NAD 1983 UTM Zone 10N
2. Data Source: Government of British Columbia, Government of Canada

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