TABLE OF CONTENTS

TABLE OF CONTENTS (cont)

List of Tables

List of Figures

List of Appendices

5.4.10 Moose *(Alces americanus)*

5.4.10.1 Introduction

This section assesses the potential effects of the Project on the moose *(Alces americanus)* Valued Component (VC). The assessment is described in the subsections below and will be conducted for this species. This introduction describes the information sources of the assessment and the applicable regulatory framework for the assessment of the VC (**Section 5.4.10.1.1**).In order to identify Project effects on moose the study area boundaries, temporal boundaries, administrative boundaries, and technical boundaries were determined and used for assessment of project and cumulative effects. Baseline information on moose and moose habitat within the LSA and RSA was used to validate model suitability models and to assess project interactions (**Section 5.4.10.3**).

Moose (*Alces americanus*) is the largest member of the deer family (*Cervidae*) and a Yellow-listed species (i.e., species of management concern, apparently secure, not at risk of extinction) in British Columbia (BC) (BC Conservation Data Centre (BC CDC) and not listed as a species of concern federally, 2014). Across BC, populations are considered stable or increasing, with a continued expansion of their range along the central coast (Darimont et al., 2005). Overall, moose ecology, biology, and conservation status are well known, both provincially and globally.

Moose was traditionally unknown in the central interior of BC until the mid to late 1800s when populations were initially established across the region after the last glaciation, and subsequently became common after the early 1900s (Seip, 2008; Hatter, 1950). Moose surveys were initiated in the Prince George region in 1991, with additional surveys in 1993, 1998, and 2005. More recent surveys have included WMU 7-11 and 7-12, which are intersected by the transmission line and access route Project study areas. Population density estimates (1.3 moose/km^2) in the 1990s were much higher than similar ecosystems elsewhere in BC; however, it is thought that reduced wolf densities (approximately 50% of natural levels) decreased predation pressure and allowed for populations to reach higher densities in the early 1990s (Heard et al., 1999; Messier, 1994). Moose populations in the province are generally considered healthy. However, recent declines in the central Omenica, Skeena and other regions of the province have raised concerns among First Nations, resident hunters and guide outfitters. The reasons for the declines are not fully understood and the BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) has initiated a five-year study to investigate causes of moose mortality. MFLNRO is also developing a provincial moose management framework and regional moose management plans. Populations in the Omineca region have been declining since 1998, with a -6.8% decline noted between 1998 and 2005, and a larger decline of 50% between 2005 and 2012 (Heard et al., 1999; Heard pers comm., 2012; Walker et al., 2006). It is thought that the mountain pine beetle (MPB) infestation may be the cause of these declines because of deeper snow cover and increased number of downed pine, which reduces foraging efficiency and increases movement difficulty and energetics (Heard, pers. comm., 2012). Increased road density to facilitate logging to remove MPB-affected pine may increase moose hunting access and pressure across the region. Moose density has consistently remained higher in younger forest, which provides more browse and easier access compared with older forest (>40 years (Walker et al., 2006). The ratio of bulls relative to cows decreased between

1998 (0.43:1.0) and 2005 (0.26:1.0) and remained similar in 2012 (0.3:1.0). The ratio of calves to cows gradually declined from 1998 (0.38:1.0) to 2012 (0.24:1.0).

Moose are important prey for many predatory carnivores (e.g., wolf, grizzly bear, black bear, wolverine, and cougar (Blood, 2000)). Moose have been identified as socially and economically important for traditional harvest and important for recreational harvest by resident and non-resident hunters (BC MFLNRO, 2013), as well as ecologically important.

Moose were selected as a representative ungulate Valued Component (VC) because of their ecological and social importance. They are year-round residents within the Project area that are dependent upon upland and lowland habitats for their survival. Moose use both forest and open habitats (e.g., wetlands, burns, and clearcuts) to satisfy their life requisites. Habitat loss and fragmentation through logging and mining exploration have altered the amount of habitat available to many ungulates in the area. Creation of abundant young forest through logging in the region has created suitable feeding habitat for moose but is offset by increased access for predators and hunters and loss of thermal habitat.

5.4.10.1.1 Regulatory Considerations

Moose is a Yellow-listed species (BC CDC, 2014) in BC and subject to provincial wildlife regulations. Moose are provided protection as big game under the BC *Wildlife Act* (Government of BC, 1996a). In addition, the *Draft Provincial Framework for Moose Management in British Columbia* (BC MFLNRO, 2013) guides moose management to ensure that the species is maintained as an integral component of natural ecosystems, as well as providing for the needs of First Nations, licensed hunters, and the guiding industry. Management of moose habitat and populations is considered under the BC *Forest and Range Practices Act* (Government of BC, 2002), BC Conservation Framework, and the Vanderhoof Land and Resource Management Plan (LRMP) (ILMB, 1997) (**Table 5.4.10-1**). Moose is not a federally designated species of conservation concern.

Table 5.4.10-1: Regulatory Considerations Regarding Moose

Regulation/ Guideline	Brief Description or Requirements	Data Required to Meet Regulation/Guideline	Timeframe
BC *Wildlife Act*	Permits are required for handling and for surveys of wildlife that may harass animals or spread disease.	Abundance and distribution data from BC CDC records and surveys, wildlife habitat suitability.	Wildlife management plan, wildlife permits for surveys and collaring.
BC *Forest and Range Practices Act*	Old Growth Management Areas and UWR areas require special management.	Impact assessment and proposed mitigation/offsets required to assess habitat loss to old-growth and UWR areas both of which can include important protected habitat for moose.	Wildlife management plan and permitting for exploration.
BC Conservation Data Centre	Moose is Yellow-listed and rated G5 (globally secure) in BC	Moose is recognized as a culturally and economically significant species of management concern. Harvest and survey data are required to monitor populations.	Wildlife management plan and permitting for exploration.
Vanderhoof Land and Resource Management Plan	Strategies for maintaining or enhancing moose populations and habitat.	Impact assessment and proposed mitigation/offsets required to minimize disturbance and loss to areas of moose habitat.	Wildlife management plan and permitting for exploration.

Note: BC CDC = British Columbia Conservation Data Centre; UWR = Ungulate Winter Range

5.4.10.2 Valued Component Baseline

Baseline information was collected as part of winter ungulate surveys to determine the presence and distribution of moose across the Project area (**Appendix 5.1.3.4A**). The winter tracking surveys completed at Mount Davidson in 2011 detected moose at several locations throughout the Project area. Habitat along the lower riparian areas of Mathews Creek, Laidman Lake, Fawnie Creek, and associated wetlands with well-developed shrub complexes appeared to provide high quality wintering habitat for ungulates. During the 2012 ground-based winter track survey, ungulates were not detected on Mount Davidson. In 2012, more moose were detected along the lower Davidson road network compared to the higher elevation mine site, which had greater snow depths. The Davidson road network northeast of the mine site, within the mine site Regional Study Area (RSA), had the most human activity impacts, as a large portion of the forest within this area was harvested. Incidental sightings of moose and their sign were used to identify moose habitat outside of the mine site LSA.

In recent decades, moose surveys were conducted in the Prince George area, including WMUs 7-11 and 7-12, which are part of the LSA around the transmission line and access route. Surveys

documented a small population decline between 1998 and 2005, and a drop of 50% between 2005 and 2012 (Heard et al., 1999; Heard, 2011; Walker et al., 2006).

The only mineral lick discovered within the Project area was beside the exploration camp; however, it was covered by a Project-associated road in 2012 and is not available to moose anymore.

Moose habitat was assessed as part of the wildlife habitat assessments and TEM and PEM characterization of the LSA and RSA. Habitat suitability was developed using habitat data and ratings for different life stages and seasons for moose so that changes due to project effects could be quantified. Provincially accepted standards (RISC) and ratings were used for developing habitat suitability models for moose.

5.4.10.2.1 Past, Present, or Future Project Activities

The project or activities considered in the assessment are in the Project Inclusion List (PIL). The PIL identifies those projects or human activities that may overlap spatially or temporally with the Project summarized in (**Table 4.3-11**). **Appendix 4C** presents the detailed PIL and descriptions of various projects and activities used for assessing potential environmental effects.

Pre-existing habitat loss and fragmentation due to logging and road development have altered the low-elevation habitat within the Project area. The recent MPB infestation has affected extensive areas of mature pine forest within the LSA and RSA, including areas that were harvested while remaining stands are in various stages of degeneration. MPB and fire effects are described qualitatively in the cumulative effects assessment for moose. Habitat impacts to moose are related to fall-down of stands and loss of winter thermal cover and security cover. Mineral exploration in the area increased the number of access roads, which have caused increased habitat fragmentation and road access for predators. There is a hunting season for moose in the Project area, and the area is also used by recreationalists who can disturb moose. Moose baseline information was collected in the Local Study Area (LSA) and portions of the RSA that have been altered by these past and present activities. Future activities in the Project area are expected to include the same activities. While the four named projects from the PIL will not have interactions with the Project, some of the listed activities from the list are anticipated to have interactions with the Project.

Forest fire and forest insects are the primary natural disturbances in low elevation winter range moose habitat. Fire directly alters habitat through loss of mature conifer stands, lichens, and other forage plants, and may create barriers to movement. Indirectly, fire transforms mature and old forests into early-seral habitat favoured by moose and deer, consequently resulting in increased wolf densities and in potentially increased moose mortality risk. Although fire is a natural mechanism for habitat renewal for moose, where it interacts with substantial amounts of human disturbance to a level that affects predator-prey dynamics, it is important to consider the cumulative creation of early-seral habitats, and potential loss of thermal and security habitat that moose require.

5.4.10.2.2 Traditional Ecological and Community Knowledge

Moose are important to local residents and Aboriginal groups. Comments provided during the engagement and consultation process have offered insight into traditional, ecological, or community knowledge (**Section 3**). This includes unique knowledge about the local environment, how it functions, and its characteristic ecological relationships.

Subsistence living and moose hunting are important to Aboriginal groups. Elders noted the moose population in the area was historically much higher, but there has been a substantial decline since the Elders' childhoods (interviews with Dakelh Elders, 2013). Moose were noted to migrate to the top and sides of the Mount Davidson range. Historically, Aboriginal groups in the area (in particular Lhoosk'uz Dene Nation) would travel up the north and south sides of mountains, such as Mount Davidson, to hunt moose. The harvested meat would be smoked and consumed during winter months (Trapline TR0512T014, 2013). Most First Nations have hunters in each community that harvest moose as a cultural necessity and an important source of food. Moose heart is used as bait for large rainbow trout (Indigenous Work Force, 2013).

The headwaters of Smith Creek are used to hunt moose. Public concerns were raised that the construction of the Project transmission line may increase access to moose by hunters. Guide outfitters in the area also hunt moose, with some hunts occurring in the Fawnie Creek area of the Project area. In addition, some areas near the Nechako area are highly valued for its wilderness tourism opportunities. Representatives noted that the moose population in the Omineca area has declined by approximately 60%, likely due to increased access to areas of intensive logging of MPB-affected pine.

Public consultation activities indicate moose are valued by stakeholders as country food, recreational hunting, and wildlife viewing. The public have raised concerns that the existing moose population is struggling and they do not want the population to decline further.

5.4.10.3 Potential Effects of the Proposed Project and Proposed Mitigation

This subsection identifies and analyzes potential adverse effects on the moose VC resulting from the proposed Project's construction, operations, closure and post-closure phases.

It first describes the features of the study area and temporal, administrative, and technical boundaries. (**Section 5.4.10.3.1** to **Section 5.4.10.3.5**).

Then, **Section 5.4.10.3.6** details the approach used in the assessment followed by **Section 5.4.10.3.8** Mitigation Measures.

The assessment considers the following:

- Terrestrial habitat, including the quality and quantity of any lost habitat for relevant species;
- Feeding, denning, or breeding habitats;

- Any wetland habitat alteration or loss;
- Barriers to wildlife, including the roads developed as part of the mine and their potential effects on wildlife movements;
- Disturbance of daily or seasonal wildlife movements (e.g., migration and home ranges), which would include potential hazards and conflicts associated with mine access and travel corridors of moose;
- Direct and indirect wildlife mortality from the mine operations and traffic;
- Increased access and indirect mortality of species through increased hunting opportunities or improved access for predator species;
- Potential implications to predator - prey dynamics from changes in habitat suitability (e.g., potential changes in wolf numbers or distribution due to habitat and prey abundance changes);
- Wildlife habitat is being rated for suitability as a surrogate for wildlife productivity; and
- Implications of the proposed Project acting as an attractant for particular species.

The Project footprint and associated activities are expected to affect moose and moose habitat. The potential effects are identified and assessed in detail in subsections below. Assessment boundaries define the scope or limits of the assessment. They encompass the areas and time periods during which the Project is expected to interact with moose, any constraints placed on the assessment of those interactions due to political, social, and/or economic realities (administrative boundaries), and any limitations in predicting or measuring changes (technical boundaries). These assessment boundaries are defined in the following subsections.

Activities occurring during each phase of the proposed Project could potentially interact with moose. Habitat loss, features that act as attractants to some moose, potential mortality, changes in habitat availability, noise disturbance (displacement), and disruptions of movement are the predicted key and moderate interactions of the proposed Project related to moose. Implications of the Project acting as an attractant for moose include potential attraction to roadsides and cleared sites for foraging on early seral vegetation, attraction to road surfaces if salts are used for dust control or snow/ice management, and attraction to project facilities if animals perceive safety from predators in proximity to site infrastructure. Taking a conservative approach, both key and moderate interactions are combined and considered jointly in assessment of project and cumulative effects.

5.4.10.3.1 Study Area Boundaries

Two geographic scales were defined for considering Project effects on moose and moose habitat, as shown on **Figure 5.4.10-1** and described below. These areas were used for collecting baseline information. The Project area encompasses the LSA and the RSA as described below. Past, present, and future activities that may affect moose within these areas were identified and assessed within the RSA.

320000 360000 400000 440000

6000000 5960000 5920000 5880000

Tchesinkut Lake
François Lake
Cheslatta Carrier
Danskin
Skin Tyee
Endako
Stellako
Fraser Lake
Nadleh Whuten
Fort Fraser
Engen
Nechako River
Vanderhoof
Weneez
Sinkut River
Saik'uz
Nulki
Nulki Lake
Mapes
Stuart River Park
Stuart River
Tachick Lake
Stony
Smith Creek
Francois Lake
Uncha Mountains Red Hills Park
Francois Lake Park
Uncha Lake
Takysie Creek
Binta Lake
Nithi River
Tahultzu Lake
Hallett Lake
Cheslatta River
Cheslatta Lake
Knapp Creek
Cheslatta
Bird Creek
Targe Creek
Corkscrew
Sinkut River
Khai
Cluculz Lake
Cluculz Creek
Meridian Road (Vanderhoof) Ecological Reserve
Nechako Canyon Protected Area
Kluskus FSR
Lucas Lake
Lucas Creek
Knewstubb Lake
Big Bend Creek
Finger Lake
Tatuk Lake
Finger Tatuk Park
Chilako River Ecological Reserve
Chilako River
Natalkuz Lake (Nechako Reservoir)
Tetachuck River
Entiako River
Chedakuz Creek
Taluk Creek
Batnuni Lake
Euchiniko River
Nataniko Creek
Euchiniko
Nazko
Kluskoil Lake Park
Entiako Park
Entiako Lake
Kluskus-Ootsa FSR
Proposed Mine Access Road
Proposed Fresh Water Pipeline
Tatelkuz Lake
Top Lake
Fawnie Creek
Laidman Lake
Johnny Lake
Tweedsmuir Park
Kluskus-Blue FSR
Kuyakuz Lake
Euchiniko Lakes
Moose Lake
Blackwater River
Kluskus
Tsacha Lake
Kushya
Baezaeko
Nazko

N

Legend

- Populated Place
- Highway
- Kluskus FSR
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Existing Transmission Line
- Stream
- Waterbody
- Parks & Protected Areas

Project Components

- Exploration Road
- Proposed Mine Site Access Road
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Transmission Line (Stellako Reroute)
- Proposed Freshwater Pipeline
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site

Moose and Associated Habitat

- Local Study Area
- Regional Study Area

Scale: 1:500,000

0 5 10 20

Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold™

PROJECT: Blackwater Gold Project

Regional Study Area Boundaries for Moose and Associated Habitat

DATE:	ANALYST:	
September, 2015	MY	**Figure** 5.4.10-1
JOB No: VE52277	QA/QC: MB	PDF FILE: 04-03-001_study_area_5.4.10-1.pdf
GIS FILE: 04-03-001_study_area_5.4.10-1.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

O:\Blackwater\Mapping\04_wildlife\03_EA\04-03-001_study_area_5.4.10-1.mxd

LSA: The AIR describes the LSA as follows (**Table 4.3-1, Section 4**):

- Mine Site: Approximate 500 m buffer around the proposed mine site facilities; and
- Transmission line, mine access road, airstrip, freshwater supply pipeline, and Kluskus FSR: approximately 250 m buffer from each side of the linear component boundary.

The rationale for the LSA is as follows (**Table 4.3-1, Section 4**):

- The LSA includes the entire mine site where habitat will be removed and considers a buffer to take into account sensory disturbances; and
- The LSA includes all linear components and a buffer to take into account sensory disturbances. The buffer along the linear corridors varies because activities along those corridors varies from an access road that may have greater sensory disturbance to a transmission line with limited human activity or traffic after construction.

The LSA for the purpose of the moose VC comprises 22,509 ha and includes 7,032 ha for the Project footprints (**Table 5.4.10-2**). The LSA includes the proposed mine site area (the mine site footprint plus a 500 m buffer), and all linear components areas (linear components with 250 m buffer on each side of linear component boundary, except for the airstrip which is 300 m buffer on each side). The linear component boundary, also referred to as the footprint, is comprised of the feature's right-of-way (ROW) and an additional buffer. The linear component boundary widths are as follows: existing Kluskus FSR is 20 m (20 m ROW with no buffer), proposed mine access road is 120 m (20 m ROW with 50 m buffer each side), proposed transmission line is 140 m (40 m ROW with 50 m buffer on each side), proposed freshwater supply pipeline is 110 m (10 m ROW with 50 m buffer on each side), proposed airstrip is 200 m (100 m ROW with 50 m buffer each side), and the proposed airstrip access road is 10 m (10 m ROW, with no buffer). The FSR re-alignment and Transmission Line access roads are included in the LSA area for these features. The transmission line includes a mainline route and two potential re-routes, the Tatelkuz Lake Ranch and Stellako options. The final location of the transmission line access roads will be determined during the detailed engineering and permitting stage, and will consider traditional knowledge and traditional use information provided by Aboriginal groups as appropriate. Existing roads will be used to access the transmission line to the greatest extent possible.

Table 5.4.10-2: Project Component Footprint Areas

Component	Area (ha)
Mine Site	4,430
Access Road	95
Existing Kluskus Forest Service Road	253
Airstrip	50
Freshwater Pipeline	132
Main Transmission Line	1,806
Mills Ranch Transmission Line	202
Stellako Transmission Line	62
Total Project Footprint	**7,032**

RSA: The AIR describes the RSA as follows (**Table 4.3-1, Section 4**):

- Mine Site: Includes ungulate winter range established for the Tweedsmuir-Entiako caribou herd (U-7-012). The western and southern edges of the RSA outline these winter ranges. The southwestern boundary follows the Upper Blackwater Management Zone where the RSA then follows the Blue Road until it reaches the Ootsa – Kluskus FSR and follows this north until it reaches the Nechako Reservoir. The northern boundary of the RSA follows the shoreline of the Nechako Reservoir. The northern boundary of the RSA follows the shoreline of the Nechako Reservoir; and
- Transmission Line and Kluskus FSR. Approximate 1 km buffer from the linear component boundary.

The rationale for the RSA is as follows (**Table 4.3-1, Section 4**):

- Extends beyond the mine site LSA to consider natural barriers for wildlife such as large water bodies or watershed divides.

The RSA for the purpose of the moose VC comprises 291,714 ha and is large enough to assess the seasonal home range movements and important seasonal habitats of moose. The RSA was selected to include a wide variety of habitat types also found in the LSA, allowing the assessment of relative abundance of habitat within the LSA relative to the greater region within which the Project is situated.

5.4.10.3.2 Temporal Boundaries

Preliminary temporal boundaries of the Project, which are contingent on permitting, include four primary phases.

- **Construction phase:** The construction phase of the Project will occur over 2 years and will likely start following receipt of the required permits;
- **Operations phase:** The operations phase of the Project will extend for approximately 17 years;
- **Closure phase:** The closure phase is estimated to last approximately 18 years (ending in Year 35); and
- **Post-closure phase:** The post-closure phase starts in Year 35.

In terms of duration of effects, the following terms are used in this effects assessment: Short-term effects occur during the construction phase; Medium-term effects are not applicable for caribou as they were considered long term to provide a conservative assessment; Long-term effects occur throughout operations and closure; and Chronic effects extend into post-closure or beyond.

5.4.10.3.3 Administrative Boundaries

The Vanderhoof LRMP identifies smaller Resource Management Zones (RMZs) that have different resource development and conservation objectives. Each RMZ has a selection of species of management concern and objectives to guide land use decisions and management. The mine site and associated infrastructure including the roads and transmission line are located within the following RMZs: Nechako Valley, Nechako West, Upper Nechako River, Vanderhoof South, Crystal Lake, Kluskus, Chedakuz, Davidson Creek, and Laidman Lake. These RMZs have objectives that are considered for each species effects assessment if relevant. Forestry management objectives within the RMZs are suitable for maintaining good moose habitat. The Project is located within five Wildlife Management Units (WMUs): 5-12, 5-13, 6-1, 7-11, and 7-12. Each WMU is the primary designation tool for conservation lands under section 4 of the *Wildlife Act*. Conservation and management of fish, wildlife, and their habitats are priority in a WMU and are used to set hunting regulations (BC MFLNRO, 2012).

5.4.10.3.4 Technical Boundaries

Technical boundaries for the assessment were established by the accuracy of the wildlife habitat model predictions used in the effects assessment. There is an uncertainty / margin of error associated with the use of habitat suitability models; however, Resource Information Standards Committee (RISC) standards for ratings and suitability classes were followed (RISC, 1998). Therefore, these models include acceptable levels of uncertainty for an assessment. Surveys were completed within the LSA and RSA.

5.4.10.3.5 Potential Project Effects

The assessment of potential Project effects on moose within the RSA included habitat effects and mortality risk, as well as potential cumulative effects.

Pre-existing habitat loss and fragmentation due to logging and road development have altered the low-elevation habitat within the Project area. Mineral exploration in the area increased the number of access roads, which have caused increased habitat fragmentation and road access. Future activities in the Project area are expected to include the same activities. The three named projects from the project inclusion list in **Section 4, Table 4.3-11** that represent present and future projects will not have interactions with the Project; however, the listed activities from the list will.

Habitat fragmentation due to forest harvesting and roads likely contribute to baseline conditions of reduced moose habitat suitability in the Project area, as do changes in wildlife population dynamics that may result in increased predation rates on moose (Heard et al., 1999; Messier, 1994). These effects were incorporated in the moose habitat model and effects assessment for mortality risk through downgrading habitat suitability within 500 m of roads and consideration of linear corridor density in the RSA. To identify the most important habitats for moose, ratings tables were developed to model the moderate to high value moose habitats (ratings values 1-3) in the Project area for the winter and growing periods (summer) (**Appendix 5.4.10B**).

Many threats to moose and moose habitat are interrelated such as increased access, predator numbers and distribution, alternate prey abundance, and changes in security cover. Cumulative effects may not be evident when threats are examined individually. Project effects consider both the key and moderate interactions defined and identified in **Section 4, Table 4.3-2** (Project Component and Activity Interaction Matrix). In order to conservatively assess interactions of the project with moose and moose habitat, both key and moderate interactions were combined and included in modeling and effects assessment. For example, limited recent use of suitable habitat in the mine RSA might be interpreted as a moderate interaction; however, it was included as important as habitat effects. The interactions were further identified using a ranking table identified using a ranking table (**Table 5.4.10-3**). Additional analysis included determining whether the resulting effect can be managed to acceptable levels through standard operating practices, through the application of best management practices (BMPs), or by codified practices. The analysis also included determining whether the resulting effect may exceed acceptable levels without implementation of specified mitigation. The table was used to guide specific mitigation and monitoring needed for this VC.

Several measurable categories of assessment for Project effects were defined, and the rationale for the selection of each category of assessment is provided in **Table 5.4.10-4**.

Evidence suggests that, below certain thresholds of habitat cover, species may decline more rapidly than would be expected from habitat loss alone. When remaining functional habitat is greater than 10% to 30% in a region, species are still affected by habitat loss (Andrén, 1994; Swift and Hannon, 2010) but are not necessarily at risk of regional extirpation. Depending on taxa and landscape, residual habitat thresholds ranging from 10% to as high as 60% may be required to avoid rapid population declines (Bennett and Ford, 1997; Villard et al., 1999; Swift and Hannon, 2010). However, most threshold evidence supports a minimum 30% residual habitat threshold at a landscape level to avoid rapid declines that may lead to regional extirpation (Swift and Hannon, 2010). For this assessment, precautionary thresholds have been identified for species for which specific thresholds do not exist. A precautionary threshold is defined as the point before a resource would be expected to undergo an unacceptable change, either from an ecological, regulatory, or social perspective. This definition allows the Proponent and regulators to enact mitigation measures with sufficient time to prevent the particular resource from reaching or exceeding the true ecological threshold. The following precautionary threshold was used in this assessment: 70% residual habitat (30% loss) for species not federally designated as a species of conservation concern including moose.

Table 5.4.10-3: Potential Interaction of the Project Activities with Moose

Project Activities	Potential Key and Moderate Interactions
Construction of Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line	
Clearing and grubbing	2
Open pit preparation	1
General earthworks (moving surface soil)	2
Equipment operation	2
Road upgrading and construction	2
Borrow pit excavation	2
Road and airstrip use	2
Operations of Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line	
Open pit mining	1
Process plant	1
Transportation system preparation	2
Temporary waste rock stockpiles	2
Tailings storage facility	1
Camp	1
Road use	2
Water collection pond	2
Decommissioning Closure and Post-Closure Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line	
Roads	2
Reclamation	2

Note: 0 = No interaction.
1 = Moderate Interaction occurs; however, based on past experience and professional judgment, the resulting effect can be managed to acceptable levels through standard operating practices and/or through the application of best management or codified practices.
2 = Key Interaction occurs. The resulting effect may exceed acceptable levels without implementation of mitigation. Further assessment and monitoring is warranted.

Table 5.4.10-4: Categories of Assessment for Moose

Category of Assessment	Notes or Rationale for Selection
Habitat Loss and Alteration	Population abundance and distribution are directly affected by habitat availability and displacement from effective habitat. Vegetation clearing for the Project, and sensory disturbance from Project activities during construction and operations, may affect habitat availability and quality. This analysis included ranking habitat quality for moose, so that the relative quantitative and qualitative loss of moderate- to high-quality versus lower-quality habitat was assessed in relation to the local and regional availability of suitable habitat measured as percentage and hectares lost.
Changes in Moose Population Dynamics	For some species, predation may be affected by changes in prey abundance / habitat availability, resulting in differential mortality of key species. The Project may indirectly alter predator-prey relationships among some species and contribute to cumulative landscape changes. This relies on provincial data and potential monitoring data of moose populations and distribution over the life of the Project, including species, features and occurrences based on regular field surveys. Future change can be monitored with intensive surveys. For moose, the focus is on relative abundance and distribution in areas of potential impact and measures of known mortality.
Mortality Risk	Mortality related to transport options and increased hunter access could alter species abundance and relative availability. Assessment of the potential effects of roads, pits, and other structural features on moose feeding, migration and movement, reproductive behaviour and success, and direct mortality. The assessment included potential effects of direct mortality from vehicles and hunting pressure (as appropriate). Primarily qualitative, in the absence of area-specific baseline data, and predictive tools; discussion based on characteristics of the species or species group and context of Project components.
Changes in Moose Movement Patterns	Changes in movement patterns may affect species breeding and survival rates, and may increase predation/mortality. Changes may positively or negatively affect hunting, which can affect local species abundance and traditional sustenance use. Qualitative discussion is generally based on information from habitat mapping, existing knowledge on moose movement patterns, and characteristics and context of Project components.
Changes in Moose Health	Contaminant loading may affect moose health. Assessment of the potential effects of identified contaminants of potential concern on moose feeding, migration and movement, reproductive behaviour and success, and direct mortality. This qualitative measure relies on reporting of moose health and provincial data. Some Human Health and Ecological Risk Assessment sampling and risk assessment address part of this concern.

Note: Includes input from consultation with regulators, Aboriginal organizations, affected stakeholders and the public, as well as EA guidelines, other regulatory drivers, policies and/or programs.

The next step was to assess each of these relative interactions of the Project phases and activities with moose to examine which effects may be expected in different areas and times (**Table 5.4.10-5**).

Potential key and moderate interactions are linked to the temporal scale of the Project phases and vary for the time needed to return to baseline conditions (**Table 5.4.10-6**). For instance, sensory disturbance effects tend to be very short-lived and transient, and effects may be related to frequency of disturbance and duration, but recovery may be very quick once disturbances stop. Conversely, habitat loss due to Project construction may require significant amounts of time to recover to baseline conditions.

Anticipated Project effects include habitat loss (i.e., cleared vegetation, changes to wetland quantity and quality) and some potential degradation (**Table 5.4.10-7**). The construction of the mine site, access roads, transmission line, freshwater supply pipeline, and airstrip will require the removal of vegetation. A small amount of vegetation (less than 1% of the RSA) will be lost permanently (greater than 100 years), while the majority of other areas will be reclaimed progressively or during closure.

In addition to direct habitat loss, activities on the mine site, airstrip, and access roads may reduce functional use of habitat. Road use may result in direct mortality from vehicle collisions and displacement from suitable habitat by sensory disturbance (e.g., noise, visual disturbance from mine-related activity). Mitigation may help reduce the incidence of vehicle mortality; however, it is not expected to eliminate the effect.

Changes in habitat availability will result in the removal of forest, vegetation and wetlands from the Project footprint, but also the change in vegetation communities at the edge of the Project footprint, where enhanced foraging habitat may become available.

Table 5.4.10-5: Potential Interactions among Project Activities and Moose by Categories of Assessment

Project Activities	Category of Assessment				
	Changes in Habitat Availability	**Changes in Moose Population Dynamics**	**Changes in Moose Mortality Risk**	**Changes in Moose Movement Patterns**	**Changes in Moose Health**
Construction of Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line					
Clearing and grubbing	2	2	2	2	1
Open pit preparation	1	1	1	1	0
General earthworks (moving surface soil)	2	1	1	2	1
Equipment operation	2	1	2	2	2
Road upgrading and construction	2	1	2	2	1
Borrow pit excavation	2	1	1	2	1
Road and airstrip use	2	2	2	2	1
Operations of Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line					
Open pit mining	1	1	1	1	1
Process plant	1	1	1	1	1
Transportation system preparation	2	1	1	2	1
Temporary waste rock stockpiles	2	1	1	1	1
Tailings storage facility	1	1	1	1	1
Camp	1	1	1	1	1
Road use	2	2	2	2	1
Water collection pond	2	2	2	2	2
Decommissioning Closure and Post-Closure Mine, Airstrip, Access Roads, Freshwater Supply Pipeline, and Transmission Line					
Roads	2	1	2	2	1
Reclamation	2	2	1	2	1

Note: 0 = No interaction.
1 = Moderate Interaction occurs; however, based on past experience and professional judgment, the resulting effect can be managed to acceptable levels through standard operating practices and/or through the application of best management or codified practices.
2 = Key Interaction occurs. The resulting effect may exceed acceptable levels without implementation of mitigation. Further assessment and monitoring is warranted

Table 5.4.10-6: Temporal Boundaries

Environmental Effect	Temporal Boundary
Habitat Loss and Alteration	Construction to closure. Late-seral forest structures and vegetation compositions (50 to 80 years after reclamation) for recovery of thermal and security habitat, although feeding habitat is expected to recover after operations.
Changes in Moose Population Dynamics	All phases after clearing and during construction
Mortality Risk	Construction and operations
Changes in Moose Movement Patterns	Construction and operations
Changes in Moose Health	All phases, and into closure, due to potential contaminants, uptake or delay in recovery of habitat

Table 5.4.10-7: Overview of Potential Project Effects on Moose

Category of Assessment	Description	Project Phases	Project Components
Habitat Loss or Alteration	Areas that will be cleared of vegetation for Project infrastructure (e.g., facility footprint, road surface and cut / fill, borrow areas, etc.) result in temporary to long-term habitat loss.	Construction, operations, closure	Mine site, access roads, transmission line, freshwater supply pipeline, and airstrip
Mortality Risk	Direct mortality from physical exposure to traffic or attractants. Mortality related to transport options and increased hunter access.	Construction, operations, closure	Mine site, access roads, transmission line, freshwater supply pipeline, and airstrip
Moose Movement Patterns	Human presence, noise, light and odours associated with construction and operations may displace moose from habitats used for reproduction or feeding adjacent to footprints.	Construction through to post-closure	Mine site, airstrip, transmission line, freshwater supply pipeline and access roads
Changes in Moose Population Dynamics	Changes in moose populations due to habitat changes, and indirect mortality of moose due to changes in predator populations.	Construction through to post-closure	Mine site, airstrip, transmission line, freshwater supply pipeline and access roads

Project effects due to changes in wildlife population dynamics are expected. Changes in potential habitat because of Project construction, as well as potential changes in predator population levels, may result in changes to the moose population over the length of the Project.

Wildlife health is not further considered due to the conclusions of the atmospheric effects assessment and the surface water quality effects assessment. The atmospheric effects assessment determined that overall, potential effects of the Project on air quality were assessed as Not Significant because adverse residual effects are not predicted to result from construction, operations, or decommissioning of the Project. The surface water quality effects assessment was that residual effects relate to parameter-specific potential exceedance of water quality guidelines that are a consequence of existing background concentrations above guidelines, and therefore

are not considered a result of Project-related effects and are not expected to increase or create health effects on moose different from baseline conditions.

5.4.10.3.6 Assessment Approach of Measuring Potential Effects

Both quantitative and qualitative approaches were used for the assessment of potential Project effects on moose. A quantitative approach was used for determining the potential loss and alteration of habitat within the RSA and a qualitative approach was used for assessing an increase in mortality risk, changes in wildlife movement patterns, and changes in population dynamics.

5.4.10.3.6.1 Habitat Suitability Model Assumptions

Habitat suitability modeling is based on assumptions related to TEM and PEM habitat interpretations, professional judgement and experience related to moose and moose habitat, literature and traditional knowledge. Assumptions include the quantitative rating of TEM and PEM units for value to moose during different life history stages and seasons and are based on similar models used and tested throughout BC and assessed over time through population estimates and research. Specific assumptions related to habitat quality are described in each sub-model. Habitat suitability value is assumed to reflect the current value of habitat and not the future value.

Assumptions related to mortality, disturbance, displacement, predation and health are described in the effects sections related to these categories of assessment. Habitat ratings were interpreted to represent potential reductions in habitat quality and effectiveness related to mine infrastructure. Models assumed that all suitable habitat could be used and that habitat was included in calculations of habitat impacted by the Project.

5.4.10.3.6.2 Habitat Loss and Alteration

To identify the most critical habitats for moose, ratings tables were developed to model the moderate to high value moose habitats (ratings values 1-3) in the Project area during the winter and growing periods (summer) (**Appendix 5.4.10B**). Potential areas affected by Project component footprints were calculated. Terrestrial Ecosystem Mapping (TEM) or Predictive Ecosystem Mapping (PEM) was the basis for habitat polygons rated in the LSA and RSA. Although moose is a less common resident in higher elevations except in summer, all potential habitat sites were included to present a conservative measure of potential effects on habitats and populations.

5.4.10.3.6.3 Moose Winter and Growing Habitat Models

Due to the extensive information about the specific life requisites for moose, a six-class habitat model was used and suitability ratings were based on the species account (**Appendix 5.4.10A**). Both growing and winter season habitats were evaluated for food and security-thermal habitat; however, winter habitat is considered most limiting for moose. The availability of high quality feeding and security/thermal habitat during the growing season also pertains to reproduction. Parturition/feeding is one of the life requisites modeled for moose along with security and thermal during the growing season and is used to address any concerns regarding productivity. Moose suitability models were based primarily on food availability and ratings were decreased one class

for proximity to features such as roads that may decrease effectiveness, or increased one class for features such as thermal and security cover forest patches.

Moose prefer wetlands, ponds, lake edges, riparian areas, and semi-open successional stages (e.g., structural stages 3a and 3b) of forested habitats with abundant browse as foraging habitat. Moose will feed in recent clearcuts and burns, but typically stay within 200 m of cover.

High quality winter habitat consists of a matrix of both food and security-thermal habitat. High quality winter food habitat is characterized as open areas with easily accessible browse, typically riparian areas, clearcuts, and burns and other areas with an age class of less than 4 and with an abundance of shrubs and low deciduous trees. Mature coniferous forest, typically spruce and fir species, with a closed canopy provides a high amount of snow interception and shallower snow depths, which facilitates travel in winter and escape from predators. This forest also provides increased cover from predators and weather in winter. As a result, this type of forest is typically rated as high winter security-thermal habitat for moose, and a matrix of this and high quality winter food habitat is rated as high winter living habitat.

5.4.10.3.6.4 Mortality Risk

Changes in mortality risk can result from increased access into an area resulting in vehicle collisions, increased hunting/poaching, lethal control of problem wildlife or reduction of habitat security due to fragmentation. There are no measureable parameters for the assessment of direct mortality risk, therefore the assessment is qualitative.

5.4.10.3.6.5 Moose Movement Patterns

Changes in moose movement patterns may be caused by changes in sensory disturbance, vehicle traffic, and alterations to wildlife habitat. However, there are no measureable parameters for the assessment of direct mortality risk, therefore the assessment is qualitative.

5.4.10.3.6.6 Moose Populations Dynamics

Changes in moose population dynamics may result from alterations to wildlife habitat or changes in predator population levels or predator access to certain habitats. Change in the regional population of moose may be measured through moose population surveys with assessment of calf:cow ratios and numbers compared to baseline population statistics.

5.4.10.3.7 Model Results for Quantification of Potential Project Effects on Habitat

The potential overlap of Project component footprints on moderate to high suitable moose habitats is tabulated in **Table 5.4.10-8** and **Table 5.4.10-9** and illustrated on **Figure 5.4.10-2** and **Figure 5.4.10-3**. The areas shown represent the maximum potential habitat affected, and do not account for existing disturbance or mitigation measures.

5.4.10.3.7.1 Habitat Loss and Alteration

The habitat loss and alteration category of effects is a method of accounting for areas of vegetation removal and/or ground disturbance due to placement of infrastructure and edge effects. To simplify

the effects assessment, all lost areas are combined regardless of how long they are lost (even though the Project area will be reclaimed, except for some small features) to represent a worst-case scenario. Clearing of forest within the Project area will result in a decrease of available potential moose habitat. Effects of direct habitat loss are assessed relative to the amount of similar habitat available within the RSA and related to the threshold of magnitude set to determine significance.

Noise from Project construction, operations, and the temporary camp may displace moose from using habitats within 250 m of these features on a relatively continuous basis; therefore, noise is considered an effect and included in the effects assessment. The proposed access road and airstrip may also temporarily displace moose from using habitats close to the road or airstrip during periods of frequent traffic. These buffers are included in the LSA to account for reduced habitat effectiveness near disturbance.

The potential degradation to moose habitat includes placement of new roads and facilities, dust, invasive plants, windthrow, and altered local hydrology. Potential degradation of moose habitat includes sensory disturbance, physical hazards, and chemical hazards that can be both a source of habitat loss and degradation. A description of potential effects to ecosystems and vegetation is provided in this section. These habitat effects are assessed within the LSA to estimate potential degradations to moose habitat. A distance of 250 m from the edge of infrastructure is used to estimate the potential area of degradations to moose. Based on professional judgment, this is considered to include the various types of degradation of effects that have potential to occur on moose. The combination of these effects is considered as one potential 'degradation' effect for a simplified approach as a worst-case scenario assessment.

Winter field surveys conducted in 2012 identified that the majority of moose sign was located in pine stands, in cutblocks, and along riparian corridors within the Sub Boreal Spruce (SBS) biogeoclimatic zone. The majority of the mine site footprint is located within the Englemann Spruce – Subalpine Fir (ESSF) zone, and a minimal amount within the SBS zone. The overall effect of the proposed mine site on moose habitat is likely little change in the amount of suitable habitat, due to the relatively high elevation and lower suitability habitat of the mine site compared to other moose habitat available at lower elevations. Clearing of forest for the transmission line is unlikely to affect moose, because most wetlands that are important to moose in spring and summer will likely be spanned with no physical infrastructure footprint.

The majority of the transmission line, Kluskus FSR, and freshwater pipeline footprints are located within the SBS zone, which is more productive for moose, and these components of the Project are more likely to affect moose. Clearing of forest for Project components will result in vegetation growth, which may provide additional suitable foraging habitat.

Winter moose habitat is the most limiting (BC MFLNRO, 2013) and consists of more open areas that provide easy access to browse and foraging habitat, as well as adjacent closed-canopy mature forests that provide security-thermal habitat. Habitat during the growing season includes more open habitats during spring and early summer that provide suitable foraging habitat, and closed-canopy mature forests that provide security-thermal habitat during mid to late summer.

The amount of winter habitat rated as high, moderately high, and moderate within the Project footprint (1,301 ha) is approximately the same percentage of the total footprint (19%) as the amount of habitat within the RSA (48,693 ha) compared to the total RSA (17%). The majority of the high to moderate value habitat expected to be lost is located within the mine site, and the high to moderate value habitat overlaid by the overall footprint represents 2% of the similar habitat within the RSA. This loss of winter habitat within the Project footprint may be mitigated by the conversion of forested areas within the Project footprint to open shrubby habitat, which will potentially increase the amount of winter food habitat available. A similar situation exists for the loss of growing (summer) habitat where the Project footprint overlays 1,913 ha of high to moderate habitat representing 2% of this habitat in the entire RSA.

Table 5.4.10-8: Potential Moderate to High Valued Moose Winter Habitat Area Affected Within Footprints, LSA, and RSA

	Project Component	Moose Habitat Area Affected (ha)	Total Area (ha)	Habitat % of Total Area	% of RSA Habitat
Footprint or Corridor	Access Road	4	95	4	<1
	Airstrip	8	50	16	<1
	Kluskus FSR	77	253	30	<1
	Mine Site	871	4,430	20	2
	Freshwater Supply Pipeline	4	132	3	<1
	Transmission Line – Main	295	1,806	16	1
	Transmission Line – Mills Ranch	15	202	7	<1
	Transmission Line – Stellako	28	62	45	<1
	Total	**1,301**	**7,032**	**19**	**3**
LSA	Access Road	20	363	6	<1
	Airstrip	83	465	18	<1
	Kluskus FSR	1,204	6,574	18	2
	Mine Site	1,242	6,123	20	3
	Freshwater Supply Pipeline	45	731	6	<1
	Transmission Line – Main	1,451	8,068	18	3
	Transmission Line – Mills Ranch	77	924	8	<1
	Transmission Line – Stellako	121	306	40	<1
	Total	**4,244**	**23,554**	**18**	**9**
RSA		48,693	291,714	17	-
Area	Footprint % RSA	2	-	-	-
	Footprint % LSA	30	-	-	-
Habitat	Footprint % RSA Habitat	3	-	-	-
	Footprint % LSA Habitat	31	-	-	-

Note: FSR = forest service road; ha = hectare; LSA = Local Study Area; RSA = Regional Study Area

Table 5.4.10-9: Potential Moderate to High Valued Moose Growing Habitat Area Affected within Footprints, LSA, and RSA

	Project Component	Moose Habitat Area Affected (ha)	Total Area (ha)	Habitat % of Total Area	% of RSA Habitat
Footprint or Corridor	Access Road	12	95	13	<1
	Airstrip	7	50	14	<1
	Kluskus FSR	19	253	8	<1
	Mine Site	1,156	4,430	26	1
	Freshwater Supply Pipeline	11	132	8	<1
	Transmission Line - Main	530	1,806	29	1
	Transmission Line - Mills Ranch	139	202	69	<1
	Transmission Line - Stellako	39	62	63	<1
	Total	**1,913**	**7,032**	**27**	**2**
LSA	Access Road	91	363	25	<1
	Airstrip	128	465	27	<1
	Kluskus FSR	1,911	6,574	29	2
	Mine Site	1,643	6,123	27	2
	Freshwater Supply Pipeline	188	731	26	<1
	Transmission Line - Main	2,950	8,068	37	4
	Transmission Line - Mills Ranch	608	924	66	1
	Transmission Line - Stellako	192	306	63	<1
	Total	**7,709**	**23,554**	**33**	**9**
RSA		81,623	291,714	28	-
Area	Footprint % RSA	2	-	-	-
	Footprint % LSA	30	-	-	-
Habitat	Footprint % RSA habitat	2	-	-	-
	Footprint % LSA habitat	25	-	-	-

Note: FSR = forest service road; ha = hectare; LSA = Local Study Area; RSA = Regional Study Area

320000 360000 400000 440000

6000000 5960000 5920000 5880000

Endako River
Proposed Transmission Line (Stellako re-route)
Nadleh Whuten
Fraser Lake
Nechako River
François Lake
Fraser Lake
Fort Fraser
STELLAKO RIVER WILDLIFE MANAGEMENT AREA
Engen Creek
Engen
16
Vanderhoof
Stuart
STUART RIVER PARK
Cheslatta Carrier
Danskin
Skin Tyee
UNCHA MOUNTAINS RED HILLS PARK
Francois Lake
FRANCOIS LAKE PARK
FRANCOIS LAKE PROTECTED AREA
Takysie Creek
Nithi River
Tachik Lake
Weneez
Sinkut River
Nechako River
Nulki
Nulki Lake
Mapes
Cluculz Creek
Cluculz Lake
Greer Creek
Knapp Creek
Khai
Targe Creek
Cheslatta Lake
Cheslatta River
Proposed Transmission Line LSA
Kluskus FSR
Sinkut River
Murray Lake
NECHAKO CANYON PROTECTED AREA
Kluskus FSR LSA
Ootsa Lake
Big Bend Creek
Lucas Creek
Knewstubb Lake
Finger Lake
Tatuk Lake
FINGER TATUK PARK
Chilako River
Chelaslie
RSA
Proposed Transmission Line
Natalkuz Lake
Proposed Transmission Line (Mills Ranch re-route)
Chedakuz Creek
Taluk Creek
Tetachuck Lake
Tetachuck River
Kluskus FSR LSA
Euchiniko River
Nataniko Creek
Proposed Mine Access Road
Proposed Airstrip
Kluskus Blue FSR
Exploration Road
ENTIAKO PARK
Tatelkuz Lake
Kluskus-Ootsa FSR
Proposed Fresh Water Pipeline
KLUSKOIL LAKE PARK
Nazko
Kuyakuz Lake
Fawnie Creek
Mine Site LSA
Entiako River
West Road (Blackwater) River
Baezaeko
Kluskus
Tsacha Lake
Kushya
Nazko
TWEEDSMUIR PARK

N

Legend

- Populated Place
- Highway
- Kluskus FSR
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Existing Transmission Line
- Exploration Road
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch re-route)
- Proposed Transmission Line (Stellako re-route)
- Proposed Fresh Water Pipeline
- Proposed Mine Site Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream (>= 4th Order)
- Waterbody (>= 100 Ha)
- Parks and Protected Areas

Wildlife and Wildlife Habitat

- Local Study Area
- Regional Study Area

Wildlife Habitat Rating

- 1 - High
- 2 - Moderately High
- 3 - Moderate
- 4 - Low
- 5 - Very Low
- 6 - Nil

Scale: 1:500,000

0 5 10 20

Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold™

PROJECT: Blackwater Gold Project

Moose Habitat Suitability, Overview

Life Stage/Season: Security-Thermal (ST) / Growing (G)

DATE:	ANALYST:	
September, 2015	MY	**Figure** 5.4.10-2
JOB No: VE52095	QA/QC: MB	PDF FILE: 04-03-007_WHR_MALAL_STG_5.4.10-2.pdf
GIS FILE: 04-03-007_WHR_MALAL_STG_5.4.10-2.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

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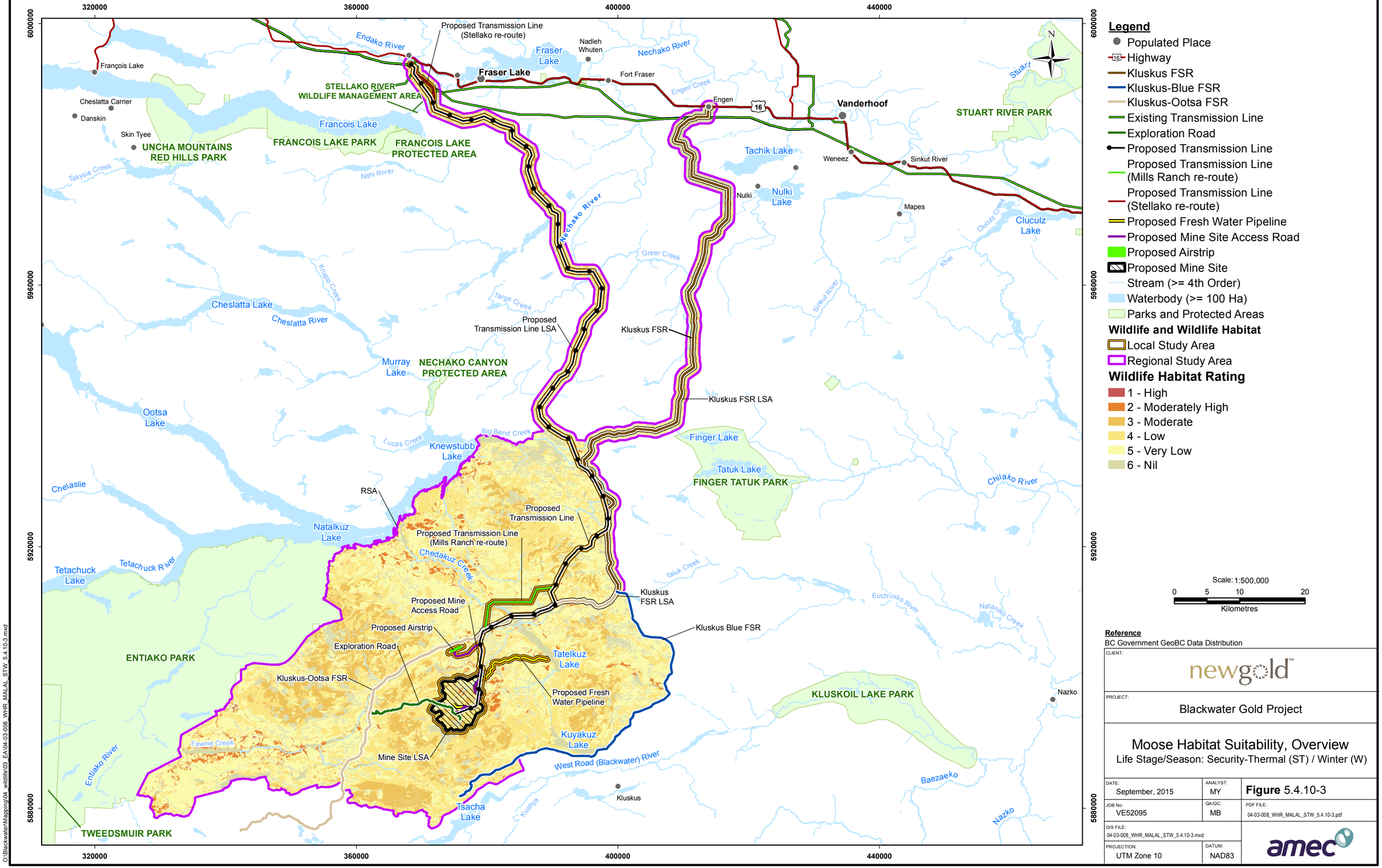

Reference
BC Government GeoBC Data Distribution

CLIENT: newgold™

PROJECT: Blackwater Gold Project

Moose Habitat Suitability, Overview

Life Stage/Season: Security-Thermal (ST) / Winter (W)

DATE:	ANALYST:	**Figure** 5.4.10-3
September, 2015	MY	
JOB No: VE52095	QA/QC: MB	PDF FILE: 04-03-008_WHR_MALAL_STW_5.4.10-3.pdf
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PROJECTION: UTM Zone 10	DATUM: NAD83	amec

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5.4.10.3.7.2 Mortality Risk

The mine site access road, Kluskus FSR, and transmission corridor may increase the potential for direct mortality risk related to vehicle collisions and indirect effects related to increased predator efficiency and hunting access. The Kluskus FSR is a permanent feature on the landscape; however, traffic is expected to increase during Project operations causing a potential limited increase in direct mortality risk related to vehicle collisions.

Baseline traffic conditions were monitored in 2012 and 2013. During construction and operations, Project-related traffic (all vehicle types) on the Kluskus and Kluskus-Ootsa FSRs would generate a substantial increase in average daily two-way traffic on these roads. The average daily increase of 28 vehicle return trips on these FSRs would represent a 67% increase in two-way traffic compared to 2012 traffic volumes, and a 97% increase in two-way traffic compared to 2013 traffic volumes. Decommissioning, closure, and port-closure phases would have an average of 6 to 7 Project-related daily return trips on the Kluskus and Kluskus-Ootsa FSRs, which is a 24% increase over the 2013 baseline traffic on the Kluskus and Kluskus-Ootsa FSRs. Increases in vehicle traffic over baseline levels may result in an increase in the number of vehicle collisions with moose during construction and operations; however, mortality risk from vehicle collisions should lessen following decommissioning.

Increased access to areas of moose habitat throughout the Project area may result in higher mortality of moose from hunting, both legal and illegal. Areas along the transmission line will cross through several areas that were previously not crossed by roads or transmission lines. These areas may provide increased access of moose hunters to these areas, and therefore increase the mortality risk for moose.

5.4.10.3.7.3 Moose Movement Patterns

Project activities during all phases and in all components may result in changes to moose movement patterns. Increased vehicle traffic, changes in habitat availability, and increased sensory disturbance may affect wildlife movement patterns.

Roads and vehicle traffic can act as a deterrent for moose moving across the landscape, and alter their traditional movement patterns. The road type (e.g., highway, forest service road) and rate of traffic are both variables that are known to influence moose travel patterns. The predicted increase in traffic along the Kluskus FSR and other roads may result in local changes in movement patterns away from these areas.

Revegetation along the edges of Project components may result in an increase in the amount of foraging habitat for moose. Increased foraging habitat may cause local populations of moose to concentrate in these areas. Fallen MPB-affected pine may present barriers to movement. The new access road may be used by moose, especially in winter for movement.

Sensory disturbance effects may occur along the access road, FSR, airstrip, and mine site. Increased noise and light levels from baseline conditions may reduce moose use of these areas;

however, habituation to routine disturbances over the length of the Project may reduce these Project effects.

5.4.10.3.7.4 Changes in Moose Population Dynamics

Clearing related to Project activities may result in the indirect effects of changes in population dynamics. Changes in population dynamics will most likely be caused by changes in habitat availability for prey and ease of increased access for predators. Revegetation along the edges of Project components may result in an increase in the amount of foraging habitat for moose. Increased foraging habitat may result in a local increase in the moose populations or use of these areas.

Risk associated with the increased ease of access to moose habitat by predators will most likely occur along the proposed access road and transmission line. Linear corridors through habitat that was previously difficult to travel through may allow wolves and other predators to access areas that previously had low predation rates for moose. Wolves frequently use linear corridors to facilitate travel instead of forested areas. In addition, recreational users (e.g., all-terrain-vehicle or snowmobile users) may create access with machines that further create pathways through these areas and an increasing ease of travel for predators. Effects have the potential to occur from the start of construction to the end of post-closure.

5.4.10.3.8 Mitigation Measures

A range of habitat mitigation measures was adapted and applied to the Project as described in the Wildlife Management Plan (WLMP) (**Section 12.2.1.18.4.6**). The following habitat mitigation measures apply to moose and will help reduce or eliminate habitat loss, direct mortality effects, changes in moose movement patterns, and potential changes in population dynamics.

5.4.10.3.8.1 Habitat Loss and Alteration

Avoiding and/or mitigating loss and degradation effects to moose and moose habitat begins with the Project design. The design of the road, transmission line, and mine site footprints include avoidance of high value, habitat-suitable riparian and wetland areas, with several iterative changes in the mine site and access road components already completed. The Kluskus FSR is an existing road for most of its footprint. Mitigation measures already in place include:

- Road design using existing roads and cleared areas, and locating proposed access roads and transmission lines away from wetland, black spruce and riparian areas or spanning wetlands where feasible.

To meet provincial regulatory requirements for wildlife, vegetation, and aquatic resources relating to the conservation of species and ecosystems at risk, the following management plans will be implemented: the Landscape, Soils, and Vegetation Management and Restoration Plan (LSVMRP) (**Section 12.2.1.18.4.4**), Invasive Species Management Plan (ISMP) (**Section 12.2.1.18.4.5**), Wetland Management Plan (WMP) (**Section 12.2.1.18.4.3**), Sediment and Erosion Control Plan (SECP) (**Section 12.2.1.18.4.1**), Reclamation and Closure Plan (RCP)

(**Section 2.6**), and the Aquatic Resources Management Plan (ARMP) (**Section 12.2.1.18.4.2**). These plans are designed to control invasive plant species, protect wildlife habitat, and protect in-stream resources. Implementing these management plans, including the wildlife and wetland specific BMPs, will protect and minimize the potential effects of the Project to wetlands not directly affected by the Project.

Mitigation for unavoidable loss of moose habitat will be limited to adjacent areas and will include:

- Minimizing ground disturbance and damage to vegetation in areas adjacent to footprints by flagging or fencing of sensitive habitats thereby reducing potential loss of moose habitat as described in the WLMP (**Section 12.2.1.18.4.6**);
- Applying soil erosion and sediment control measures as described in the SECP (**Section 12.2.1.18.4.1**);
- Implementing dust control measures as defined in the Air Quality and Emissions Management Plan (AQEMP) (**Section 12.2.1.18.4.9**), including watering roads and avoiding use of road salts for dust control during summer and winter to reduce attractants to wildlife that might draw moose close to roads;
- Restoring disturbed habitats at mine closure or development of habitats capable of supporting moose as defined in the RCP (**Section 2.6**) and LSVMRP (**Section 12.2.1.18.4.4**);
- Implementing a WMP (**Section 12.2.1.18.4.3**) and a Wetlands Compensation Plan (**Appendix 5.3.7A**) as defined in other sections of the Application including the creation of offsetting habitat;
- Implementing invasive plant management techniques as defined in the ISMP (**Section 12.2.1.18.4.5**); including developing and implementing detailed construction and operational plans of invasive plant prevention and detection strategies, and an action protocol if invasive plants are detected (management techniques will include annual monitoring for invasive plants, although recognizing that current data from baseline reports on invasive species identified within the LSA do not pose a risk to moose within the LSA or RSA); and
- Minimizing sensory disturbance due to noise adjacent to the mine area and airstrip, as stated in the Noise and Vibration Mitigation Measures (**Section 5.2.2.3**).

5.4.10.3.8.2 Mortality Risk

Mitigation measures to reduce potential mortality effects on moose include:

- Posting speed limits along roads for Project related vehicles, as well as implementation of BMPs of road surface maintenance;
- Implementing water quality monitoring and adaptive management (Compliance Monitoring and Follow-up Program **Section 13**);

- Selecting revegetation species that minimize attraction of wildlife to roadsides to reduce potential vehicle collisions and predation of many species;
- Implementing a no hunting and no firearms policy, as stated in the WLMP (**Section 12.2.1.18.4.6**);
- Providing breaks in snow banks along the access road to allow wildlife escape in the WLMP (**Section 12.2.1.18.4.6**);
- Removing carrion along the road to reduce the risk of attractants that may bring predators into moose habitat, as described in the WLMP (**Section 12.2.1.18.4.6**);
- Posting road signs warning drivers of speed limits and of the possibility of moose sensitive areas such as migration routes and seasonal feeding areas;
- Reporting and documenting wildlife observations and incidents/accidents along access roads as described in the WMP (**Section 12.2.1.18.4.6**);
- Restricting and controlling road access to ensure no unauthorized traffic use of the road. All traffic flow on the FSR will be monitored and controlled via radio communications. Reporting observations of wildlife along the road to environmental staff;
- Implementing adaptive management (WLMP) (**Section 12.2.1.18.4.6**); and
- Including moose awareness information into regular safety and environmental inductions performed by the mine.

5.4.10.3.8.3 Wildlife Movement Patterns

Mitigation measures to reduce changes in movement patterns of moose will include:

- Posting signs warning drivers of the possibility of wildlife encounters in areas of high wildlife activity;
- Implementing BMPs for road surface maintenance to allow good vehicle line of sight and control to help reduce potential collisions with moose;
- Selecting revegetation species that minimize attraction of wildlife to roadsides to reduce potential vehicle collisions, as well as help reduce changes in prey-predator densities and distribution;
- Clearing road ROWs of brush to assist in reducing foraging attractants;
- Implementing adaptive management, as described in the Wildlife Management Plan; and
- Minimizing sensory disturbance due to noise and light at the mine area and airstrip as stated in the Noise and Vibration Mitigation Measures (**Section 5.2.2.3**).

5.4.10.3.8.4 Moose Population Dynamics

Mitigation measures to reduce changes in moose population dynamics will include the following:

- Removing carrion along the road to reduce the risk of attracting predator species, as described in the WLMP (**Section 12.2.1.4.18.6**); and
- Implementing adaptive management to manage alternate prey habitat, wolf access or other similar measures, as described in the WLMP (**Section 12.2.1.4.18.6**).

5.4.10.3.8.5 Effectiveness of Mitigation

Table 5.4.10-10 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on moose during mine site development. Mitigation measures will be based on site-specific information and construction engineering and are therefore preliminary at this stage.

Table 5.4.10-10: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Moose during Mine Site Development

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Habitat loss and alteration	Construction, Operations, Closure, Post-closure	Road design using existing roads and cleared areas, and locating proposed access roads and transmission lines away from wetland, mature spruce and riparian areas or spanning wetlands where feasible	High
		Minimizing ground disturbance and damage to vegetation in areas adjacent to footprints by flagging or fencing of sensitive habitats thereby reducing potential loss of moose habitat as described in the WLMP (**Section 12.2.1.18.4.6**)	High
		Applying soil erosion and sediment control measures as described in the SECP (**Section 12.2.1.18.4.1**)	Moderate
		Implementing dust control measures as defined in the AQEMP (**Section 12.2.1.18.4.9**), including watering roads and avoiding use of road salts for dust control during summer and winter to reduce attractants to wildlife that might draw moose close to roads	High
		Restoring disturbed habitats at mine closure or development of habitats capable of supporting moose as defined in the RCP (**Section 2.6**) and LSVMRP (**Section 12.2.1.18.4.4**)	High
		Implementing a WMP (**Section 12.2.1.18.4.3**) and a Wetlands Compensation Plan (**Appendix 5.3.7A**) as defined in other sections of the Application including the creation of offsetting habitat	High

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Implementing invasive plant management techniques as defined in the ISMP (**Section 12.2.1.18.4.5**); including developing and implementing detailed construction and operational plans of invasive plant prevention and detection strategies, and an action protocol if invasive plants are detected (management techniques will include annual monitoring for invasive plants, although recognizing that current data from baseline reports on invasive species identified within the LSA do not pose a risk to moose within the LSA or RSA)	Moderate
		Minimizing sensory disturbance due to noise adjacent to the mine area and airstrip, as stated in the Noise and Vibration Mitigation Measures (**Section 5.2.2.3**)	High
Mortality risk	Construction, Operations, Closure, Post-closure	Posting speed limits along roads for Project related vehicles, as well as implementation of BMPs of road surface maintenance	Moderate
		Implementing water quality monitoring and adaptive management (Compliance Monitoring and Follow-up Program (**Section 13**))	High
		Selecting revegetation species that minimize attraction of wildlife to roadsides to reduce potential vehicle collisions and predation of many species	High
		Implementing a no hunting and no firearms policy, as stated in the WLMP (**Section 12.2.1.18.4.6**)	High
		Providing breaks in snow banks along the access road to allow wildlife escape in the WLMP (**Section 12.2.1.18.4.6**)	High
		Removing carrion along the road to reduce the risk of attractants that may bring predators into moose habitat, as described in the WLMP (**Section 12.2.1.18.4.6**)	High
		Posting road signs warning drivers of speed limits and of the possibility of moose sensitive areas such as migration routes and seasonal feeding areas	Moderate
		Reporting and documenting wildlife observations and incidents/accidents along access roads as described in the WMP (**Section 12.2.1.18.4.6**)	Moderate
		Restricting and controlling road access to ensure no unauthorized traffic use of the road. All traffic flow on the FSR will be monitored and controlled via radio communications. Reporting observations of wildlife along the road to environmental staff	High
		Implementing adaptive management (WLMP) (**Section 12.2.1.18.4.6**)	High

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Including moose awareness information into regular safety and environmental inductions performed by the mine	High
Changes in moose health	Construction, Operations, Closure, Post-closure	Manage attractants	High
		Spill Management and Prevention Plan, effluent and dust management	High
Changes in moose movement patterns	Construction, Operations, Closure, Post-closure	Posting signs warning drivers of the possibility of wildlife encounters in areas of high wildlife activity	Moderate
		Implementing BMPs for road surface maintenance to allow good vehicle line of sight and control to help reduce potential collisions with moose	High
		Selecting revegetation species that minimize attraction of wildlife to roadsides to reduce potential vehicle collisions, as well as help reduce changes in prey-predator densities and distribution	High
		Clearing road ROWs of brush to assist in reducing foraging attractants	High
		Implementing adaptive management, as described in the Wildlife Management Plan	High
		Minimizing sensory disturbance due to noise and light at the mine area and airstrip as stated in the Noise and Vibration Mitigation Measures (**Section 5.2.2.3**)	High
Changes in moose population dynamics	Construction, Operations, Closure, Post-closure	Removing carrion along the road to reduce the risk of attracting predator species, as described in the WLMP (**Section 12.2.1.4.18.6**)	High
		Implementing adaptive management to manage alternate prey habitat, wolf access or other similar measures, as described in the WLMP (**Section 12.2.1.4.18.6**)	Moderate

Note: AQEMP = Air Quality and Emissions Management Plan; BC MFLNRO = British Columbia Ministry of Forests, Lands and Natural Resource Operations; BMP = Best Management Practice; FSR = Forest Service Road; ISMP = Invasive Species Management Plan; LSA = Local Study Area; LSVMRP = Landscape, Soils and Vegetation Management and Restoration Plan; RCP = Reclamation and Closure Plan; ROW = right-of-way; RSA = Regional Study Area; WLMP = Wildlife Management Plan

The mitigation/offsetting success ratings shown in **Table 5.4.10-10** are incorporated into the confidence ratings defined in **Section 4.3.5** and summarized in **Table 5.4.10-12**. In summary, low success rating means mitigation has not been proven successful, moderate success rating means mitigation has been proven successful elsewhere, and high success rating means mitigation has been proven effective.

In the case of moose for the mine site, mitigation/offsetting success rating is classified as moderate overall because most mitigation measures are consistent with those proposed by BC MFLNRO for

protection of moose populations, and demonstrated as moderate to high in effectiveness in other locations.

5.4.10.4 Residual Effects and their Significance

Table 5.4.10-11 summarizes the residual effects after mitigation, as well as management strategies by Project phase and component. Residual effects on moose are characterized in terms of magnitude, geographical extent, frequency, duration, reversibility, context, likelihood of effect, and significance of moose or moose habitat, probability, and confidence in the conclusions (**Table 5.4.10-12**)**.**

The thresholds provide the ability to likely detect change in local populations as a result of Project effects (**Table 5.4.10-13**).

Table 5.4.10-14 presents the residual effects assessment summary for moose, based on the categorization of effects.

Table 5.4.10-11: Summary of Categories of Assessment and Mitigation Measures – Moose

Project Phase	Project Component	Category of Assessment	Mitigation and Management of Effects	Potential for Residual Effect?
Construction, Operations, Closure, and Post-Closure	Mine site, access roads, freshwater supply pipeline, airstrip, and transmission line	Habitat Loss and Alteration	Vegetation Management Plan, progressive reclamation with appropriate species to accelerate reclamation of preferred moose habitat through silviculture methods to promote site restoration to pre-disturbance condition. Avoid large scale clearing of old-growth forest and riparian stands. Wetland compensation measures are expected to increase suitable moose wetland habitat. Minimize Project footprint. Noise and Vibration Mitigation Measures to reduce displacement from roads, air traffic, and operations. Adaptive measures to respond to presence of moose in proximity to the mine or access issues along transmission ROW or fresh water pipeline ROW.	Yes
Construction, Operations, Closure, and Post-Closure	Mine site, access roads, freshwater supply pipeline, airstrip, and transmission line	Mortality Risk	Follow wildlife management plan to reduce potential effects to moose and moose habitat. Enforce speed limits on access roads. Manage attractants and their use on roadways and around the mine site. Restrict access to only individuals working directly for the Proponent; gate access points and close road after mine reclamation (Transportation and Access Management Plan (TAMP), Reclamation and Closure Plan (RCP)) (**Section 2.6**). No hunting and no firearm policy as defined in Wildlife Management Plan.	Yes
Construction, Operations, Closure, and Post-Closure	Mine site, access roads, freshwater supply pipeline,	Changes in Moose Health	Manage attractants during construction, operation, and decommissioning and closure. Spill Management and Prevention Plan, effluent and dust management.	No

Project Phase	Project Component	Category of Assessment	Mitigation and Management of Effects	Potential for Residual Effect?
	airstrip, and transmission line			
Construction, Operations, and Closure	Mine site, access roads, freshwater supply pipeline, airstrip, and transmission line	Changes in Moose Movement Patterns	Minimize Project footprint; outlined in existing Project Description. Noise and Vibration Mitigation Measures (**Section 5.2.2.3**) and Transportation and Access Management Plan (**Section 12.2.1.18.4.14**) (to reduce displacement from roads, air traffic and operations). Reduce attractants such as road salt, roadside vegetation and invasive species as outlined in the Landscape, Soils and Vegetation Management and Restoration Plan (LSVMRP) (**Section 12.2.1.18.4.4**), WLMP (**Section 12.2.1.18.4.6**) and Industrial and Domestic Waste Management Plan (IDWMP) (**Section 12.2.1.18.4.11**).	Yes
Construction, Operations, Closure, and Post-Closure	Mine site, access roads, freshwater supply pipeline, airstrip, and transmission line	Changes in Moose Population Dynamics	Vegetation management, reducing predator access and alternate prey through habitat management.	Yes

Table 5.4.10-12: Characterization of Residual Environmental Effects for Moose

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in a measurable parameter or variable relative to baseline case	Negligible—Effects are not measurable Low—A measurable change but within the range of expected natural variation based on species life history Medium—A measurable change but less than high High[(1)]—A >20% change of density, abundance or distribution for listed species and >30% change of density, abundance or distribution for all other species
Geographical Extent	The geographic area in which an environmental, economic, social, heritage, or health effect of a defined magnitude occurs	Local: Within the LSA—Effect is prevalent in the LSA Regional: Within the RSA—Effect extends beyond the LSA into the RSA
Frequency	When the effect occurs and the number of times during the Project or a specific Project phase that an environmental effect may occur	Once—Effect occurs on one occasion Intermittent—Effect occurs several times Continuous—Effect occurs continuously

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until moose and moose habitat returns to its baseline condition, or the effect can no longer be measured or otherwise perceived	Short-term—Less than two years (i.e., effects happens during the construction phase only) Medium-term—Not applicable for moose Long-term—From more than 17 to less than 35 years (i.e., effect happens during construction, operations and closure) Chronic—More than 35 years and beyond (i.e., effect happens from construction through to post closure and beyond)
Reversibility	The likelihood that a measurable parameter will recover from an effect	Yes—Effect is reversible within part of a whole generation after the impact ceases No—Effect is not reversible over the time scales listed
Context	Resilience to stress due to ecological fragility and degree of disturbance of area in which the Project is located	Low—Moose have high resilience to stress, have not been affected by other projects or activities or natural changes. No listed species or ecosystems identified Medium—Moose have moderate resilience to stress, the VC has been affected by other projects or activities, or natural changes but still has capacity to assimilate more changes. Presence of blue-listed species or ecosystems High—Moose have weak resilience to stress, the VC has been severely affected by other projects or activities, or natural changes. Presence of red-listed or SARA-listed species or ecosystems
Likelihood of Effect	The likelihood that a residual effect will occur	Low—Low likelihood a residual effect will occur Medium—Moderate likelihood a residual effect will occur High—High likelihood a residual effect will occur
Significance	Expectation of a residual effect on moose that is above the threshold	Not Significant (negligible) —Effects are point-like or local in geographic extent, with a low context rating, and a negligible magnitude, short-term, reversible, and with a low frequency (once or intermittent) Not Significant (minor—)Effects are local in geographic extent, with a low magnitude, and low context rating, short-term to chronic, reversible, and with a low frequency (once or intermittent) Not Significant (moderate) —Effects are local to regional in geographic extent, and medium in magnitude, medium context rating, medium-term to chronic, reversible, and occur at all frequencies Significant—Effects occur to moose with a medium to high context, and high context rating, high magnitude, regional in geographic extent, long-term to chronic, non-reversible, and occur at all frequencies

Note: LSA = Local Study Area; RSA = Regional Study Area; VC = Valued Component
High: A threshold of 20% change or loss is proposed for high magnitude. This is a general environmental practitioner approach, which has been used and supported in the past for resource development projects, including the Joint Review Panel Report on the Jackpine Mine Expansion Project which decision statement was made under *CEAA 2012*.

Table 5.4.10-13: Threshold(s) for Determining Magnitude of Residual Moose Habitat and Population Effects in the RSA

Category of Assessment	Proposed Threshold of Environmental Effect
Habitat Loss and Alteration	>30% reduction in relative moose habitat abundance or habitat areas with a moderate to high suitability ratings (e.g., >30% change in amount of moose moderate to high suitable habitats within the RSA, as estimated in suitability model). Evidence of lack of use or displacement due to sensory disturbance may be included as lost habitat if evident.
Mortality Risk	Qualitative measure of risk within the RSA because of Project effects (e.g., road density and relative frequency of use of the area by moose). Quantitative measure for magnitude for the mine access road effect is defined as: Low - one moose is killed during the life of the Project as the result of collisions with Project-related traffic; Medium - less than 5 moose are killed during the life of the Project as the result of collisions with Project-related traffic; and High - more than 5 moose are killed during the life of the Project as the result of collisions with Project-related traffic.
Changes in Moose Movement Patterns	Qualitative measure of risk within the RSA because of Project effects.
Changes in Moose Population Dynamics	Qualitative measure of risk within the RSA because of Project effects.

Table 5.4.10-14: Residual Effects Assessment Summary for Moose

Project Phase	Project Component	Description of Effect	Mitigation and Management	Potential for Residual Effect?	Residual Effect	Context	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Likelihood Determination	Level of Confidence for Likelihood	Significance Determination	Level of Confidence for Significance
Construction through to Post-Closure	Mine site, airstrip, transmission line, freshwater supply pipeline, and access roads	Habitat Loss and Alteration	Vegetation Management Plan, progressive reclamation with appropriate species. Minimize Project footprint in existing Project Description. Maintain mature and old growth coniferous forest with high canopy closure and wetlands functionality and vegetation, were ever possible.	Yes	Unavoidable loss or degradation of habitat	Medium	Low	Local	Short-term	Reversible long-term (mine site, airstrip, transmission line and access road) Irreversible (FSR)	One time	Low	High	Not Significant (negligible)	High
Construction through to Post-Closure	Mine site, airstrip, transmission line, freshwater supply pipeline, and access roads	Wildlife Mortality	Follow wildlife management plan to reduce potential effects to moose and their habitat. Enforce speed limits on access roads. Manage chemical hazards and attractants and their use on roadways and around the mine site. Restrict access to only individuals working directly for the proponent; gate site access points and road closure after mine closure (Closure and Reclamation Plan) (**Section 2.6**). No hunting policy as outlined in Wildlife Management Plan.	Yes	Unavoidable direct mortality of moose	Medium	Low	Local	Long-term	Reversible	Intermittent	Low	High	Not Significant (minor)	Moderate
Construction through to Post-Closure	Mine Site, Airstrip, Transmission Line, Freshwater Supply Pipeline, and Access Roads	Moose Movement Patterns.	Minimize Project footprint; outlined in existing Project Description. Noise and Light Management Plan (to reduce displacement from roads, air traffic and operations).	Yes	Unavoidable displacement from habitats near mine site, access road or airstrip	Medium	Low	Local	Long-term	Reversible	Intermittent	Low	High	Not Significant (minor)	High
Construction through to Post-Closure	Mine Site, Airstrip, Transmission Line, Freshwater Supply Pipeline, and Access Roads	Changes in Moose Population Dynamics	Vegetation management	Yes	Unavoidable indirect mortality of moose Change in predator-prey dynamics	Medium	Low	Local	Long-term	Reversible	Intermittent	Low	High	Not Significant (minor)	High

5.4.10.4.1 Mine Site

The residual effects of habitat loss are rated as Not Significant (negligible) with high confidence, due to the context, magnitude, geographical extent, duration, reversibility and frequency of the effect occurring (**Table 5.4.10-14**). The effects will have a moderate context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes. The magnitude of loss and alteration of moose habitat is low because, regionally, moderate and high value habitat are widespread and relatively common, as the high to moderate value habitat within the footprint accounts for only 2% of the same habitat within the RSA. The loss and alteration of moose habitat will occur once during the construction phase and these adverse effects will be evident through the post-closure phase. The habitat changes are rated as local as this evaluation is limited to the mine site. The clearing of mature coniferous forest habitats will generally make these habitats unsuitable for moose for the Project term, as it will result in an immediate loss of both winter security/thermal and foraging habitat. Project effects will be reversible; however, the duration of the habitat effect will be long term for mature forest; some areas lost will potentially be replaced relatively quickly by new foraging habitat. .

The residual effects of mortality are rated as Not Significant (minor) with moderate confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring (**Table 5.4.10-14**). Direct mortality may occur intermittently from the construction phase through the closure phase, due to increased traffic and potential access from vehicle collisions and, to a lesser extent, hunting and poaching). The magnitude of the adverse effect is rated as low because of mitigation and BMPs related to mine traffic and access management. The probability of direct mortality is evaluated for the mine site and therefore rated as local with respect to geographic extent. Duration is expected to occur throughout the life of the project and frequency is expected to be intermittent. Project effects will be reversible; however, the duration of the habitat effect will be long-term as recovery of mature forest thermal and security habitat is expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes. The residual effects of a change in movement patterns are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in movement patterns will occur intermittently from the construction phase through the closure phase. Movement changes will be local in geographic extent due to changes in local vegetation and habitat surrounding different areas of the mine site. Within the mine site, the adverse effect is rated with low magnitude because changes in movement patterns due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in movement patterns will be long-term as some the effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in population dynamics are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in population dynamics will occur intermittently from the construction

phase through the closure phase. Changes in population dynamics will be local in geographic extent due to changes in foraging habitat and predator populations in areas of the mine site. Clearing of vegetation may result in increased foraging habitat, which could result in changes to local moose populations. In addition, clearing may increase access for predators to certain areas within the mine site and increase the risk of predation for moose within these areas. The adverse effect within the mine site is rated with low magnitude because the changes in population dynamics due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in population dynamics will be long-term as some the effects are expected to last for the length of the Project. The effects will have a low context due to the high resilience of the ecosystems present within the Project to recover from disturbance.

5.4.10.4.2 Access Road and Kluskus Forest Service Road

The residual effects of habitat loss are rated as Not Significant (negligible) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. The loss and alteration of moose habitat will occur once during the construction phase and these adverse effects will be evident through the post-closure phase. The habitat changes have a local effect within the access roads and Kluskus FSR, the adverse effect is rated with low magnitude because regionally, moderate, and high value habitat are widespread and relatively common, as the high to moderate value habitat within the footprint accounts for only 2% of the same habitat within the RSA. The clearing of mature coniferous forest habitats will generally make these habitats unsuitable for moose, as it will result in an immediate loss of both winter security-thermal and food habitat. Additional food habitat potentially will be created following the re-growth of deciduous vegetation along areas that were cleared for road construction. Project effects will be reversible; however, the duration of the habitat effect will be chronic for mature forests, but some areas lost will potentially be replaced relatively quickly by new foraging habitat. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in mortality are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in mortality will occur intermittently from the construction phase through the closure phase. Mortality changes have a local effect and within the access roads and Kluskus FSR, the adverse effect is rated with low magnitude because the increase in mortality due to Project activities is considered low, and moose are relatively common within the RSA. Direct mortality as a result of the Project is anticipated to mostly result from vehicle collisions, however, additional mortality may result from other activities (e.g., additional chemical spills, hunting, poaching). Project effects will be reversible; however, the duration of the habitat effect will be long term as some the effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes. The residual effects of a change in movement patterns are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in movement patterns will occur intermittently from the construction phase through the closure phase. Movement changes will be local in geographic extent. Expected changes in movement

patterns are due to changes in local vegetation and habitat surrounding different areas of the access roads and Kluskus FSR. Within the access roads and Kluskus FSR, the adverse effect is rated with low magnitude because the changes in movement patterns due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in movement patterns will be long-term as some the effects are expected to last for the length of the Project. The effects will have a moderate context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in population dynamics are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in population dynamics will occur intermittently from the construction phase through the closure phase. Changes in population dynamics will be local in geographic extent due to changes in foraging habitat and predator populations along parts of the access roads and Kluskus FSR. Clearing of vegetation may result in increased foraging habitat, which could result in changes to local moose populations. In addition, clearing may increase access for predators to certain areas along the access roads and Kluskus FSR and increase the risk of predation for moose within these areas. The adverse effect along the access roads and Kluskus FSR is rated with low magnitude because the changes in population dynamics due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in population dynamics will be long-term as some effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

5.4.10.4.3 Airstrip, Transmission Line, and Freshwater Supply Pipeline

The residual effects of habitat loss are rated as Not Significant (negligible) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. The loss and alteration of moose habitat will occur once during the construction phase and these adverse effects will be evident through the post-closure phase. The habitat changes have a local effect within the airstrip, transmission line, and freshwater pipeline. The adverse effect is rated with low magnitude because regionally, moderate, and high value habitat are widespread and relatively common, as the high to moderate value habitat within the footprint accounts for only 2% of the same habitat within the RSA. The clearing of mature coniferous forest habitats will generally make these habitats unsuitable for moose, as it will result in an immediate loss of both winter security-thermal and food habitat. Additional food habitat will be created following the re-growth of deciduous vegetation along areas that were cleared for the airstrip, transmission line, and freshwater supply pipeline. Project effects will be reversible; however, the duration of the habitat effect will be chronic for mature forests, but some areas lost will potentially be replaced relatively quickly by new foraging habitat. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in mortality are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in mortality will occur intermittently from the construction phase through the closure phase. Mortality changes have a local effect and within the airstrip, transmission line, and freshwater supply pipeline, the adverse effect is rated with low magnitude because the increase in mortality due to Project activities is considered low, and moose are relatively common within the RSA. Direct mortality because of the Project is anticipated to mostly result from vehicle collisions; however, additional mortality may result from other activities (e.g., chemical spills, hunting, poaching). Project effects will be reversible; however, the duration of the habitat effect will be long-term as some the effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in movement patterns are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in movement patterns will occur intermittently from the construction phase through the closure phase. Movement changes will be local in geographic extent. Expected changes in movement patterns are due to changes in local vegetation and habitat surrounding different areas of the airstrip, transmission line, and freshwater supply pipeline. Within the airstrip, transmission line, and freshwater supply pipeline, the adverse effect is rated with low magnitude because the changes in movement patterns due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in movement patterns will be long-term as some the effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

The residual effects of a change in population dynamics are rated as Not Significant (minor) with high confidence, due to the magnitude, geographical extent, frequency, and reversibility of the effect occurring. Changes in population dynamics will occur intermittently from the construction phase through the closure phase. Changes in population dynamics will be local in geographic extent due to changes in foraging habitat and predator populations along areas of the airstrip, transmission line, and freshwater supply pipeline. Clearing of vegetation may result in increased foraging habitat, which could result in changes to local moose populations. In addition, clearing may increase access for predators to certain areas along the airstrip, transmission line, and freshwater supply pipeline and increase the risk of predation for moose within these areas. The adverse effect along the airstrip, transmission line, and freshwater supply pipeline is rated with low magnitude because the changes in population dynamics due to Project activities are expected to be minimal. Project effects will be reversible; however, the duration of changes in population dynamics will be long-term as some the effects are expected to last for the length of the Project. The effects will have a medium context due to moose within the Project area being affected by other projects or activities, or natural changes but still having the capacity to assimilate more changes.

5.4.10.4.4 Project Area

Changes in availability of moose habitat, moose mortality, movement patterns, and wildlife population dynamics will occur from Project construction to closure. Mortality risk may increase along newly cleared sections of the Project components, in particular areas along the access roads, Kluskus FSR, and transmission line. These effects will be evident over the long term, occurring intermittently resulting in a Not Significant (minor) rating.

Changes in movement patterns may result from changes in habitat availability and sensory disturbance. Sensory disturbance will have a higher likelihood of occurring at the mine site, access road, and Kluskus FSR, and changes in habitat availability will potentially occur at all Project components. These effects will be evident over the long term, occurring intermittently resulting in a Not Significant (minor) rating.

Changes in wildlife population dynamics may result from changes in habitat availability and increased access for predators. Changes in habitat availability will potentially occur at all Project components and these may result in changes to the local moose individuals. Clearing vegetation and creating linear corridors may allow for easier predator access to areas of moose habitat; increases in predator access may result in an increase in predator risk for moose. These effects will be evident over the long term, and will occur intermittently and result in a Not Significant (minor) rating.

5.4.10.5 Cumulative Effects

A cumulative effects assessment (CEA) for the Moose VC is necessary because the Project is expected to have Not Significant (minor) residual adverse effects on moose mortality, movement patterns, and population dynamics. Residual effects on moose that could arise from other projects or activities in the region are assessed to understand the context of the residual adverse Project effects on moose. The spatial boundary for this assessment is the RSA. The temporal boundaries include historical, present, and certain and reasonably foreseeable projects within the RSA. Rationale for carrying forward into the CEA is shown in **Table 5.4.10-15**.

Table 5.4.10-15: Project Related Residual Effects; Rationale for Carrying forward into the CEA

Project Component	Project Phase	Residual Effect	Rationale	Carried Forward to Cumulative Effects Assessment
Mine Site, Airstrip, Transmission Line, Freshwater Supply Pipeline, and Access Roads	Construction through to Closure	Unavoidable mortality of moose	Changes in the mortality of moose	Yes
Mine Site, Airstrip, Transmission Line, Freshwater Supply Pipeline, and Access Roads	Construction through to Closure	Unavoidable changes in moose movement patterns	Changes in movement patterns	Yes
Mine Site, Airstrip, Transmission Line, Freshwater Supply Pipeline, and Access Roads	Construction through to Closure	Unavoidable indirect mortality of moose Change in predator-prey dynamics	Changes in predator-prey dynamics	Yes

The interactions between residual effects on moose related to the Project or past, present, and foreseeable projects and potential ecological effects are summarized below. Pre-existing habitat loss and fragmentation due to logging and road development have altered the low elevation habitat within the Project area. The MPB infestation has affected large areas of mature pine forest in the region, which has resulted in alteration of moose habitat, some of which has been harvested while remaining forests are in various stages of degeneration due to the MPB. Mineral exploration in the area has increased the number of access roads, which have caused increased habitat fragmentation and road access for predators and hunters. Hunting season in the Project area is managed by BC MFLNRO; however, the area is also used by recreationalists who may impact moose by disturbance and displacement. Moose baseline information was collected in the LSA and portions of the RSA that were altered by these past and present activities. The current activities in the Project area are expected continue during the foreseeable future. For assessing cumulative effects for mortality of moose CEA, the most relevant land uses in the RSA that could potentially interact include forestry, mining, and agriculture activities.

Table 5.4.10-16 presents identified interactions between past, present, and future projects and land uses in the RSA.

Table 5.4.10-16: Interactions between Moose Residual Effects and other Past, Present, and Future Projects/Activities

Residual Effect	Historical Land Use		Representative Current and Future Land Use			Carried Forward into CEA?
	Forestry (cut blocks and woodlots)	Agriculture (range tenures	Mining (active, current prospecting, quarries)	Forestry (cut blocks and woodlots)	Agriculture (active range tenures)	
Mortality	I	I	I	I	I	Yes
Movement Patterns	I	I	I	I	I	Yes
Population Dynamics	I	I	I	I	I	Yes

Note: I = interaction, KI = key interaction, NI = no interaction

A Wildlife Management Plan has been developed for the Project to provide mitigation recommendations for all components and phases of the Project. Other management plans (e.g., Landscape, Soils and Vegetation Management and Restoration, Sediment and Erosion Control) also provide relevant recommendations for Project mitigation. The Proponent is committed to following mitigation measures provided in the management plans to minimize adverse Project effects.

5.4.10.5.1 Residual Cumulative Effects and Mitigation Measures

Forestry-related activities in the RSA have the potential to increase traffic along forest service roads creating potential barriers to the location of foraging and shelter habitat, thereby potentially altering moose movement and distribution patterns. The creation of new linear corridors may result in increased predator access and hunting, and change wildlife population dynamics. Although forestry activities may result in these effects, suitable habitat loss is typically temporary for moose. As forests and other habitats regenerate, they begin to revert to their baseline conditions and the nature of the effects typically subsides.

Suggested mitigation measures for forestry activities include those suggested by BC MFLNRO (2004) as BMPs: 1) maintaining drainage pathways and wetland hydrology by installing appropriately sized culverts for stream and wetland crossings; 2) avoiding harvesting in wetland and riparian areas; 3) replanting native vegetation to expedite succession; 4) installing road signs to alert drivers of speed limits and of wildlife sensitive areas; 5) including wildlife awareness training for drivers during regular safety and environmental meetings; 6) decommissioning roads when they are no longer in use; and 7) providing breaks in snow banks along the access road to allow wildlife to escape. Several of these mitigation activities are already included in the environmental management plans for the Project (**Section 12.2.1**). Logging activities in the RSA have generated loss of habitat; however, application of BMPs (BC MFLNRO, 2014) will protect the key habitat needed by moose.

Agricultural activities in the RSA have the potential to increase moose mortality, change movement patterns, and alter wildlife population dynamics. Cattle grazing can alter vegetation cover in emergent habitats, and potentially introduce invasive vegetation species. Trampling can compact wetland soils and cause erosion in riparian areas resulting in sedimentation of surface waters. Mechanical harvesting of vegetation can cause rutting and soil displacement. Similar to forestry activities, agricultural activities do not typically result in large changes to mortality risk, wildlife movements or wildlife population dynamics.

Suggested mitigation measures include those suggested by BC MFLNRO (2004) as BMPs for agricultural activities include: 1) establishing cattle exclusion zones to limit grazing to uplands, thereby minimizing erosion and sedimentation; 2) minimizing pesticide and fertilizer use around aquatic resources and before precipitation events to limit chemical runoff from entering watersheds; 3) establishing protected riparian areas prior to clearing; and 4) controlling invasive species.

Mining activities (e.g., current prospecting, exploration) occur southeast and northwest of the mine site, and are likely to continue into the future. Mineral prospecting can result in changes to moose habitat, increased predator and hunter access, and increased vehicle collision mortality. These factors may result in minor changes to mortality risk, movement patterns, and population dynamics.

Suggested mitigation measures for mineral exploration and prospecting, which are typical permit conditions under the *Mines Act* (Government of BC, 1996b), include: 1) pre-planning to avoid important wildlife areas (e.g., wetlands, salt licks); 2) minimizing stream crossings for access roads; 2) avoiding work during critical breeding and rearing seasons for wildlife; 3) limiting the production of excess drilling fluids; 4) avoiding discharges of drilling fluids into aquatic systems; 5) installing road signs to alert drivers of speed limits and of wildlife sensitive areas; 6) including wildlife awareness training for drivers during regular safety and environmental meetings; 7) decommissioning roads when they are no longer in use; and 8) providing breaks in snow banks along the access road to allow wildlife to escape.

5.4.10.5.2 Significance of Residual Cumulative Effects

The significance of the Project's contribution to cumulative effects in the RSA was determined at the post-closure phase for this assessment as forest and other habitat mitigation and compensation will occur primarily during closure.

The Project will contribute to increased moose mortality, and changes in moose movement patterns and population dynamics in combination with the past, present, and future activities (e.g., forestry, agricultural, and mineral exploration) identified in the RSA for this CEA. The significance of the Project's contribution to cumulative effects in the RSA was determined at the post-closure phase for this assessment as forests and other habitat mitigation and compensation will occur primarily during closure. Logging activities in the RSA have generated loss of habitat; however, application of BMPs (BC MFLNRO, 2014) will protect the key habitats needed by moose. Although Project effects and the effects of other activities in the RSA may be cumulative, no additional

adverse residual effects on moose are anticipated due to the Project. Due to the minimal changes in mortality risk, movement patterns or population dynamics associated with forestry, agricultural, and mineral exploration, the significance determination for residual cumulative effects is Not Significant (minor) (**Table 5.4.10-17**). This assumes effective implementation of the mitigation and compensation measures (e.g., Wildlife Management Plan, Vegetation Management and Restoration Plan, and Sediment and Erosion Control Plan) for the Project, and that forestry, agricultural, and mineral prospecting practitioners in the RSA follow the mitigation measures discussed above. With this guidance, potential effects of increased mortality and changes in wildlife movement patterns and population dynamics resulting from these activities can be successfully mitigated through avoidance and minimization.

Table 5.4.10-17: Residual Cumulative Effects Assessment on Moose Mortality, Movement Patterns, and Population Dynamics

Effect Attribute	Current/Future Cumulative Environmental Effect(s) without Project	Cumulative Environmental Effect with Project Contributions
Mortality Risk		
Context	Medium	Medium
Magnitude	Low	Low
Geographic Extent	Regional	Local
Duration	Chronic	Long-term
Reversibility	Yes	Yes
Frequency	Intermittent	Intermittent
Likelihood Determination	High	High
Level of Confidence for Likelihood	High	High
Significance Determination	Not Significant (minor)	Not Significant (minor)
Level of Confidence for Significance	Moderate	Moderate
Change in Movement Patterns		
Context	Medium	Medium
Magnitude	Low	Low
Geographic Extent	Regional	Site Specific
Duration	Chronic	Long-term
Reversibility	Yes	Yes
Frequency	Intermittent	Intermittent
Likelihood Determination	High	High
Level of Confidence for Likelihood	High	High
Significance Determination	Not Significant (minor)	Not Significant (minor)
Level of Confidence for Significance	Moderate	High
Change in Population Dynamics		
Context	Medium	Medium
Magnitude	Low	Low
Geographic Extent	Regional	Local

Effect Attribute	Current/Future Cumulative Environmental Effect(s) without Project	Cumulative Environmental Effect with Project Contributions
Duration	Chronic	Long-term
Reversibility	Yes	Yes
Frequency	Intermittent	Intermittent
Likelihood Determination	High	High
Level of Confidence for Likelihood	High	High
Significance Determination	Not Significant (minor)	Not Significant (minor)
Level of Confidence for Significance	Moderate	High

5.4.10.6 Limitations

The key limitation of this assessment is the limited surveys conducted in the study areas to quantify moose presence over time across the Project area. Regional abundance is not known beyond results of habitat suitability models and professional judgment based on Provincial population data.

5.4.10.7 Conclusion

Moose populations will be adversely affected through loss and alteration of habitat, increased mortality, changes in movement patterns, and changes in population dynamics. Moose mortality, movement patterns, population dynamics, and habitat within the Project area will be negatively affected during the life of the Project, but are expected to return to average baseline conditions upon post-closure based on the application of mitigation and monitoring from the WLMP (**Section 12.2.1.18.4.6**), RCP (**Section 2.6**), and results of the vegetation environmental assessment (**Section 5.4.6**).

The Project residual effects include increased mortality due to vehicle collisions, and increased access for legal and illegal hunting within the RSA. Mortality effects will occur throughout construction and operations phases. The maximum geographic extent of these effects is considered local and there is moderate confidence and high likelihood that the effects will occur and that they will not have a significant effect on moose populations, due to mitigation measures and reclamation of habitats to baseline conditions for moose.

The Project residual effects in movement patterns result from changes in habitat availability and sensory disturbance. Effects on movement patterns will occur from all Project components, and will initially occur during construction, and will continue throughout operations. The maximum extent of these effects is considered local and there is high confidence and high likelihood that the effects will occur and that they will not have a significant effect on moose populations, due to mitigation measures.

The Project residual effect of changes in wildlife population dynamics will result from changes in foraging habitat and increased access for predators changing predation rates within the RSA. Population dynamic effects will occur from all Project components, will initially occur during construction, and will continue throughout operations. The maximum geographic extent of these effects is considered local and there is high confidence and high likelihood that the effects will occur and that they will not have a significant effect on moose populations, due to mitigation measures.