# 21. FEDERAL CUMULATIVE EFFECTS ASSESSMENT

## 21.1 INTRODUCTION

This chapter describes the methodology and results of the Cumulative Effects Assessment (CEA) for the Murray River Coal Project (the Project).

Cumulative effects are the result of a project-related effect interacting with the effects of other human actions (i.e., anthropogenic developments, projects, or activities) to produce a combined effect. Cumulative effects are assessed in each of the assessment chapters (Chapters 6 through 19), as required by the BC EAO (2013a). A synthesis of these sections is provided as Chapter 21, to address CEA Agency (2013) requirements.

## 21.2 REGULATORY FRAMEWORK

The CEA Agency issued an Operational Policy Statement in May 2013 entitled *Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act 2012* (CEA Agency 2013) that provides a method for undertaking CEA. Recently the British Columbia Environmental Assessment Office (BC EAO) also released the updated *Guideline for the Selection of Valued Components and the Assessment of Potential Effects* (BC EAO 2013b), which includes advice for determining the need for a cumulative impact assessment. The CEA methodology adopted in this Application/EIS therefore follows the guidance of the CEA Agency, as well as the selection criteria in BC EAO (2013a).

The following documents are used to guide the CEA, where applicable:

- *BC EAO User Guide* (BC EAO 2010) for a cumulative effect assessment;
- *Guideline for the Selection of Valued Components and Assessment of Potential Effects* (BC EAO 2013b);
- *Operational Policy Statement: Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013);
- *Cumulative Effects Assessment Practitioners' Guide* (Hegmann et al. 2007);
- *A Reference Guide for the Canadian Environmental Assessment Act: Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects* (Federal Environmental Assessment Review Office 1994); and
- *A Reference Guide for the Canadian Environmental Assessment Act: Assessing Environmental Effects on Physical and Cultural Resources* (CEA Agency 1996).

## 21.3 METHODS

The method for assessing cumulative effects generally follows the same steps as the Project-specific effects assessment, as described in Sections 5.6 to 5.9. These steps include:

1. scoping and identification of potential cumulative effects;

2. description of potential cumulative effects and mitigation measures, with subsequent identification of residual cumulative effects; and
3. characterization of residual cumulative effects and significance.

Due to the broader scope and greater uncertainties inherent in CEA (e.g., data limitations associated with some human actions, particularly future actions); there is greater dependency on qualitative methods and expert judgement. This method for assessing cumulative effects is tailored to how much information is available and facilitates comparison between the project-specific assessment and the cumulative effects assessment. It also facilitates comparison between assessment categories.

### 21.3.1 Scoping and Identification of Potential Cumulative Effects;

Issues scoping within the cumulative effects assessment is a tool used to determine if Project-related residual effects on VCs will interact with residual effects of past, present, and reasonably foreseeable future human actions. The scoping process involves identification of the VCs for which residual effects are predicted, definition of the spatio-temporal boundaries of the assessment, and an examination of the relationship between the residual effects of the Project and those of other projects and activities.

Project-related residual effects are carried forward into the cumulative effects assessment if the residual effect of the Project is demonstrated to operate cumulatively with the effects of another human action; and if the other human action is known to have been carried out, or it is probable (using best professional judgement) that it *will be* carried out.

#### *21.3.1.1 Spatial Boundaries*

Spatial boundaries for the CEA are determined individually for each assessment category, and comprise the area within which the VCs affected by the Project could also be affected by past, present, or future human actions (as defined in Section 5.10.2.2). It is not necessary for the spatial extent of the Project's effects to physically overlap with that of another human action, only for the Project to affect *the spatial extent of the same VC* affected by another human action. For some assessment categories, spatial boundaries correspond to the RSA, as described in Section 5.6.2.1; a larger spatial extent (for example, the range of caribou herds) is selected for other assessment categories to encompass the full area utilized by the VC under consideration.

#### *21.3.1.2 Temporal Boundaries*

The temporal boundaries for the CEA go beyond the phases of the Project, beginning before major human actions were undertaken in the region, and extending into the future. The temporal boundaries for the CEA were determined based on publically available information. Assumptions are made considering typical projects of similar size and type where information is missing or lacking. Documentation and justification of these assumptions are provided for each assessment category. Each assessment category uses the following temporal periods to evaluate potential cumulative effects on VCs:

- **Past:** 1940 (to capture the early non-Aboriginal human activities in the region) to 2010 (when baseline studies at the Murray River Project began);

- **Present:** 2010 (from the start of the Project baseline studies) to 2014 (completion of the environmental assessment); and
- **Future:** temporal boundaries are stated in each assessment chapter, and vary according to the time estimated for VCs to recover to baseline conditions (taking into account natural cycles of ecosystem change).

The other human actions considered in the CEA (described in Section 5.10.5) fall into the following temporal categories:

- **Past** (closed) human actions;
- **Present** (continuing and active) human actions; and
- **Future** human actions, which may be:
  - **certain actions:** those actions that have received regulatory authorizations but are not as yet built or operating;
  - **reasonably foreseeable actions:** those actions that are currently in some stage of a regulatory authorization process, and for which a general concept is available from which potential cumulative effects may be anticipated; and
  - **hypothetical actions:** those actions that are conjectural but probable, based on best professional judgement of currently available information, including leases, licences, and extrapolations from historical development patterns; *the potential cumulative effects of such actions are discussed on a conceptual basis only in this CEA*.

Sections 5.10.5.1 to 5.10.5.5 provide high-level descriptions of each human action. For the purposes of the CEA, where relevant data on these actions are not available, professional judgement and data from comparable projects are used to predict trends. The assumptions made as well as the data sources used are documented in each assessment category chapter.

### 21.3.2 Identification of Potential Cumulative Effects

An initial list of past, present, and future human actions to be considered in the CEA was developed as part of the Murray River Land Use Baseline Report via desk-based review of existing information and field research conducted between 2010 and 2014 (see Appendix 16-A for a detailed description of this methodology). For the purposes of the CEA, this list was augmented with information on past historic mining operations retrieved from the BC Ministry of Energy, Mines, and Natural Gas, information on current and future hydroelectric projects from BC Hydro, FortisBC, and Columbia Power Corporation, and information on future actions from the BC EAO and the BC Ministry of Forests, Lands, and Natural Resource Operations.

An impact matrix approach was used to identify other projects/activities that may be expected in interact cumulatively with Project-specific residual effects. For each VC, this analysis narrows the scope of the CEA to focus only on those projects and activities where there is an anticipated cumulative interaction with the predicted changes and residual effects from the Project. The results are presented in an impact matrix, as shown in Table 21.3-1. If there is no spatial and temporal overlap between the residual effects of the Project and those of another human action, the relevant cell is marked with a

dash (-). Where there is spatial and temporal overlap, but no interaction is anticipated, the cell is marked grey (■), and a rationale as to why no interaction is predicted is given in the accompanying text. If there is overlap, and an interaction is anticipated, the cell is marked with a green (■), yellow (■), or red (■). Supporting rationale for the rankings assigned to interactions is then provided in the text.

**Table 21.3-1. Example of Ranking Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on a VC**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | |
|---|---|---|---|---|---|---|---|
| | Human Action 1 | Human Action 2 | Human Action 3 | Human Action 4 | Human Action 5 | Human Action 6 | Human Action 7 |
| Residual Effect 1 | L | L | O | L | M | - | - |
| Residual Effect 2 | H | - | M | H | - | M | - |
| Residual Effect 3 | - | H | H | H | M | M | - |
| Residual Effect 4 | - | M | M | M | - | - | - |
| Residual Effect 5 | L | L | - | L | - | - | - |
| Residual Effect 6 | M | - | M | M | - | M | - |
| Residual Effect 7 | L | L | - | L | - | - | - |
| Residual Effect 8 | - | - | - | - | - | - | - |

*Notes:*

| | |
|---|---|
| *(-)* | *No spatial or temporal overlap.* |
| O | *Spatial and temporal overlap, but no interaction is anticipated, no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

As in the Project-specific effects assessment, only potential adverse effects ranked as moderate or major (yellow or red) before active application of mitigation measures will be carried forward in the CEA.

### 21.3.3 Description of Potential Cumulative Effects and Mitigation

The potential effects identified as moderate or major (as discussed in Section 21.3.2) are described in detail. Where data are lacking, assessors employ best professional judgement, and document the specific data limitations encountered and assumptions made.

After describing each potential effect, any additional measures proposed as mitigation are identified and summarized. Quantitative, semi-quantitative, and qualitative techniques are used to assess the anticipated results of this mitigation, and the specific methods and assumptions used are documented.

Potential cumulative effects that are expected to persist after mitigation measures are applied are called **residual cumulative effects**. In light of the relevant mitigation measures proposed, anticipated residual effects are also described. This step of the assessment is summarized in a format similar to the one presented in Table 21.3-2.

**Table 21.3-2. Example of Summary of Residual Cumulative Effects**

| Valued Component | Murray River Activity | Other Human Action Activity | Description of Potential Cumulative Effect | Description of Mitigation Measure(s) | Description of Residual Cumulative Effect |
|---|---|---|---|---|---|

If a potential effect is judged to be fully mitigated, it is not considered further in the CEA; only residual cumulative effects are carried forward and characterized.

### 21.3.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence

The residual cumulative effects to VCs are characterized using the same criteria described in Section 5.9 (e.g., Magnitude, Geographic Extent, Duration, Frequency, Reversibility, and Context). Each assessment chapter documents if and how these generic criteria have been tailored to the specific assessment category. Narrative descriptions and justifications for the application of each descriptor are provided in the accompanying text.

Significance, probability and confidence are also assessed using the same criteria described in Section 5.9. A summary of the assessment of residual cumulative effects is provided at the conclusion of each assessment chapter in a format similar to that presented in Table 21.3-3.

## 21.4 OTHER HUMAN ACTIONS CONSIDERED IN THE CEA

The past, present, and future projects considered within the Cumulative Effects Assessment are shown in Figure 21.4-1 and listed in Table 21.4-1.

## 21.5 AIR QUALITY

### 21.5.1 Summary of Project-specific Residual Effects on Air Quality

Residual effects assessed for Air Quality are summarized in Table 21.5-1. The TSP, $PM_{10}$, $PM_{2.5}$, and dust deposition residual effects have been carried forward into a cumulative impact assessment. A cumulative effects assessment for GHG emissions was not completed as the contribution of an individual project to climate change cannot be measured and climate change is a global and not a local issue. The cumulative effects on air quality are discussed in detail in Chapter 6.

### 21.5.2 Cumulative Effects Assessment Boundaries for Air Quality

#### *21.5.2.1 Spatial Boundaries*

The cumulative effects assessment spatial boundary is intended to encompass an area beyond which effects of the Project would not cumulatively interact with effects of other Projects.

**Table 21.3-3. Example of Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence**

| Residual Cumulative Effect | Effect Characterization | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | Significance | Probability | Confidence |
| Effect 1 | | | | | | | | | |
| Effect 2 | | | | | | | | | |
| Effect 3 | | | | | | | | | |

**Figure 21.4-1**
**Past, Present, and Future Projects within the Cumulative Effects Assessment**

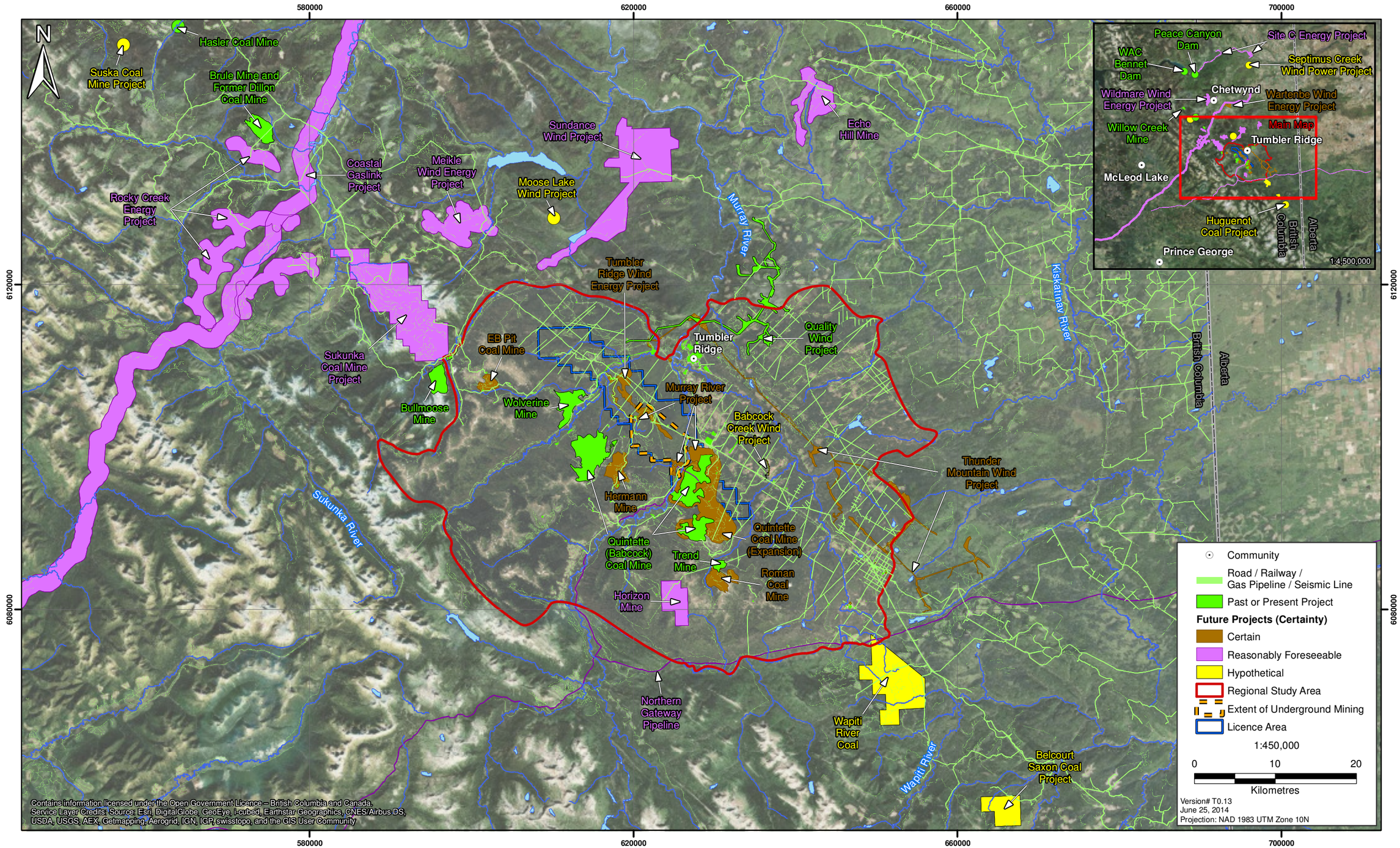

**Table 21.4-1. Past, Present, and Reasonably Foreseeable Future Project Considered within the Murray River Cumulative Effects Assessment**

| INDUSTRIAL PROJECTS | | | | |
|---|---|---|---|---|
| **Timeframe** | | **Name of Action** | **Dates Active** | **Proponent (If Applicable)** |
| **Past** | **Historic** | Hasler Coal Mine | 1941 – 1945 | Hasler Creek Coal Company |
| | | Sukunka (Bullmoose) Mine | 1972 – 1975 | BP Exploration Canada Ltd. |
| | **Recent** | Bullmoose Mine | 1983 – 2003 | Teck Corporation |
| | | Dillon Coal Mine | 2004 – 2007 | Walter Energy / Western Coal |
| | | Quintette (Babcock) Mine | 1983 – 2000 | Teck Corporation |
| | | Willow Creek Mine | 2000 – 2013 | Walter Energy |
| **Present** | | Brule Mine | 2005 – 2016 | Walter Energy |
| | | Trend Mine | 2003 – 2016 | Peace River Coal |
| | | Quality Wind Project | 2013 – unknown | Capital Power |
| | | Peace Canyon Dam | 1980 – unknown | BC Hydro |
| | | Wolverine Mine (Perry Creek) and EB Pit | 2004 – 2016 | Walter Energy |
| | | WAC Bennett Dam | 1961 – unknown | BC Hydro |
| **Future** | **Certain** | Hermann Mine | 2014 – 2025 | Walter Energy |
| | | Quintette Mine | 2013 – 2025 | Teck Corporation |
| | | Roman Mine Project | 2013 – 2024 | Peace River Coal |
| | | Thunder Mountain Wind Park | 2014 – unknown | Aeolis Wind |
| | | Tumbler Ridge Wind Project | 2013 – unknown | Pattern Energy Group |
| | | Wartenbe Wind Project | 2014 – unknown | Avro Wind Energy Inc. |
| | **Reasonably Foreseeable** | Echo Hill Mine | 2015 – 2029 | Hillsborough Resources Ltd. |
| | | Coastal Gaslink Project | 2015 – 2048 | TransCanada Pipelines |
| | | Horizon Mine | 2015 – 2038 | Peace River Coal |
| | | Meikle Wind Energy Project | 2015 – 2041 | Meikle Wind Energy Partnership |
| | | Northern Gateway Pipeline | 2016 – 2068 | Enbridge Northern Gateway Pipelines |
| | | Rocky Creek Energy Project | 2015 – unknown | Rupert Peace Power Corporation |
| | | Site C Clean Energy Project | 2015 – 2115 | BC Hydro |
| | | Sukunka Coal Mine Project | 2016 – 2038 | Glencore |
| | | Sundance Wind Project | 2015 – 2040 | EDF Energies Nouvelles |
| | | Wildmare Wind Energy Project | 2014 – 2039 | Wildmare Wind Energy Limited Partnership |
| | **Hypothetical** | Babcock Creek Wind Project | Unknown | Babcock Ridge Wind Limited Partnership |
| | | Belcourt Saxon Coal Project | Unknown | Walter Energy / Peace River Coal |
| | | Huguenot Mine | Unknown | Colonial Coal International |
| | | Moose Lake Wind Power | Unknown | Moose Lake Wind Power Corporation |
| | | Septimus Creek Wind Power Project | 2014-2039 | Renewable Energy Systems Canada Inc. |
| | | Suska Mine | Unknown | Glencore / JX Nippon |
| | | Wapiti River Coal Project | Unknown | Canadian Dehua International Mines Group Inc. |

*(continued)*

**Table 21.4-1. Past, Present, and Reasonably Foreseeable Future Projects Considered within the Murray River Cumulative Effects Assessment (completed)**

| OTHER LAND USE ACTIVITIES |
|---|
| • Aboriginal harvest (fish, animals, and plants)<br>• Agriculture and range<br>• Forestry and manufacturing<br>• Industrial roads<br>• Coal and mineral exploration<br>• Oil and gas drilling and exploration<br>• Other fishing and trapping (commercial and recreational)<br>• Recreation and tourism<br>• Transportation (road and rail access and traffic) |

**Table 21.5-1. Summary of Residual Effects, Mitigation, and Significance on Air Quality**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| Increase in TSP, $PM_{10}$, $PM_{2.5}$, and Dust Deposition | Operation | • Emission reduction measures<br>• Fugitive dust reduction measures | Not Significant (moderate) |
| | Construction, Decommissioning and Reclamation, Post Closure | • Emission reduction measures<br>• Fugitive dust reduction measures | Not Significant (minor) |
| Increase in GHGs | All phases | • Emission reduction measures and methane liberation reduction measures | Not Significant (minor) |

The same study area used in the project-specific effects assessment was selected as a suitable boundary for the cumulative effects assessment as it encompasses the regional setting for the Project and other relevant regionally important projects. The study area was based on the "zone of influence" beyond which potential residual effects of the Project are expected to diminish to a negligible state; therefore the effects of any projects outside this area are not expected to interact cumulatively.

### 21.5.3 Cumulative Effects Assessment on Air Quality

#### *21.5.3.1 Identification of Potential Cumulative Interactions*

Residual effects carried forward from the Project-specific assessment are considered in combination with the residual effects of past, present, and future human actions, where some spatial and temporal overlap occurs. Table 21.5-2 summarizes the ranking potential for residual effects to interact cumulatively with effects of other human actions on air quality.

The Quintette (Babcock) Mine is located within the study area, however as a past project there are unlikely to be any emissions to overlap with potential effects from the Project. No further consideration is warranted.

**Table 21.5-2. Ranking Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Air Quality**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | Certain | | | | | | | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| TSP, $PM_{10;}$ $PM_{2.5}$, and Dust Deposition | - | - | - | - | O | - | - | M | O | - | - | - | M | M | M | - | L | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | Hypothetical | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| TSP, $PM_{10;}$ $PM_{2.5}$, and Dust Deposition | - | - | - | - | - | - | - | - | - | - | L | - | - | - | - | - | - |

*Notes:*

| | |
|---|---|
| *(-)* | *No spatial or temporal overlap.* |
| O | *Spatial and temporal overlap, but no interaction is anticipated, no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

Quality Wind Project and the Peace River Coal Loadout (Trend Mine Project) are the only present projects within the study area. It is unlikely there will be TSP, $PM_{10}$, and $PM_{2.5}$ emissions associated with a wind project, therefore due to the nature of the project and the distance from the Murray River Project, it is not expected that there will be any cumulative effects associated with the project. No further consideration of the Quality Wind Project is warranted. The Peace River Coal Loadout (Trend Mine Project) is a source of TSP, $PM_{10}$ and $PM_{2.5}$ emissions. The potential for cumulative effects is considered moderate.

The Herman Mine, Quintette Mine and the Peace River Coal Loadout (Roman Mine Project) are likely to overlap spatially and temporally with the Project. Each of these projects is a source of TSP, $PM_{10}$, and $PM_{2.5}$ emissions, however not an appreciable source of $SO_2$, CO, or $NO_X$. The potential for cumulative effects is considered moderate.

Tumbler Ridge Wind Project and Babcock Creek Wind Project are the only other future projects which overlap spatially and temporally with the Project. It is unlikely there will be TSP, $PM_{10}$, and $PM_{2.5}$ emissions associated with a wind project during operation; however, there may be emissions during construction. The emissions during construction are likely to be short lived and localised. Assuming standard mitigation and management measures are in place, the cumulative impacts are considered negligible. No further consideration is warranted.

Other land use activities that interact temporally with air quality include: forestry activities, agriculture activities, industrial roads, oil and gas exploration, coal and mineral resource exploration, and transportation. These activities will produce TSP, $PM_{10}$, $PM_{2.5}$, and dust, primarily due to traffic on unpaved roads. The emissions are likely to be short lived and localised. Assuming standard mitigation and management measures are in place, the cumulative impacts are considered negligible. No further consideration is warranted.

#### *21.5.3.2 Description of Potential Cumulative Effects*

The Peace River Coal Loadout (Trend Mine Project) is a source of TSP, $PM_{10}$, $PM_{2.5}$, and dust emissions. Emissions from the loadout will have been captured in the baseline monitoring and have therefore already been taken into account within the modelling.

Air quality modelling carried out for the Quintette Mine concluded that maximum predicted concentrations of TSP, $PM_{10}$, and dustfall may be higher than the most stringent objectives for short durations on a 24-hour basis. All other predicted results are well below the most stringent objectives (Stantec 2012). The emissions are based on the peak operating year and it was assumed that all processes are occurring simultaneously; the emission estimates are therefore considered conservative. The episodes of PM concentrations above the applicable objectives are predicted to occur in relatively small areas south of the project boundary on the slopes of Mount Babcock and Mount Kostuik. Dustfall amounts decrease rapidly to amounts less than the objective 1 km south of the project boundary. There is likely to be overlap between the Murray River and Quintette Mine emissions, however, the timing of the peak emissions is unlikely to be the same for each project, and the wind will blow the emissions to different locations so the location of the maximum emissions from each project is unlikely to overlap. The likelihood of peak Quintette Mine effects occurring at the same place and time as maximum baseline and Murray River Project effects are therefore extremely small.

Air quality modelling carried out for the Roman Mine concluded that maximum predicted concentrations of TSP and $PM_{10}$ may be higher than the most stringent objectives on a 24-hour basis (PRC 2011). The highest concentrations are predicted just northeast of the rail load-out property boundary, with predicted concentrations decreasing rapidly with distance from the load-out property. Elevated concentrations are also predicted southwest of the property boundary, however, this is outside of the study area. There is likely to be overlap between the Murray River and Roman Project emissions, however, the timing of the peak emissions is unlikely to be the same for each project, and the wind will blow the emissions to different locations so the location of the maximum emissions from each project is unlikely to overlap. The likelihood of peak Roman Mine effects occurring at the same place and time as maximum baseline and Murray River Project effects are therefore extremely small.

The combined effects of the Roman Mine, Quintette Mine and Murray River Project are shown in Table 21.5-3. In order to carry out a worst-case assessment, the area where the maximum Roman mine concentration predictions (PRC 2011), found just northeast of the PRC rail load-out, was assessed. The Quintette Mine and Murray River Project concentration predictions for the same location, and the baseline concentrations, are presented. Exceedances of the TSP 24 hr, $PM_{10}$ 24 hr and dustfall objectives are predicted.

**Table 21.5-3. Cumulative Concentrations at the PRC Rail Load-out**

| Pollutant | Averaging Period | Objective | Baseline Concentrations[a] (µg/m³) | Roman Contribution (µg/m³) | Quintette Contribution (µg/m³) | Murray River Contribution (µg/m³) | Cumulative Concentration (µg/m³) |
|---|---|---|---|---|---|---|---|
| TSP | 24-hour | 120 | 45.2 | 73.6 | 1.7 | 45.9 | **166.4** |
| | Annual | 60 | 12.5 | 15.9 | 0.06 | 8.3 | 36.8 |
| $PM_{10}$ | 24-hour | 50 | 21.4 | 27 | 2.6 | 13.8 | **64.8** |
| $PM_{2.5}$ | 24-hour | 25 | 10.9 | 7.3 | 0.2 | 4.1 | 22.5 |
| | Annual | 8 | 3.3 | 1.5 | 0.4 | 0.8 | 6.0 |
| Dust Deposition | 30-day | 1.7 | 1.2[b] | 0.4 | 0.03 | 0.2 | **1.8** |

*Note: Exceedances highlighted in bold.*

*[a] Baseline monitoring will include emissions from existing activities, such as the Trend Coal Mine.*

*[b] Site specific monitoring (see Appendix 6-B).*

There is limited data available in order to assess the cumulative impacts of the Herman Mine on air quality. There will be TSP, $PM_{10}$, $PM_{2.5}$, and dustfall emissions associated with the project, however, the mine is located approximately 6 km from the Project area and emissions from the mine would likely have dispersed to low concentrations by the time they reach the Project area.

### *21.5.3.3 Mitigation Measures to Address Cumulative Effects on Air Quality*

There are two main types of mitigation and management measures that will be put in place in order to reduce air quality impacts associated with cumulative effects, emission reduction measures and fugitive dust reduction measures. The most relevant mitigation measures will be fugitive dust

suppression measures, particularly watering of roads and storage piles, and installing covers on equipment and loads carried by vehicles. The exceedances from the other mines are also likely to be due to unpaved road dust. Road watering is particularly effective, with a control efficiency of 75% (US EPA 2006). Dustfall monitoring will also be carried out by each of the mines in order to assess the cumulative effects. If exceedances are identified then there is the opportunity for the mines to work together to manage the effects. Further details of mitigation measures are provided in the Air Quality Management Plan.

#### *21.5.3.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence*

A summary of the characterization of residual cumulative effects is provided in Table 21.5-4. Predicted maximum TSP, $PM_{10}$, and dustfall values associated with the Murray River Project are low to moderate at most receptors, with a possibility of high magnitude, short duration effects over a small area along the proposed access road. The residual effects for $PM_{2.5}$ are predicted to have a low to moderate magnitude. The episodes of high TSP, $PM_{10}$, $PM_{2.5}$, and dustfall are predicted to occur sporadically for the life of the Operation phase and are reversible. Hence, the residual effects are considered not significant.

The residual cumulative effects for TSP, $PM_{10}$, and dust deposition are predicted have a high magnitude as the cumulative concentrations may exceed the relevant objectives. The residual effects for $PM_{2.5}$ are predicted to have a moderate magnitude as the cumulative effects are not expected to exceed the objectives. The duration is classed as short-term and the frequency of the effects is considered sporadic. The geographic extent of emissions is landscape. The effects are reversible short-term as the concentrations will return to baseline levels as soon as the emission sources are removed. The ecological context is considered neutral as the air quality in the air area is considered pristine, with localised areas of poor air quality around industrial areas. The residual cumulative effects are considered not significant.

## 21.6 GROUNDWATER

### 21.6.1 Summary of Project-specific Residual Effects on Groundwater

Table 21.6-1 summarizes the Project-related residual effects, mitigation strategies and significance for groundwater quantity and quality. For groundwater quantity, the residual effect of the underground mine will occur during Operation through Post Closure (until full recovery of water table), including water table drawdown, alteration of groundwater flow pattern toward the mine zone, and potential reduction of groundwater discharge to the creeks.

In order to mine the coal, dewatering of the underground mine workings is required during the Operation. This may result in lowering of the water table in the range of 1 to 15 m, which will have associated changes in flow directions, hydraulic gradients, and baseflow discharge to local streams. While predicted drawdown will be outside the range of natural variability in some areas, there are no groundwater users (drinking water, agriculture or industry) in the area. Following the end of the mine life, the workings will be flooded, and the water table will rebound, eventually returning to near pre-mine conditions. The residual effect is rated Not Significant (moderate).

**Table 21.5-4. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Air Quality**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| TSP, $PM_{10}$, $PM_{2.5}$, and Dust Deposition | High | Short | Sporadic | Landscape | Reversible short-term | Neutral | Not Significant (moderate) | High | Medium |

**Table 21.6-1. Summary of Residual Effects, Mitigation, and Significance on Groundwater Quantity and Quality**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| **Groundwater Quantity** | | | |
| Underground Mine:<br>Water table drawdown, alteration of groundwater flow pattern (flow direction, hydraulic gradient) toward the mine zone, and potential reduction of groundwater discharge to the creeks, until the water table fully recovers to the baseline conditions. | Operation, Post Closure | Groundwater flow into the mine will be collected and managed | Not Significant (moderate) |
| Surface Subsidence:<br>Potential changes in groundwater levels and flow patterns, as well as groundwater discharge in localized areas. | Operation, Post Closure | - | Not Significant (moderate) |
| Coarse Coal Rejects (CCR) Piles:<br>Change of hydraulic gradients causing a small reduction of groundwater discharge in the small area between the two piles along the M19A Creek section. | Operation, Post Closure | Liners under the CCR Piles, seepage collection drain systems, top covers at Post Closure | Not Significant (minor) |
| **Groundwater Quality** | | | |
| Coarse Coal Rejects (CCR) Piles:<br>Seepage leaching from the CCR Piles through the liners, in very low concentrations due to dilution and attenuation. | Operation, Post Closure | Liners under the CCR Piles, seepage collection drain systems, top covers at Post Closure | Not Significant (minor) |

Imprinted within the area of water table drawdown, surface subsidence is also predicted to occur, ranging from 1 to 9 m, depending on the number of coal seams mined vertically. The changes in topography associated with subsidence are anticipated to have less influence on groundwater tables than mine dewatering; however, localized changes may be observed in some areas. The residual effect is rated Not Significant (moderate).

At the Coal Processing Site, the two CCR piles will result in reduced recharge to the groundwater system in the local area between the footprints of the two piles; however, the resultant change in groundwater quantity is very small. The residual effect is rated Not Significant (minor).

The CCR piles are designed with a geomembrane liner, overdrains, and seepage collection systems. This mitigation results in very limited potential for loss of contact water to groundwater during Operation. Flow path and solute transport analyses show that seepage would stay in shallow groundwater beneath and down-gradient of each CCR pile, discharging to M19 and M19A creeks a short distance downslope. The residual effect of the CCR piles on groundwater quality is assessed to be Not Significant (minor).

The cumulative effects on groundwater are discussed in detail in Chapter 7.

### 21.6.2 Cumulative Effects Assessment Boundaries for Groundwater

#### *21.6.2.1 Spatial Boundaries*

The cumulative effects assessment spatial boundary is intended to encompass an area beyond which effects of the Project would not cumulatively interact with effects of other Projects. The RSA was selected as a suitable boundary upon which to base the cumulative effects assessment (see Figure 7.6-2 in Chapter 7). The RSA is intended to encompass an area beyond-which effects of the Project would not be expected. It is also intended to be hydrogeologically relevant, based on the groundwater catchment divides indicated by terrain and rivers / streams in the region. The RSA boundary includes the neighbouring projects (e.g., Quintette Coal Mine, Hermann Coal Mine, Wolverine Coal Mine, Roman-Trend Coal Mine, Natural Gas Pipelines, and Wind Energy Projects) as well as groundwater supply wells that may potentially have interactions with the Project and cumulative effects on the Project.

### 21.6.3 Cumulative Effects Assessment on Groundwater

#### *21.6.3.1 Identification of Potential Cumulative Interactions on Groundwater*

The potential for cumulative effects on groundwater quantity and quality arising due to the interactions with nearby projects and human activities was investigated. All identified Project-specific residual effects were included in the cumulative effects assessment. These include: 1) mine dewatering and water level management; and 2) seepage of contact groundwater and management. They were carried forward into the cumulative effects assessment and considered in combination with the residual effects of past, present, and future human actions.

Table 21.6-2 shows the screening for residual effects to interact cumulatively with potential effects of other projects on groundwater quantity and quality. The footprints of the past, present and future projects located within the RSA for the cumulative effects assessment on groundwater is shown in Figure 7.11-1 in Chapter 7. Within the RSA, the following projects are considered to have a potential spatial or temporal overlap with the residual effects of this Project on groundwater quantity and quality:

- the historic Quintette (Babcock) Mine;
- the proposed Hermann Mine; and
- the proposed expansion of Quintette Mine.

#### *21.6.3.2 Description of Potential Cumulative Effects on Groundwater*

Teck's historic Quintette (Babcock) Mine spatially overlaps with both the underground mine zone and the CCR site of the Project. It opened in 1983, mining over 135 Mt of coal from four open pits in three separate mining areas before its closure in 2000. As shown on the satellite map, on the west side of Murray River, the historic open pits of this mine are located adjacent to the proposed underground mine footprint of the Murray River Project, but they are located on the other side of the M20 Creek catchment. These pits were mined 14 years ago, and they are small and shallow, it is expected that the groundwater flow and quality in these pits have stabilized.

**Table 21.6-2. Screening for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Groundwater Quantity and Quality**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| **Groundwater Quantity** | | | | | | | | | | | | | | | | | | |
| Underground Mine | - | - | - | - | L | - | - | - | - | - | - | - | L | - | - | - | *O* | - |
| Surface Subsidence | - | - | - | - | L | - | - | - | - | - | - | - | L | - | - | - | *O* | - |
| Coarse Coal Rejects (CCR) Piles | - | - | - | - | L | - | - | - | - | - | - | - | - | L | - | - | - | - |
| **Groundwater Quality** | | | | | | | | | | | | | | | | | | |
| Coarse Coal Rejects (CCR) Piles | - | - | - | - | L | - | - | - | - | - | - | - | - | L | - | - | - | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | Hypothetical | | | | | | |
| | | | | | | | | | | | Septimus | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| **Groundwater Quantity** | | | | | | | | | | | | | | | | | |
| Underground Mine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Surface Subsidence | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Coarse Coal Rejects (CCR) Piles | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Groundwater Quality** | | | | | | | | | | | | | | | | | |
| Coarse Coal Rejects (CCR) Piles | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

*Notes:*

| | |
|---|---|
| - | *No spatial or temporal overlap.* |
| *O* | *Spatial and temporal overlap, but no interaction anticipated; no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

These pits have been represented with drain boundaries in the baseline groundwater model built for the Murray River Project, and their effect to the baseline conditions has been accounted for in the characterization. Therefore, no residual cumulative effect from these pits is expected on groundwater quantity effect to be caused by the Murray River Project's underground mining and subsequent subsidence.

On the east side of Murray River, a historic tailings pile from the Quintette (Babcock) Mine is located immediately up-gradient of the proposed CCR site of the Murray River Project. The baseline groundwater quality sampling data collected by HD Mining up to May 2014 shows no evidence that this tailings pile is generating any significant groundwater contamination towards the CCR site. Therefore, this tailings pile causes no residual cumulative effect on the predicted effect to be caused by the Murray River Project on groundwater quality.

The Hermann Mine Project of the Walter Energy possesses a total of 40 Mt of proven coal reserves. It has an approved EA certificate and is awaiting approvals for production. The proposed mine facilities include four open pits, two ex-pit dumps and one in-pit dump, and a water management facility. This mine project is located in the headwaters of M20 (Camp) Creek, about 5 km away from the proposed underground mine footprint of the Murray River Project. The design for this mine shows that the sizes of the pits are relatively small and the waste rock dumps are located inside or immediately up-gradient of the pits; thus, any potential seepage from the waste rock dumps will most likely be captured in the pits.

#### *21.6.3.3 Mitigation Measures to Address Cumulative Effects on Groundwater*

Each past, present, and future project would have had or will have different mitigation and management for groundwater; however, it assumed that any present and future projects will follow best practices, standard mitigation and management measures.

#### *21.6.3.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Groundwater*

No residual cumulative effects on ground water quality or quantity are expected (Table 21.6-3).

**Table 21.6-3. Summary of Residual Cumulative Effects on Groundwater Quantity and Quality**

| Murray River Activity | Other Human Action Activity | Description of Potential Cumulative Effect | Description of Mitigation Measure(s) | Description of Residual Cumulative Effect |
|---|---|---|---|---|
| **Groundwater Quantity** | | | | |
| Underground Mine | • Historic Quintette (Babcock) Mine<br>• Proposed Hermann Mine | No | None required | Not applicable |
| Surface Subsidence | • Historic Quintette (Babcock) Mine<br>• Proposed Hermann Mine | No | None required | Not applicable |
| Coarse Coal Rejects (CCR) Piles | • Historic Quintette (Babcock) Mine<br>• Proposed Quintette Mine | No | None required | Not applicable |

*(continued)*

**Table 21.6-3. Summary of Residual Cumulative Effects on Groundwater Quantity and Quality (completed)**

| Murray River Activity | Other Human Action Activity | Description of Potential Cumulative Effect | Description of Mitigation Measure(s) | Description of Residual Cumulative Effect |
|---|---|---|---|---|
| **Groundwater Quality** | | | | |
| Coarse Coal Rejects (CCR) Piles | • Historic Quintette (Babcock) Mine<br>• Proposed Quintette Mine | No | None required | Not applicable |

## 21.7 SURFACE WATER AND AQUATIC RESOURCES

### 21.7.1 Summary of Project-specific Residual Effects on Surface Water and Aquatic Resources

Table 21.7-1 provides a summary of the residual effects, mitigation, and significance on surface water and aquatic resources VCs. The Project-related residual effects of :1) a changes in surface water quantity in M20, M17B, and M19A creeks; 2) a change in surface water quality (elevated selenium concentrations) in M19A Creek and; 3) a change in surface water quality (elevated selenium concentrations) in M19A Creek on aquatic resources were carried forward from the Project-specific assessment and are considered in combination with the residual effects of other past, present, and future human actions.

**Table 21.7-1. Summary of Residual Effects, Mitigation, and Significance on Surface Water and Aquatic Resources**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| **Surface Water** | | | |
| Change in surface water quantity in M20, M17B, and M19A creeks | Construction, Operation, Decommissioning and Reclamation, Post Closure | Water Management Plan | Not Significant (minor) |
| Change in surface water quality (elevated selenium concentrations) in M19A Creek | Decommissioning and Reclamation, Post Closure | Erosion and Sediment Control Management Plan; Water Management Plan; ML/ARD Management Plan; Selenium Management Plan | Not Significant (minor) |
| **Aquatic Resources** | | | |
| Change in surface water quality (elevated selenium concentrations) in M19A Creek | Decommissioning and Reclamation, Post Closure | Erosion and Sediment Control Management Plan; Water Management Plan; ML/ARD Management Plan; Selenium Management Plan | Not Significant (minor) |

The residual effects on surface water due to a change in water quantity as a result of Project activities are predicted to be **not significant (minor)**. Minor streamflow changes are anticipated to be confined

to M17B, M19A, and M20 creeks. Predicted effects at the downstream end of the LSA (i.e., Murray River downstream of confluence with M19 Creek) are negligible.

The Project- related residual effects on surface water due to a change in water quality as a result of Project activities are predicted to be **not significant (minor)**. Minor increases in selenium concentrations in M19A Creek under low flow conditions beginning in Decommissioning and Reclamation and extending into Post Closure were identified through predictive water quality modelling. A change in water quality at the downstream end of the LSA (i.e., Murray River downstream of confluence with M19 Creek) was not predicted.

The Project- related residual effects on aquatic resources due to a change in water quality as a result of Project activities are predicted to be **not significant (minor)**. There is potential for minor increases in selenium tissue concentrations in aquatic resources in M19A Creek, but it is unlikely that aquatic resources will experience toxicity due to selenium.

Project-related residual effects were carried forward to the cumulative effects assessment. Potential interactions with other human actions were considered in the cumulative effects assessment. No interactions were identified for potential cumulative effects due to a change in water quality in M19A Creek. The cumulative effects on surface water and aquatic resources are discussed in detail in Chapter 8.

### 21.7.2 Cumulative Effects Assessment Boundaries for Surface Water and Aquatic Resources

#### *21.7.2.1 Spatial Boundaries*

The cumulative effects assessment boundary for the surface water and aquatic resources includes M20, M17B, and M19A creeks for the surface water quantity and M19A creek for surface water quality and aquatic resources. Project-related residual effects on surface water and aquatic resources due to a change in water quality were assessed in M19A Creek. No residual effect on surface water due to a change in water quality was identified in M20 or M19 creeks, and no change in water quality (for any sensitivity analysis) was identified for Murray River. Project design and mitigation (e.g., lined CCR piles) result in relatively small volumes of effluent discharge (< 60 L/s) and minimal seepage loss to the receiving environment.

### 21.7.3 Cumulative Effects Assessment on Surface Water and Aquatic Resources

#### *21.7.3.1 Identification of Potential Cumulative Interactions on Surface Water and Aquatic Resources*

A review of the interaction between potential Project-related effects and effects of other projects and activities on surface water and aquatic resources was undertaken within the spatial and temporal boundaries identified in Sections 8.11.2.1 and 8.11.2.2 and is presented in Table 21.7-2.

Streamflow changes in M20 Creek have the potential to interact with streamflow changes induced by activities related to development of the Hermann Mine. The Hermann Mine is located east of the Project and will discharge into M20 Creek. No potential interactions with other human actions were identified for Project-related residual effects due to changes in water quantity in M17B and M19A creeks; therefore, no potential cumulative effects were identified.

No potential interactions with other human actions were identified for Project-related residual effects due to changes in water quality and aquatic resources in M19A Creek; therefore, no potential cumulative effects were identified.

#### *21.7.3.2 Description of Potential Cumulative Effects on Surface Water and Aquatic Resources*

Based on the predictions included in the Hermann Mine Application for an Environmental Assessment Certificate, streamflows at M20 Creek will be increased during the low flow months. The Murray River Project will decrease the low flows at M20 Creek (Section 8.8.1.1). That is, the effects of Murray River Coal and Hermann Mine projects on M20 Creek flows are predicted to be in two opposite directions (decreasing and increasing the low flows, respectively). Therefore, adverse interactions between the two projects are not anticipated and additional mitigation is not required.

## 21.8 FISH AND FISH HABITAT

### 21.8.1 Summary of Project-specific Residual Effects on Fish and Fish Habitat

Fish and fish habitat VCs (sub-components Bull Trout and Arctic Grayling) were assessed for a range of potential Project-related residual effects. This process identified four potential key effects, which included: direct mortality, erosion and sedimentation, change in water quality, and habitat loss. After accounting for mitigation and management, it was concluded that Project activities will not result in residual effects to fish and fish habitat. Mitigation and management methods include the implementation of best management plans (e.g., Selenium Management Plan, Water Management Plan, Erosion and Sediment Control Management Plan) and adherence to standards and best practices (e.g., Fisheries and Oceans Canada's best practices, operating window for in-stream work, site isolation, riparian re-vegetation, fishing prohibition, water quality maintenance and dust suppression). The Project will not result in fish habitat loss; therefore, a fisheries offsetting plan is not required. Given that no Project-related residual effects were identified, no residual effects on fish and fish habitat were carried forward to cumulative effects assessment. The assessment of Project-related effects on fish and fish habitat are described in Chapter 9.

## 21.9 TERRAIN

### 21.9.1 Summary of Project-specific Residual Effects on Terrain

The Project-related residual effects on terrain are shown in Table 21.9-1 and are discussed in Chapter 10. The Project is expected to result in one residual effect on terrain stability, which includes an increased risk of geohazards (mass movement of surficial materials, active fluvial processes, or soil erosion) associated with subsidence and lateral stress on surficial strata. These phenomena may cause mass movement of the surficial deposits and changes to the intensity of active fluvial processes. Soil erosion may also result from surface disturbances during Construction, Operation, and Decommissioning and Reclamation. The residual effect on terrain stability was carried forward from the Project-specific assessment and is considered in combination with the residual effects of past, present, and future human actions that have or are reasonably expected to occur in the RSA.

**Table 21.7-2. Screening for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Surface Water and Aquatic Resources**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| Change in surface water quantity in M20, M17B, and M19A creeks. | - | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - | - | - |
| Change in surface water quality in M19A Creek. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Increase in selenium tissue concentrations in aquatic resources in M19A Creek. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | | Hypothetical | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| Change in surface water quantity in M20, M17B, and M19A creeks. | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| Change in surface water quality in M19A Creek. | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| Increase in selenium tissue concentrations in aquatic resources in M19A Creek. | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |

*Notes:*

| | |
|---|---|
| - | *No spatial or temporal overlap.* |
| *O* | *Spatial and temporal overlap, but no interaction anticipated; no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

**Table 21.9-1. Summary of Residual Effects, Mitigation, and Significance on Terrain**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| **Terrain Stability** | | | |
| Increased risk of geohazards (mass movement of surficial materials, active fluvial processes, or soil erosion) resulting from subsidence. | Construction, Operation, Closure and Reclamation | Monitoring of subsidence will allow for identification of new areas of instability. Since the extent or location of occurrence is difficult to predict, management and mitigation of effects will reflect the required response level at the time of potential event. | Not Significant (Moderate) |

## 21.9.2 Cumulative Effects Assessment Boundaries for Terrain

### *21.9.2.1 Spatial Boundaries*

Spatial boundaries for the terrain CEA comprise the area within which the terrain stability affected by the Project could also be affected by past, present, or future human actions (Effects Assessment Methodology, Section 5.10). Because terrain stability is a very site-specific phenomenon, it is assumed that the spatial extent of the Project's residual effects have to physically overlap with the extent of another human action (or at least contact it) to cause an interaction. Consequently, while the typical extent of spatial boundaries for terrestrial disciplines corresponds to the RSA, the assessment of the cumulative effects on terrain stability is focused on projects and human actions that spatially contact the predicted extent of effects associated with the Project. The spatial boundary for the assessment of cumulative effects on Terrain is shown in Figure 10.11-1.

## 21.9.3 Cumulative Effects Assessment on Terrain Stability

### *21.9.3.1 Identification of Potential Cumulative Interactions*

A matrix identifying the potential cumulative effect interactions for terrain VCs is provided in Table 21.9-2.

It is expected that the residual effects of the Murray River Project development on terrain stability will be associated with subsidence and lateral stress on surficial strata. These phenomena may potentially cause mass movement of the surficial deposits, affect intensity of active fluvial processes and induce soil erosion. Potential interactions of the residual effects of the Murray River Project with the residual effects resulting from other past, present, or future projects or activities in the CEA study area were identified through reviews of relevant data (e.g., Project description, data made available from First Nations and local stakeholders, scientific literature, data acquired via data sharing agreements, government documents, and publically available data associated with relevant adjacent projects) and professional judgement of the author.

### *21.9.3.2 Description of Potential Cumulative Effects*

Terrain disturbed by subsidence and areas from which vegetation has been removed (e.g., construction and laydown areas, borrow pits, soil stockpiles, and especially roads) are typically associated with soil erosion and increased likelihood of mass movement of surficial materials. Roads in sloping areas can interfere with subsurface water flow and runoff. On steeper slopes, changes to the subsurface water

flow and runoff increases the potential for landslides and soil erosion (Noss 1995; Gunn 2009). It is thus possible that vegetation removal, tree harvesting, skid trail and road construction, and subsidence could have a synergistic effect on slope hydrology and stability will affect intensity of fluvial processes and increase soil erosion. Table 21.9-3 summarizes the potential cumulative effects on terrain stability.

#### *21.9.3.3 Mitigation Measures to Address Cumulative Effects on Terrain Stability*

Cumulative effects on terrain stability are typically managed soil and overburden management plans designed to avoid and/or minimize potential effects to terrain stability. it is assumed that any present and future projects will take into consideration the goals and objectives outlined in the *Dawson Creek Land & Resource Management Plan (LRMP)* (BC ILMB 1999) and follow best management practices recommended in their respective fields (e.g., Bittman 1995; Predika, Dawson, and Stephenson 1999; Neville 2003; BC MEMPR 2008; BC MOE 2010). It is also assumed that the following general mitigation measures will be common amongst any present and future projects or activities:

- avoid activities in areas classified as potentially unstable;
- avoid or minimize the spatial and temporal extents of soil disturbance through adoption of appropriate project development design, strategic planning, and coordination of activities;
- employ experienced, professional engineers to plan and oversee all construction work;
- monitor environmental impacts and the effectiveness of mitigation methods;
- collaborate and implement data sharing agreements, including assessment of the effectiveness of mitigation and monitoring methodologies and actions taken to improve them.

#### *21.9.3.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence*

While mitigation efforts play a significant role in reducing the magnitude of these processes, the effects of land development on terrain stability cannot be entirely eliminated. At a regional scale, the magnitude of cumulative effects on terrain stability is highly dependent on the proportion of anthropogenically altered terrain (Oldeman 1992; Noss 1995; US FWS 1998; Jakob 2000; Sloat and Redden 2005; Gunn 2009; Porter et al. 2012). Therefore, cumulative residual effects on terrain stability are expected to reflect the level of industrial development in the RSA. Terrain instability can occur on a small scale due to vegetation clearing or on a larger scale due to long term changes in geomorphology and hydrological patterns associated with mining pit excavation or subsidence. The effects may range from sporadic, highly localized soil erosion events to slope failures affecting changes in fluvial deposition/bank erosion patterns noticeable over several kilometre scales. Based on the review of available data on the current and future extent of anthropogenically altered terrain and road density in the RSA (Section 10.11.6), the predicted magnitude of the cumulative effects on terrain stability is assessed as medium. Since the intensity of human activity in the region is expected to gradually increase, the duration of the effects will extend continuously into far future at a regional scale. While the morphological changes associated with land development are usually irreversible, their effects on terrain stability are reversible in the long term. The resiliency of the affected land is likely dependant on the intensity of future development, and specifically the relationship between the stabilization rate of disturbed terrain vs. destabilization of the newly disturbed areas. The current existence of naturally unstable terrain and the projected 4.9% increase of the area of disturbed land in the RSA suggest that the resiliency of the receiving environment will be neutral.

**Table 21.9-2. Screening for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Terrain Stability**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | HF Nodes Construction (gravel pit) | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| Terrain Stability | - | - | - | - | L | - | - | - | - | - | - | - | L | O | L | - | - | L | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | | | | Hypothetical | | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | Forestry and manu-facturing | Industrial roads, rail, pipelines, seismic lines, power lines | Transport (road and rail access and traffic) | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| Terrain Stability | - | - | - | - | - | - | - | - | - | - | M | M | L | - | - | - | - | - | - | - |

*Notes:*

| | |
|---|---|
| - | *No spatial or temporal overlap.* |
| O | *Spatial and temporal overlap, but no interaction anticipated; no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

**Table 21.9-3. Summary of Potential Cumulative Effects**

| Murray River Activity | Other Human Action Activity | Description of Potential Cumulative Effect |
|---|---|---|
| **Terrain Stability** | | |
| Land subsidence, constructed slopes, storage areas, construction and use of roads, water crossings, soil disturbance. | Quintette (Babcock) Mine | Synergistic effects of terrain re-contouring, vegetation removal, and road construction on slope hydrology and stability. |
| | HF Nodes Construction (gravel pit) | Synergistic effects of vegetation removal, and road construction on soil erosion. |
| | Tumbler Ridge Wind Project | Synergistic effects of vegetation removal in the ROW, road/trail construction and subsidence on slope hydrology and stability. |
| | Forestry and manufacturing | Synergistic effects of tree removal, skidding, trail construction, and subsidence on slope hydrology and stability, on fluvial processes and on soil erosion. |
| | Industrial roads, rail, pipelines, seismic lines, power lines | Synergistic effects of vegetation removal in the ROW, road/trail construction and subsidence on soil erosion, slope hydrology and stability. |

Overall, the cumulative effects on terrain stability in the RSA are expected to be Not Significant (moderate). The potential that the effects of land development will be manifested in decreased terrain stability is highly probable; however, due to a large number of interacting factors, the confidence in the predicted outcomes (e.g., magnitude and extent of the effects and resiliency of the environment) is low (Table 21.9-4).

## 21.10 TERRESTRIAL ECOLOGY

### 21.10.1 Summary of Project-specific Residual Effects on Terrestrial Ecology

Table 21.10-1 summarizes the Project-related residual effects, mitigation strategies and significance for terrestrial ecology VCs. The Project-related residual effects of direct (i.e., loss) and indirect (i.e., degradation or alteration) effects on soil quality and quantity and on ecosystem function and extent will result in not significant effects on ecologically valuable soils, forested ecosystem, rare ecosystems, harvestable plants and rare plants and lichens. All of the Project-related residual effects on Terrestrial Ecology VCs were carried forward from the Project-specific assessment and are considered in combination with the residual effects of other past, present, and future human actions. The cumulative effects on terrestrial ecology VCs are discussed in detail in Chapter 11.

### 21.10.2 Cumulative Effects Assessment Boundaries for Terrestrial Ecology

#### *21.10.2.1 Spatial Boundaries*

The cumulative effects assessment spatial boundary is intended to encompass an area beyond which effects of the Project would not cumulatively interact with effects of other Projects. The RSA was selected as a suitable boundary to base the cumulative effects assessment on. It encompasses the regional setting for the Project and implicitly considers ecological factors, such as height of land in boundary delineation. The RSA also encompasses other relevant regionally important projects (Figure 11.12-1).

**Table 21.9-4. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Terrain Stability**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Increased risk of terrain instability (mass movement of surficial materials, active fluvial processes, or soil erosion) resulting from subsidence and soil disturbance. | Medium | Far Future | Continuous | Regional | Reversible Long-term | Neutral | Not Significant (moderate) | High | Medium |

**Table 21.10-1. Summary of Residual Effects, Mitigation, and Significance on Terrestrial Ecology Valued Components**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| Loss and alteration of ecologically valuable soil | All Phases | Minimize loss of soil quality and quantity by adhering to the Site Preparation and Soil Salvage Plan. | Not significant |
| Loss and alteration of forested ecosystems | All Phases | Minimize loss and adaptively manage effects through an ecosystem based approach. | Not significant |
| Loss and alteration of rare ecosystems | Construction and Operation | Minimize loss and adaptively manage effects through an ecosystem based approach. | Not significant |
| Loss and alteration of harvestable plants | Construction and Operation | Minimize clearing; dust abatement; invasive plant control. | Not significant |
| Loss and alteration of rare plants and lichens and associated habitat | Construction and Operation | Optimize alternatives; minimize clearing; dust abatement; invasive plant control. | Not significant |

### 21.10.3 Cumulative Effects Assessment on Terrestrial Ecology

A review of the interaction between potential residual effects of the Murray River Coal Project and the residual effects of other past, present and reasonably foreseeable future projects and activities on terrestrial ecology VCs was undertaken to determine the potential cumulative effects on ecologically valuable soils, terrestrial ecosystems, rare ecosystems, harvestable plants and rare lichens and plants (including their habitats). A matrix identifying the potential cumulative effect interactions for terrestrial ecology VCs is provided in Table 21.10-2.

The potential Project-related residual effects in combination with residual effects from other past, present, or future project or development activities in the CEA study area on the terrestrial ecology VCs were identified through reviews of relevant literature and assessed through GIS analysis as well as professional judgement and experience.

In order to account for historic effects in the CEA boundary, a pre-disturbance inventory of terrestrial ecosystems was created. To accomplish this, a moving window filter was used to fill the barren values in the PEM that were associated with anthropogenic footprints. All barren cells associated with infrastructure footprints (excluding barren cells in the alpine BEC zones) were set to 0 and removed. Then a raster calculator was used to create a 20 × 20 pixel moving window around each barren cell. The barren cell was replaced with the ecosystem type which occurs most frequently within the specified moving window. The window samples the raster cells adjacent to the barren cells and then populates them based on the neighbouring raster cells. As the barren raster cell footprints are small, this provides a reasonable approximation of pre-existing ecosystems.

As barren cells are calculated for naturally occurring features (rock outcrops and other un-vegetated areas), the barren cells that the moving filter was applied to were identified in the PEM by using the digitized disturbance footprints. Linear and other small features like roads, wells, or other small

footprints were back-dated using the moving window. Large footprints associated with mines, development such as the community of Tumbler Ridge, or other infrastructure could not be back dated using the moving window method.

To fill these larger holes, historic TEM data was used where available from other projects. However, for many older projects, no PEM or TEM data exists. To identify cumulative losses for these areas, the area of the Biogeoclimatic (BEC) subzones and variants in each footprint was calculated. Then the distribution of site series for each BEC unit in the RSA was calculated and these distributions were assigned to the footprints that had not BEC data to approximate pre-disturbance ecosystems distributions in the footprints.

To calculate cumulative loss for projects, the digitized disturbance footprints were overlaid on the back-dated PEM. The footprints were then clipped out of the PEM and assumed as lost. For mine footprints and other polygonal features, loss was determined by polygon size. For linear features, buffers were applied. A 10 m buffer was applied to roads and 4 m buffers were applied to seismic lines to account for footprints.

Alteration of ecosystem function was calculated using 100 m buffers of all polygons and roads to account for changes in hydrology, dust inputs, increased potential for invasive species, fragmentation, and edge effects. Seismic lines were not buffered due to their narrow footprints and lack of anticipated edge effects, dust, and fragmentation.

The alteration of ecologically valuable soils was assessed in terms of the ecological function that soils provide for forested ecosystems but was not assessed directly for each ecologically valuable soils type as this information was unavailable for the region.

#### *21.10.3.1 Description of Potential Cumulative Effects on Terrestrial Ecology*

The cumulative loss and alteration on terrestrial ecology VCs were assessed according to the pre-disturbance conditions as described in Section 11.12.2. The loss and alteration of each terrestrial ecology VC is summarized in Table 21.10-3 and discussed below.

The cumulative loss on ecologically valuable soils and forested ecosystems from past and present projects is 10,723 ha (5.5%). The cumulative loss of ecologically valuable soils including reasonably foreseeable future projects – excluding the Project – is 15,983 ha (8.3%). The Murray River Coal Project will contribute 466 ha (0.24%) to equal 16,449 ha (8.5%) total cumulative loss.

The cumulative alteration of forested ecosystems from past and present projects is 42,257 ha (22%). The cumulative loss of forested ecosystems including reasonably foreseeable future projects – excluding the Project – is 49,026 ha (25%). The Murray River Coal Project will contribute 164 ha (0.1%) to equal 49,190 ha (25%) total cumulative alteration.

Collectively the cumulative loss and alteration of forested ecosystem from past and present projects is 52,980 ha (27.2%). The cumulative loss and alteration of forested ecosystem including reasonably foreseeable future projects within the CEA boundary is 65,639 ha (33.7%). The detailed summary of the cumulative loss and alteration of terrestrial ecosystems is presented in Appendix 11-E and Appendix 11-F, respectively.

**Table 21.10-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Terrestrial Ecology**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effects | Comments |
|---|---|---|---|---|---|---|
| Past | Historical | Hasler Coal Mine | 1941 - 1945 | Hasler Creek Coal Company | - | No spatial overlap with the RSA |
| | | Sukunka (Bullmoose) Mine | 1972 – 1975 | BP Exploration Canada Ltd. | H | Overlay mine footprints and calculate distribution of ecosystems based on RSA PEM |
| | Recent | Bullmoose Mine | 1983 – 2003 | Teck Corporation | - | No spatial overlap with the RSA |
| | | Dillon Coal Mine | 2004 – 2007 | Walter Energy / Western Coal | - | No spatial overlap with the RSA |
| | | Quintette (Babcock) Mine | 1983 - 2000 | Teck Corporation | H | Source: EA historic TEM mapping |
| | | Quintette (MESA Pit) Mine | 1983 - 2000 | Teck Corporation | H | Overlay mine footprints and calculate distribution of ecosystems based on RSA PEM |
| | | Willow Creek Mine | 2000 - 2013 | Walter Energy | - | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | M | Overlay cut block distribution and identify potential overlap of effects |
| | | Roads/Gravel Pits | | | H | Buffer roads and intersect with backdated RSA PEM |
| | | Oil and Gas Footprints | | | H | Overlay O&G footprints and intersect with backdated RSA PEM |
| | | Oil and Gas Seismic Lines | | | H | Buffer O&G seismic lines and intersect with backdated RSA PEM |
| Present | | Brule Mine | 2005 - 2016 | Walter Energy | - | - |
| | | Trend Mine | 2003 - 2016 | Peace River Coal | H | Spatial overlap with the RSA |
| | | Quality Wind Project | 2013 - unknown | Capital Power | L | Spatial overlap with the RSA |
| | | Peace Canyon Dam | 1980 – unknown | BC Hydro | - | - |

*(continued)*

**Table 21.10-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Terrestrial Ecology (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effects | Comments |
|---|---|---|---|---|---|---|
| Present (*cont'd*) | | Wolverine Mine (Perry Creek) and EB Pit | 2004 - 2016 | Walter Energy | M | Overlay mine footprints and calculate distribution of ecosystems based on RSA PEM |
| | | WAC Bennett Dam | 1961 – unknown | BC Hydro | - | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | L | Riparian buffers used by forest companies adjacent to cut blocks |
| | | Roads/ Oil and Gas Footprints/Seismic Lines | | | H | Buffer roads and intersect with backdated RSA PEM. Overlay O&G footprints and intersect with backdated RSA PEM. Buffer O&G seismic lines and intersect with backdated RSA PEM |
| | | Community of Tumbler Ridge | | | M | Overlay town footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Tumbler Ridge Community Forest | | | L | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| Future | Certain | Hermann Mine | 2014 - 2025 | Walter Energy | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Quintette Mine | 2013 - 2025 | Teck Corporation | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Roman Mine Project | 2013 - 2024 | Peace River Coal | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Thunder Mountain Wind Park | 2014 – unknown | Aeolis Wind | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Tumbler Ridge Wind Project | 2013 - unknown | Pattern Energy Group | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Wartenbe Wind Project | 2014 - unknown | Avro Wind Energy Inc. | - | No spatial overlap with the RSA |

*(continued)*

**Table 21.10-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Terrestrial Ecology (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Comments |
|---|---|---|---|---|---|---|
| Future (*cont'd*) | Certain (*cont'd*) | Major Forest Licensees | | | L | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Roads | | | H | No available data |
| | | Oil and Gas Footprints | | | | No available data |
| | | Oil and Gas Sesimic Lines | | | M | No available data |
| | | Tumbler Ridge Community Forest | | | L | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | Reasonably Foreseeable | Echo Hill Mine | 2015 - 2029 | Hillsborough Resources Ltd. | - | No spatial overlap with the RSA |
| | | Coastal Gaslink Project | 2015 – 2048 | TransCanada Pipelines | - | No spatial overlap with the RSA |
| | | Horizon Mine | 2015 - 2038 | Peace River Coal | M | Overlay footprint and calculate distribution of ecosystems based on RSA PEM |
| | | Meikle Wind Energy Project | 2015 – 2041 | Meikle Wind Energy Partnership | - | No spatial overlap with the RSA |
| | | Northern Gateway Pipeline | 2016 – 2068 | Enbridge Northern Gateway Pipelines | M | Footprint loss determined using PEM and identified pipeline route and ROW width. |
| | | Rocky Creek Energy Project | 2015 – unknown | Rupert Peace Power Corporation | - | No spatial overlap with the RSA |
| | | Site C Clean Energy Project | 2015 – unknown | BC Hydro | - | No spatial overlap with the RSA |
| | | Sukunka Coal Mine Project | 2015 – 2038 | Glencore | - | No spatial overlap of development with the RSA |
| | | Sundance Wind Project | 2015 - unknown | EDF Energies Nouvelles | - | No spatial overlap with the RSA |
| | | Wildmare Wind Energy Project | 2015 – unknown | Pattern Energy Group | - | No spatial overlap with the RSA |

*(continued)*

**Table 21.10-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Terrestrial Ecology (completed)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Comments |
|---|---|---|---|---|---|---|
| Future (*cont'd*) | Hypothetical | Babcock Creek Wind Project | Unknown | Babcock Ridge Wind Limited Partnership | - | Spatial overlap with the RSA |
| | | Belcourt Saxon Coal Project | Unknown | Xstrata Coal Canada Ltd. | - | No spatial overlap with the RSA |
| | | Huguenot Mine | Unknown | Colonial Coal International | - | No spatial overlap with the RSA |
| | | Moose Lake Wind Power | Unknown | Moose Lake Wind Power Corporation | - | No spatial overlap with the RSA |
| | | Septimus Creek Wind Power Project | Unknown | Zero Emission Energy Developments | - | No spatial overlap with the RSA |
| | | Suska Mine | Unknown | Xstrata Coal Canada Ltd. | - | No spatial overlap with the RSA |
| | | Wapiti River Coal Project | Unknown | Canadian Dehua International Mines Group Inc. | L | Spatial overlap with the RSA |

*Notes:*

- *No spatial or temporal overlap.*

*O* *No interaction anticipated.*

*L* *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*

*M* *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*

*H* *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

**Table 21.10-3. Summary of Cumulative Loss and Alteration from Past, Present, and Reasonably Foreseeable Future Projects within the CEA Boundary for Terrestrial Ecosystems**

| Terrestrial Ecology Valued Component | Project Timeframe | Past / Present Contribution | | Future Project Contribution | | Past, Present, and Future Contribution Total | | Total Mapped in RSA |
|---|---|---|---|---|---|---|---|---|
| | Units | ha | % | ha | % | ha | % | ha |
| Ecologically Valuable Soil | Loss | 10,723 | 5.5 | 5,726 | 2.9 | 16,449 | 8.5 | 194,326 |
| | **Total Loss** | **10,723** | **5.5** | **5,726** | **2.9** | **16,449** | **8.5** | |
| Forested Ecosystems | Loss | 10,723 | 5.5 | 5,726 | 2.9 | 16,449 | 8.5 | 194,326 |
| | Alteration | 42,257 | 22 | 6,933 | 3.9 | 49,190 | 26 | |
| | **Total Loss and Alteration** | **52,980** | **27.2** | **12,659** | **7** | **65,639** | **33.7** | |
| Rare Ecosystems | Loss | 1,910 | 5.8 | 455 | 1.4 | 2,366 | 7.1 | 33,128 |
| | Alteration | 7,841 | 24.0 | 936 | 3.0 | 8,777 | 26.0 | |
| | **Total Loss and Alteration** | **9,751** | **29.8** | **1,391** | **4.4** | **11,143** | **33.1** | |
| Harvestable Plant Habitat | Loss | 10,723 | 5.5 | 5,726 | 2.9 | 16,449 | 8.5 | 194,326 |
| | Alteration | 42,257 | 22 | 6,933 | 4 | 49,190 | 25 | |
| | **Total Loss and Alteration** | **52,980** | **27.2** | **12,659** | **7** | **65,639** | **33.7** | |

*Note: Totals are approximate due to rounding errors.*

The cumulative loss on BC CDC listed ecosystems from past and present projects is 1,910 ha (5.8%). The cumulative loss of BC CDC listed ecosystems including reasonably foreseeable future projects – excluding the Project – is 2,320 ha (7.0%). The Murray River Coal Project will remove 45 ha (0.14%) to equal 2,366 ha (7.1%) total cumulative loss.

The cumulative alteration on BC CDC listed ecosystems from past and present projects is 7,841 ha (24%). The cumulative alteration of BC CDC listed including reasonably foreseeable future projects-excluding the Project is 8,753 ha (26%). The Murray River Coal Project may affect 24 ha (< 1%) to equal 8,777 ha (26%) total cumulative alteration.

Collectively the cumulative loss and alteration of BC CDC listed ecosystems from past and present projects is 52,980 ha (27.2%). The cumulative loss and alteration of BC CDC listed ecosystems including reasonably foreseeable future projects within the CEA boundary is 9,751 ha (29.8%). The detailed summary of the cumulative loss and alteration of terrestrial ecosystems is presented in Appendix 11-E and Appendix 11-F, respectively.

The cumulative loss and alteration to harvestable plant habitat is difficult to accurately characterize because the location, type and quantity of harvestable plants within the region is unknown. Many of the ecosystems within the region can provide suitable habitat for harvestable plants and as such harvestable plant habitat was assessed in relation to effects on forested ecosystems. However, the effects to harvestable plant habitat are expected to be considerably less in extent than the loss and alteration reported for forested ecosystem. Furthermore, in certain cases, human derived alteration will increase the amount of harvestable plant habitat.

### *21.10.3.2 Rare Plants and Lichens*

The spatial coverage of rare plant and lichen survey data regionally is very sparse, and as a result uncertainty exists with respect to the presence of rare plants and lichens throughout the CEA study area. Of the information available, 16 blue-listed and 3 red-listed plant or lichens may be impacted by human activities within the CEA boundary. Noteworthy species include whitebark pine (*Pinus albicaulis*), which is listed on Schedule 1 of the SARA and *Collema tenax* var. *expansum*, which is listed as globally rare. The cumulative loss of rare plants and lichens within the CEA, summarized by project species and rarity rank, is presented in Table 21.10-4.

### *21.10.3.3 Mitigation Measures to Address Cumulative Effects on Terrestrial Ecology*

Ecosystem management and mitigation plans are designed to avoid and minimize adverse effects to ecosystems and plants resulting from project activities within the feasible limits of project design and activities. Each past, present, and future project would have had or will have different mitigation and management for terrestrial ecosystems and plants; however, it is assumed any present and future projects will take into consideration the goals and objectives outlined in the *Dawson Creek Land & Resource Management Plan (LRMP).* It is also assumed that the following general mitigation measures will be common amongst any present and future projects or activities:

- avoid and minimize detrimental effects to terrestrial ecosystems and wetlands through strategic planning;
- minimize all clearing dimensions during any construction activities;
- minimize soil degradation through best management practices for soil stripping, handling and stockpiling;
- minimize soil loss and degradation (i.e., compaction, erosion, and soil horizon mixing);
- avoid the introduction and spread of invasive plants;
- avoid and minimize detrimental effects to rare plants and lichens, including rare plant and lichen habitat;
- avoid and minimize loss or alteration of ecosystem functions due to clearing activities, dust deposition, fragmentation, edge effects, windthrow, and altered hydrology;
- ensure clearing activities are coordinated with other management plans;
- maintain natural levels of plant and lichen biodiversity through avoidance, offsetting, and other mitigation strategies;
- avoid direct harm to rare plant and lichen populations through realignment of footprint boundaries when possible;
- avoid use of all herbicide sprays within 200 m of rare plant and lichen populations and limit such use to direct application rather than broadcast sprays; and
- create exclusion zones around priority rare plant and lichen (e.g., red-listed and globally rare species) habitats to avoid direct disturbance and to minimize effects related to fugitive dust transport, weed invasion, and vehicular activities.

**Table 21.10-4. Summary of Cumulative Loss or Alteration of Rare Plants and Lichens within the CEA Boundary**

| | Project Name | Data Status | Scientific Name | English Name | Global Rank | Provincial Rank | BC CDC Rank | SARA Listed |
|---|---|---|---|---|---|---|---|---|
| Past / Present Projects | Wolverine | no red- or blue-listed plants identified during sampling | - | - | - | - | - | - |
| | Tumbler Ridge Wind Energy | no red- or blue-listed plants identified during sampling | - | - | - | - | - | - |
| | Trend | 2 vascular plants | *Polemonium occidentale* var. *occidentale* | western Jacob's ladder | G5?T5? | S2S3 | blue | - |
| | | | *Silene involucrata* ssp. *involucrata* | Arctic campion | G5T5 | S2S3 | blue | - |
| | Sukunka (Bullmoose) | data unavailable | - | - | - | - | - | - |
| | Quality Wind Project | data unavailable | - | - | - | - | - | - |
| | Quintette | 2 mosses | *Brachythecium holzingeri*[1] | none | GU | S2S3 | blue | - |
| | | | *Scorpidium cossonii* | none | GU | S2S4 | blue | - |
| | Roads and all other infrastructure | data unavailable | - | - | - | - | - | - |
| | EB Pit Coal Mine | data unavailable | - | - | - | - | - | - |
| Future Projects | Hermann Mine | 10 vascular plants | *Carex tenera* | - | G5 | S2S3 | blue | - |
| | | | *Carex xerantica* | dryland sedge | G5 | S2 | red | - |
| | | | *Draba alpina* | Alpine draba | - | - | not listed | - |
| | | | *Draba lactea* | milky draba | G5 | S2S3 | blue | - |
| | | | *Draba lonchocarpa* var. *thompsonii* | lance-fruited draba | G5T3T4Q | S2S3 | blue | - |
| | | | *Erigeron trifidus* | three lobed daisy | G2G3Q | S2 | red | - |
| | | | *Euphrasia arctica* var. *disjuncta* | Arctic eyebright | - | S3S4 | yellow | - |

*(continued)*

**Table 21.10-4. Summary of Cumulative Loss or Alteration of Rare Plants and Lichens within the CEA Boundary (completed)**

| | Project Name | Data Status | Scientific Name | English Name | Global Rank | Provincial Rank | BC CDC Rank | SARA Listed |
|---|---|---|---|---|---|---|---|---|
| **Future Projects (*cont'd*)** | Hermann Mine *(cont'd)* | 10 vascular plants *(cont'd)* | *Glyceria pulchella* | slender managrass | G5 | S2S3 | blue | - |
| | | | *Oxytropis jordalii* var. *jordalii* | Jordal's locoweed | G5T4 | S2S3 | blue | - |
| | | | *Ranunculus eschscholtzii* var. *suksdorfii* | subalpine buttercup | - | S3S4 | yellow | - |
| | Horizon Mine | data unavailable | - | - | - | - | - | - |
| | Northern Gateway Pipeline | 1 vascular plant | *Pinus albicaulis* | whitebark pine | G3G4 | S2S3 | blue | Schedule 1 |
| | Quintette Coal Mine | 2 mosses | *Brachythecium holzingeri* | - | GU | S2S3 | blue | - |
| | | | *Scorpidium cossonii* | - | GU | S2S4 | blue | - |
| | Roman Coal Mine | 3 vascular plants | *Polemonium occidentale* var. *occidentale* | western Jacob's ladder | G5?T5? | S2S3 | blue | - |
| | | | *Silene involucrata* ssp. *involucrata* | Arctic campion | G5T5 | S2S3 | blue | - |
| | | | *Draba porsilidii* | Porsild's draba | G3G4 | S2S3 | blue | - |
| | Murray River - MSAF | 3 vascular plants and 2 lichens | *Drymocallis arguta* | tall cinquefoil | G5T5 | S1S3 | red | - |
| | | | *Cardamine parviflora* | small-flowered bittercress | G5 | S2S3 | blue | - |
| | | | *Botrychium crenulatum* | dainty moonwort | G3G4 | S2S3 | blue | - |
| | | | *Collema tenax* var. *expansum* | - | G1 | SU | currently not ranked | - |
| | | | *Hypogymnia dichroma* | - | GU | SU | currently not ranked (species new to science) | - |

*Note:*

[1] *Report is being prepared for the CDC suggesting its provincial status be changed to the Yellow List (Stanteck 2012); this change in ranking will occur in 2012 or 2013. It will be included with* Brachythecium oedipodium *in the revised status (and given a new name:* Sciuro-hypnum oedipodium*).*

Collaborative approaches to address cumulative effects to the terrestrial ecology receptor VC have been initiated through data sharing agreements between some proponents regionally. Further collaborative efforts with additional proponents, and to maximize the effectiveness of monitoring programs and other biodiversity initiatives should be pursued.

#### *21.10.3.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Terrestrial Ecology*

Residual cumulative effects are expected due to historic activities, present and/or future planned activities within the CEA where residual effects persist. Residual cumulative effects are anticipated for ecologically valuable soil, forested ecosystems, rare ecosystems, harvestable plants and rare plants and lichens. The cumulative residual effects remaining after the implementation of all mitigation measures and are summarized in Table 11.12-4. The characterization of cumulative residual effects is summarized in Table 21.10-5.

Ecologically Valuable Soils

The cumulative loss of ecologically valuable soils is considered not significant. The magnitude of effects is considered moderate because 8.5% of all ecologically valuable soils will be affected. Cumulative effects to ecologically valuable soils include, nibbling losses to soil quality and quantity by many projects and synergistic effects on soil moisture regime associated with land clearing, tree harvesting, road construction, and subsidence. The effect will extend into the far future due to the slow recovery rate of soils. Frequency of effects will vary, but most typically will be sporadic. The effects will occur at a regional level. Loss of some ecologically valuable soils is considered reversible in the far future depending on quality of mitigation and effectiveness of reclamation. The ecological context of ecologically valuable soils is neutral as the affected soils have some unique attributes, and some of their functions will have been degraded. The probability of the effects to soils is high because surface clearing activities and soil handling practices are known to result in the loss and degradation of soils. Confidence in the analysis is medium, however, because, while the type and distribution of soils within the impacted area are well understood, there is a considerable uncertainty regarding the range of potential ecological responses of soils to a combination of various effects within the region.

Forested Ecosystems

Loss and alteration of forested ecosystem function and/or extent are considered significant. The magnitude of effects is considered major because more than 33.7% of all forested ecosystems will have been affected by past, present and future projects. Cumulative effects to forested ecosystems include nibbling loss of forested land, physical transport of invasive plant propagules, chemical transport of dust from various sources, spatial and temporal crowding in areas where multiple project effects intersect with forested ecosystems as well as growth inducing effects due to the creation of new forest edges that could lead to windthrow and introduction of invasive plant species. The frequency of cumulative effects range from once to continuous depending on the effect. Effects will occur within a regional level and the majority of effects are considered reversible in the far future. Forested ecosystems are considered to be of neutral resiliency. In an ecological context, forested ecosystems are considered neutral according to the definitions provided in Table 11.11-1.

**Table 21.10-5. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Terrestrial Ecology Valued Components**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Loss of soil quality and quantity | moderate | far future | once, sporadic, regular | regional | reversible far future | neutral | not significant (moderate) | high | medium |
| Loss and alteration of forested ecosystem function and/or extent | major | far future | once, sporadic, regular and continuous | regional | reversible far future | neutral | significant (major) | high | medium |
| Loss and alteration of rare ecosystem function and/or extent | major | far future | once, sporadic | beyond regional | irreversible | high | significant (major) | medium | low |
| Loss or alteration of harvestable plant quantity or quality | moderate | medium to long | sporadic | regional | reversible long-term | neutral | not significant (moderate) | medium | medium |
| Loss of biodiversity, rare plants and lichens; loss and alteration of rare plant and lichen habitat | moderate to major | far future | once | beyond regional | irreversible | high | significant (major) | medium | low |

The probability of the effects is high because there are already known cumulative effects within the CEA study area, notably nibbling effects. Any further effects resulting from past, present or future projects will contribute to the existing cumulative effects within the CEA boundary. There is an overall moderate level of confidence in the data sources used for this analysis. The predictive ecosystem mapping is a landscape level tool that can be used to determine potential effects on ecosystem type and distribution and to guide mitigation and management strategies. However, the accuracy of the PEM is limited by the availability of site level data as well as the resolution at which it is mapped. Furthermore, uncertainty exists with respect to where and to what degree alteration of functions may occur due to the complexity of ecological processes between components and their response to cumulative effects. Nevertheless, there is a high level of probability that effects to forested ecosystems will occur. The majority of the effects to forested ecosystems, including fragmentation and edge effects are well understood and well documented in the scientific literature. Therefore, there is an overall medium confidence level in the assessment of effects on forested ecosystems.

Rare Ecosystems

Loss and alteration of rare ecosystems are considered significant. The magnitude of the effects is considered major based on the determination of magnitude outlined in Table 11.9-3 as well as the magnitude ratings outlined in Table 11.12-7. Cumulative effects to rare ecosystems include nibbling loss of rare ecosystems and relevant surrounding ecosystem that contribute to the ecological function of rare ecosystems, physical transport of invasive plant propagules, chemical transport of dust from various sources, spatial and temporal crowding in areas where multiple project effects intersect with rare ecosystems as well as growth inducing effects due to the creation of new forest edges that could lead to windthrow and introduction of invasive plant species. The effects are expected to affect the viability of this resource in the short, medium and long term. Loss of rare ecosystems is considered irreversible as these ecosystems contain unique attributes that are not easily replicable. The effects of surface clearing will occur once and the remainder of effects will occur sporadically. All of the effects are considered beyond regional in extent and will extend into the far future. In an ecological context, rare ecosystems are rated high as they have unique attributes that are uncommon and of conservation interest in the province. There is a low level of confidence in the analyses because uncertainty exists regarding how the unique combinations of environmental conditions that characterize rare ecosystems will respond to potential cumulative effects.

Harvestable Plants

Loss and alteration of harvestable plants are considered not significant. The magnitude of the direct effects to harvestable plants is considered moderate because although 33.7% of the available habitat could be lost or altered by cumulative effects, some of the human derived alteration will increase the amount of harvestable plants. Development activities such as timber harvesting can favour berry production by increasing the light available to plants and by reducing competing vegetation. Other cumulative effects to harvestable plants include nibbling loss of relevant habitat, physical transport of invasive plant propagules, spatial and temporal crowding in areas where multiple project effects intersect with harvestable plant habitat as well as additive effects from the accumulation of metals in some soils and subsequent plant uptake as well as growth inducing effects due to the creation of new edges. All of the effects are considered regional in extent and reversible in the long term. The duration of effects are expected to occur over the medium to long term depending on the relevant

plant and its associated habitat requirements. In an ecological context, harvestable plants are considered neutral as they have some unique attributes, particularly to the local communities (discussed further in Chapter 16, Land Use). There is a medium level of confidence in the analyses because the effects to harvestable plants are generally well understood; however, uncertainty exists regarding the magnitude of alteration.

Rare Plants and Lichens

Additional knowledge of local and regional floral biodiversity is required in order to evaluate the significance of the Project effects on many of the rare plant and lichen populations. Nevertheless, the magnitude of the removal or alteration of rare plants and lichens or their associated habitat will vary from moderate to major depending on the species affected and their associated conservation rank. The conservation rank for each species takes into consideration the rarity, current trends and threats to the species. Of the plant or lichen species impacted, there are several with less than 20 known occurrences in the province, one with less than 5 known occurrences in the province and one with less than 20 documented occurrences in the world. One species, white bark pine, is listed on Schedule 1 of SARA.

Rare plants and lichens represent at-risk components of regional, provincial, federal or global biodiversity. These species are often highly habitat-specific with low resiliency to habitat loss or degradation, invasive alien species, changes in ecological dynamics or natural processes, and disturbance (Province of British Columbia 2013). The effect is beyond regional, will occur once, and will last into the far future. Loss of rare plans and lichens is considered an irreversible effect as transplantation is usually ineffective (BC *Mines Act* 1998; BC MOE 2005; Northwest Invasive Plant Council 2012; Barker 2013). Furthermore, rare plants and lichens can have limited dispersal ability, poor recruitment or reproduction, population fluctuations, inbreeding, and/or restricted ranges. There is a high level of confidence in the specific location of the species as well as the identification of the species that have been surveyed to date for the Project; however, the spatial coverage of surveys regionally is very sparse, and as a result uncertainty exists with respect to the presence of rare plants and lichens throughout the CEA study area. Furthermore, information regarding the magnitude of effects discussed in this chapter to rare plants and lichens is limited. Further uncertainty exists regarding the magnitude of the effect on rare plant and lichens as well the individual species response to the effect. In an ecological context, rare plants and lichens (depending on their conservation rank) are considered unique attributes according to the definitions in Table 11.11-1.

## 21.11 WETLANDS

Table 21.11-1 summarizes the Project-related residual effects, mitigation strategies and significance for wetlands. None of the residual effects on wetland extent or function were rated as being significant due to the Project. The Project-related residual effects of loss of wetland extent and alteration of wetland function were carried forward from the Project-specific assessment and are considered in combination with the residual effects of other past, present, and future human actions. The cumulative effects on wetland are discussed in detail in Chapter 12.

**Table 21.11-1. Summary of Residual Effects, Mitigation, and Significance on Wetlands**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| Loss of extent | Construction and Operation | None | Not significant (moderate) |
| Alteration of function | Operation to Post Closure | Air Quality and Dust Control Plan, Access Management Plan, Erosion and Sediment Control Plan, Selenium Management Plan, Aquatic Effects Monitoring Plan, Spill Response Plan, and Invasive Plant Management Plan | Not Significant (moderate) |

## 21.11.1 Cumulative Effects Assessment Boundaries for Wetlands

### *21.11.1.1 Spatial Boundaries*

The cumulative effects assessment spatial boundary for wetlands is the baseline RSA as identified in the Figure 12.11-1. The RSA encompasses the maximum area within which the Project effects to wetlands could interact with residual effects from other past, present of reasonably foreseeable future projects and activities. The definition of these assessment boundaries is an integral part of the wetland CEA, and encompasses possible direct, indirect, and induced effects of the Project on wetlands.

## 21.11.2 Cumulative Effects Assessment on Wetlands

### *21.11.2.1 Identification of Potential Cumulative Interactions*

A review of the interaction between potential residual effects of the Project and the residual effects of other projects and activities on wetlands was undertaken to determine the potential cumulative effects on wetland extent and function.

For most projects that occurred in the past to present, these were calculated using the pre-disturbance PEM and the methods described in Section 12.11.1.5. For future projects, environmental assessments were retrieved from the BC EAO website and reviewed. To assess the Northern Gateway Pipeline and Wapiti River Coal Project, the proposed footprints for these projects were overlaid with the backdated PEM and wetland loss was calculated. Figure 12.11-1 shows the footprints of all the potential projects assessed for cumulative effects on wetlands.

A matrix identifying the potential cumulative effect interactions for wetlands is provided in Table 21.11-2. The table identifies the rationale for inclusion or exclusion in the cumulative effects assessment and summarizes the source of the data used for the assessment.

To evaluate the effects of human activity on wetlands in the RSA a pre-disturbance map of ecosystems was adapted to back-date the predictive ecosystem mapping for the RSA.

To accomplish this, a moving window filter was used to fill the barren values in the PEM that were associated with anthropogenic footprints. All barren cells associated with infrastructure footprints (excluding barren cells in the alpine BEC zones) were set to 0 and removed. Then a raster calculator was used to create a 20 × 20 pixel moving window around each barren cell.

**Table 21.11-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wetlands**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Area Lost (ha) [Altered] | Comments |
|---|---|---|---|---|---|---|---|
| Past | Historical | Hasler Coal Mine | 1941 - 1945 | Hasler Creek Coal Company | - | 0 | No spatial overlap with the RSA |
| | | Sukunka (Bullmoose) Mine | 1972 – 1975 | BP Exploration Canada Ltd. | N | 10.2 | Overlay mine footprints and calculate distribution of wetlands based on RSA PEM |
| | Recent | Bullmoose Mine | 1983 – 2003 | Teck Corporation | - | 0 | No spatial overlap with the RSA |
| | | Dillon Coal Mine | 2004 – 2007 | Walter Energy / Western Coal | - | 0 | No spatial overlap with the RSA |
| | | Quintette (Babcock) Mine | 1983 - 2000 | Teck Corporation | H | 52.9 [12.5] | Source: EA historic TEM mapping |
| | | Quintette (MESA Pit) Mine | 1983 - 2000 | Teck Corporation | H | | Overlay mine footprints and calculate distribution of wetlands based on RSA PEM |
| | | Willow Creek Mine | 2000 - 2013 | Walter Energy | - | 0 | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | □ | 0 | Riparian buffers used by forest companies adjacent to cut blocks |
| | | Roads/Gravel Pits | | | H | Combined with present | Buffer roads and intersect with backdated RSA PEM |
| | | Oil and Gas Footprints | | | H | | Overlay O&G footprints and intersect with backdated RSA PEM |
| | | Oil and Gas Seismic Lines | | | H | | Buffer O&G seismic lines and intersect with backdated RSA PEM |
| Present | | Brule Mine | 2005 - 2016 | Walter Energy | - | | No spatial overlap with the RSA |
| | | Trend Mine | 2003 - 2016 | Peace River Coal | M | 5.2 [4.2] | Used PEM to identify potential historic wetland distribution |
| | | Quality Wind Project | 2013 - unknown | Capital Power | L | 0.03 | Source: EA |
| | | Peace Canyon Dam | 1980 – unknown | BC Hydro | - | | No spatial overlap with the RSA |

*(continued)*

**Table 21.11-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wetlands (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Area Lost (ha) [Altered] | Comments |
|---|---|---|---|---|---|---|---|
| Present (*cont'd*) | | Wolverine Mine (Perry Creek) and EB Pit | 2004 - 2016 | Walter Energy | M | 52.1 [16.0] | Historic TEM Data from Wolverine Mine EA used to calculate wetland loss of extent. Where TEM data was absent, PEM was used to identify potential historic wetland distribution |
| | | WAC Bennett Dam | 1961 – unknown | BC Hydro | - | | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | L | | Riparian buffers used by forest companies adjacent to cut blocks |
| | | Roads/ Oil and Gas Footprints/Seismic Lines | | | H | 262.1 [1913.9] | Buffer roads and intersect with backdated RSA PEM.<br>Overlay O&G footprints and intersect with backdated RSA PEM. Buffer O&G seismic lines and intersect with backdated RSA PEM |
| | | Community of Tumbler Ridge | | | H | 18.4 [4.1] | Used PEM to identify potential historic wetland distribution |
| | | Tumbler Ridge Community Forest | | | L | 0 | Riparian buffers around wetlands used by community forest |
| Future | Certain | Hermann Mine | 2014 - 2025 | Walter Energy | M | 10.2 | Source: EA |
| | | Quintette Mine | 2013 - 2025 | Teck Corporation | M | 1.3 | Source: EA |
| | | Roman Mine Project | 2013 - 2024 | Peace River Coal | M | 5.4 | Source: EA |
| | | Thunder Mountain Wind Park | 2014 – unknown | Aeolis Wind | M | 1.5 | Source: EA |
| | | Tumbler Ridge Wind Project | 2013 - unknown | Pattern Energy Group | M | 13 | Source: EA |
| | | Wartenbe Wind Project | 2014 - unknown | Avro Wind Energy Inc. | - | 0 | No spatial overlap with the RSA |

*(continued)*

**Table 21.11-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wetlands (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Area Lost (ha) [Altered] | Comments |
|---|---|---|---|---|---|---|---|
| Future (*cont'd*) | Certain (*cont'd*) | Major Forest Licensees | | | L | 0 | Riparian buffers used by forest companies adjacent to cut blocks |
| | | Roads | | | H | | No available data |
| | | Oil and Gas Footprints | | | H | | No available data |
| | | Oil and Gas Sesimic Liness | | | M | | No available data |
| | | Tumbler Ridge Community Forest | | | L | | Riparian buffers around wetlands used by community forest |
| | Reasonably Foreseeable | Echo Hill Mine | 2015 - 2029 | Hillsborough Resources Ltd. | - | | No spatial overlap with the RSA |
| | | Coastal Gaslink Project | 2015 – 2048 | TransCanada Pipelines | - | | No spatial overlap with the RSA |
| | | Horizon Mine | 2015 - 2038 | Peace River Coal | M | 7.1 | Source: EA |
| | | Meikle Wind Energy Project | 2015 – 2041 | Meikle Wind Energy Partnership | - | | No spatial overlap with the RSA |
| | | Northern Gateway Pipeline | 2016 – 2068 | Enbridge Northern Gateway Pipelines | M | 16.8 | Footprint loss determined using PEM and identified pipeline route and ROW width. Area overlap with the RSA is 141.4 ha. |
| | | Rocky Creek Energy Project | 2015 – unknown | Rupert Peace Power Corporation | - | | No spatial overlap with the RSA |
| | | Site C Clean Energy Project | 2015 – unknown | BC Hydro | - | | No spatial overlap with the RSA |
| | | Sukunka Coal Mine Project | 2015 – 2038 | Glencore | - | | No spatial overlap of development with the RSA |
| | | Sundance Wind Project | 2015 - unknown | EDF Energies Nouvelles | - | | No spatial overlap with the RSA |
| | | Wildmare Wind Energy Project | 2015 – unknown | Pattern Energy Group | - | | No spatial overlap with the RSA |

*(continued)*

**Table 21.11-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wetlands (completed)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Cumulative Effects | Area Lost (ha) [Altered] | Comments |
|---|---|---|---|---|---|---|---|
| Future (*cont'd*) | Hypothetical | Babcock Creek Wind Project | Unknown | Babcock Ridge Wind Limited Partnership | N | 0 | This has a very small footprint about 400 m from closest wetland. Footprint is all in a clearcut. |
| | | Belcourt Saxon Coal Project | Unknown | Xstrata Coal Canada Ltd. | - | | No spatial overlap with the RSA |
| | | Huguenot Mine | Unknown | Colonial Coal International | - | | No spatial overlap with the RSA |
| | | Moose Lake Wind Power | Unknown | Moose Lake Wind Power Corporation | - | | No spatial overlap with the RSA |
| | | Septimus Creek Wind Power Project | Unknown | Zero Emission Energy Developments | - | | No spatial overlap with the RSA |
| | | Suska Mine | Unknown | Xstrata Coal Canada Ltd. | - | | No spatial overlap with the RSA |
| | | Wapiti River Coal Project | Unknown | Canadian Dehua International Mines Group Inc. | L | 29.0 | PEM calculation; 83.4 ha extent overlap of the project boundary with the RSA. Many wetlands exist in this area. |

*Notes:*

- *No spatial or temporal overlap.*

*N* *No interaction anticipated.*

*L* *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*

*M* *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*

*H* *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

The barren cell was replaced with the ecosystem type which occurs most frequently within the specified moving window. The window samples the raster cells adjacent to the barren cells and then populates them based on the neighbouring raster cells. As the barren raster cell footprints are small, this provides a reasonable approximation of pre-existing ecosystems.

As barren cells are calculated for naturally occurring features (rock outcrops and other un-vegetated areas), the barren cells that the moving filter was applied to were identified in the PEM by using the digitized disturbance footprints. Linear and other small features like roads, wells, or other small footprints were back-dated using the moving window. Large footprints associated with mines, development such as the community of Tumbler Ridge, or other infrastructure could not be back dated using the moving window method.

To fill these larger holes, historic TEM data was used where available from other projects. However, for many older projects, no PEM or TEM data exists. To identify cumulative losses for these areas, the area of the Biogeoclimatic (BEC) subzones and variants in each footprint was calculated. Then the distribution of site series for each BEC unit in the RSA was calculated and these distributions were assigned to the footprints that had not BEC data to approximate pre-disturbance ecosystems distributions in the footprints.

To calculate cumulative loss for projects that occurred in the past to present, the digitized disturbance footprints were overlaid on the back-dated PEM. The footprints were then clipped out of the PEM and assumed as lost. For mine footprints and other polygonal features, loss was determined by polygon size. For linear features, buffers were applied. A 10 m buffer was applied to roads and 4 m buffers were applied to seismic lines to account for footprints.

Alteration of function was calculated using 100 m buffers of all polygons and roads to account for changes in hydrology, dust inputs, increased potential for invasive species, fragmentation, and edge effects. Seismic lines were not buffered due to their narrow footprints and lack of anticipated edge effects, dust, and fragmentation.

To determine alteration of function and loss of wetland extent due to future projects, environmental assessments on the BC EAO's website were reviewed for information regarding effects on wetlands and are included in Table 12.11-1.

#### *21.11.2.2 Description of Potential Cumulative Effects*

The cumulative loss and alteration on wetland extent and function were assessed according to the pre-disturbance conditions as described in Section 12.11.3. The cumulative loss of wetland extent 803 ha (7.6%), when the Murray River Coal Project is included, this increases by 28.6 ha to 832 ha, which accounts for 7.9% of wetlands in the RSA. Alteration of wetland function is anticipated on 1,950 ha (18.6%; Table 21.11-3). Including the Project, this increases to 2,014 ha which accounts for 19.2% of all wetlands in the RSA. Alteration of function is primarily associated with roads and other linear features. In total, 2,846 ha or 27.1% of wetlands in the RSA will be affected by development through either loss or alteration.

**Table 21.11-3. Summary of Cumulative Loss and Alteration of Wetlands from Past, Present, and Reasonably Foreseeable Future Projects**

| Project Timeframe | Past / Present Contribution | | Murray River Coal Project Contribution | | Future Project Contribution | | Past, Present and Future Contribution Total (With the Project) | | Total Mapped in RSA |
|---|---|---|---|---|---|---|---|---|---|
| **Units** | **ha** | **%** | **ha** | **%** | **ha** | **%** | **ha** | **%** | **ha** |
| **Wetlands** | | | | | | | | | |
| Loss | 401.4 | 3.8% | 28.6 | 0.3 | 401.7 | 3.8 | 831.7 | 7.9% | |
| Alteration | 1,950.7 | 18.6% | 63.8 | 0.6 | 0 | 0 | 2,014.5 | 19.2% | |
| **Total Loss and Alteration** | **2,352.1** | **22.4** | **92.4** | **0.9** | **2,753.8** | **26.3** | **2,846.2** | **27.1%** | **10,488** |

*21.11.2.3 Mitigation Measures to Address Cumulative Effects on Wetlands*

Each past, present, and future project would have had or will have different mitigation and management for wetlands; however, it is assumed any present and future projects will take into consideration the goals and objectives outlined in the *Dawson Creek Land & Resource Management Plan (LRMP)*. It is also assumed that the following general mitigation measures will be common amongst any present and future projects or activities:

- avoid and minimize detrimental effects to wetlands through strategic planning;
- minimize all clearing dimensions during any construction activities;
- minimize soil degradation through best management practices for soil stripping, handling and stockpiling;
- minimize soil loss and degradation (i.e., compaction, erosion, and soil horizon mixing);
- avoid the introduction and spread of invasive plants;
- avoid and minimize detrimental effects to rare plants and lichens, including rare plant and lichen habitat;
- avoid and minimize loss or alteration of ecosystem functions due to clearing activities, dust deposition, fragmentation, edge effects, windthrow, and altered hydrology;
- ensure clearing activities are coordinated with other management plans; and
- avoid use of herbicide sprays near water in accordance with guidelines outlined in the Handbook for Pesticide Applicators and Dispensers.

Collaborative approaches to address cumulative effects to wetlands have been initiated through data sharing agreements between some proponents regionally. Further collaborative efforts with additional proponents, and to maximize the effectiveness of monitoring programs and other biodiversity initiatives should be pursued.

#### *21.11.2.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence*

The characterization of residual effects was completed by comparing predicted cumulative effects against thresholds, standards, trends, or objectives relevant to wetlands, as defined in Table 12.11-4. Residual cumulative effects on wetlands are expected due to historic activities, present and/or future planned activities within the CEA where residual effects persist. The cumulative residual effects remaining after the implementation of all mitigation measures and are summarized in Table 21.11-4.

The magnitude of cumulative residual effects is moderate as the total loss and alteration of wetland is 27.1% based on the pre-disturbance conditions (Table 12.11-2). This total does not account for residual effects that may occur due to future oil and gas exploration, road construction, other unforeseen projects or those lacking sufficient data to predict future effects. Residual cumulative effects on wetlands are close to exceeding the threshold for high magnitude and substantially changes from pre-disturbance conditions. The geographic extent of effects is considered regional. The duration of effects is considered long-term as most footprints will not be restored in the medium term. The frequency of effect is sporadic and most effects are considered reversible in the long term. Wetlands are relatively rare and unique ecosystems on the landscape and their ecological context is considered high. The probability of cumulative effects is high for most of the projects assessed and confidence is high. The cumulative effects of the proposed Project and the other projects assessed as part of the cumulative effects assessment are considered not significant (Table 21.11-4).

## 21.12 WILDLIFE

### 21.12.1 Summary of Project-specific Residual Effects on Wildlife

Table 21.12-1 summarizes the Project-related residual effects, mitigation strategies and significance on wildlife and wildlife habitat for the three wildlife VCs with residual effects: moose, fisher, and grizzly bear (Section 13.7). None of the residual effects were rated as being significant due to the Project (Section 13.9). Residual effects on wildlife were carried forward from the Project-specific assessment and are considered in combination with the residual effects of past, present, and future human actions in the wildlife cumulative effects assessment (Section 13.11) and summarized in following sections. The cumulative effects on wildlife are discussed in detail in Chapter 13.

### 21.12.2 Cumulative Effects Assessment Boundaries for Wildlife

#### *21.12.2.1 Spatial Boundaries*

The cumulative effects assessment spatial boundary for wildlife is the baseline RSA (Figure 13.11-1). The RSA encompasses the regional setting for the Project and implicitly considers ecological factors, such as height of land and other relevant regionally important projects. The RSA encompasses the area within which the Project effects to wildlife may interact with residual effects from other past, present of reasonably foreseeable future projects and activities and stretches an average of 25-30 km from the Project site.

**Table 21.11-4. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Wetlands**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Wetland extent loss and alteration of function | Moderate | Far future | Sporadic | Regional | Reversible long-term | High | Not Significant (moderate) | High | High |

**Table 21.12-1. Summary of Residual Effects, Mitigation, and Significance on Wildlife and Wildlife Habitat**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| **Habitat Loss and Alteration** | | | |
| Moose and Fisher | Construction and Operation | Maintain known and potential mineral licks in a natural state and ensure ungulates have access to them during the season when they are most used.<br>No destruction or disruption of areas that contain known wallows, particularly during the ungulate breeding season.<br>No destruction or disruption of active fisher or marten dens. | Not Significant (Minor) |
| **Disruption to Movement** | | | |
| Moose, Grizzly Bear, and Fisher | Construction and Operation | Since the Project access road (the Murray River FSR) crosses the forested area likely used as a movement corridor along the Murray River, wildlife will be given the right-of-way along access roads and the highway.<br>Enforcement of speed limits along on-site Project roads.<br>Avoid vegetation alteration in the block of forested area between the Project footprint and the Murray River such that it can be used as movement corridor by wildlife. | Not Significant (Minor) |

## 21.12.3 Cumulative Effects Assessment on Wildlife

### *21.12.3.1 Identification of Potential Cumulative Interactions*

Wildlife VCs and effects were scoped into the assessment in Section 13.6, and then assessed in Section 13.7 where each effect was evaluated for whether there would be a residual effect after standard mitigation and management activities. Residual effects are summarized in Section 13.8 and each residual effect is evaluated for their significance on VCs in Section 13.9 and summarized in Section 13.10. Residual effects were also carried forward to the cumulative effects assessment.

Two potential effects were identified with residual effects: 1) habitat loss and alteration for moose and fisher (as a proxy for furbearers), and 2) disruption of movement for moose, grizzly bear, and fisher. These residual effects are predicted because the Project is situated in low elevation valley-bottom habitat, which is preferred by moose and fisher, and because the Project occurs in the Murray River corridor, a movement corridor for wildlife species. Grizzly bear were also included as a VC with residual effects due to disruption of movement because their movements are sensitive to human disturbance and infrastructure.

A review of the interaction between potential residual effects of the Project and the residual effects of other projects and activities on wildlife and wildlife habitat VCs was conducted to determine the potential cumulative effects on the wildlife VCs of moose, grizzly bear and fisher (furbearers). A matrix identifying the potential cumulative effect interactions for wildlife VCs is provided in Table 13.11-1 (of Section 13.11) of various past, present and future projects (Figure 13.11-1).

If there is no spatial and temporal overlap between the residual effects of the Project and those of another human action, the project or activity was excluded from the assessment. Where there is spatial and temporal overlap, but no interaction is anticipated, the cell is marked with a grey box, and a rationale as to why no interaction is predicted is given in the table. If there is overlap, and an interaction is anticipated, the activity was included in the cumulative effects assessment.

Activities such as mining, road development and building communities have permanent or far-future effects on both the vegetation and the land structure in the RSA and were included in the assessment as habitat loss. Activities such as forestry and seismic lines alter vegetation communities and therefore habitat. These activities were therefore rated as altering habitats and included in the cumulative effects assessment.

A matrix identifying the potential cumulative effect interactions for wildlife VCs is provided in Table 21.12-2.

*21.12.3.2 Description of Potential Cumulative Effects*

Cumulative effects were evaluated for two residual effects on wildlife: 1) habitat loss (moose and fisher); and 2) disruption of movement (moose, grizzly bear and fisher). To evaluate cumulative effects on habitat loss, a vegetation map was first created that approximates the current vegetation community without disturbance from industrial activities. Habitat suitability models were then created for moose, grizzly bear and fisher using the same techniques as those for the baseline studies. These habitat maps model the habitat as it would occur today without industrial and other human activities.

For moose, late winter habitat was evaluated for both habitat loss and disruption of movement. Late winter habitat is critical and limiting for moose since snow restricts their movement to low elevation valley bottoms at this time. Spring habitat was evaluated for grizzly bear because bears preferentially use low elevation areas in spring and would therefore have the largest interaction with the Murray River Project during this period. Birthing season (winter) was used for fisher, since birthing habitat is the most restrictive and important season for fisher.

Habitat loss and alteration was evaluated by comparing the area of high-quality habitat lost and altered due to past, current, Murray River project and other projects compared to the amount of habitat in the RSA. Disruption of movement was evaluated by comparing the areas lost and altered for the same activities in the Murray River Resource Management Zone (MRRMZ) a corridor along the Murray River identified in the Dawson Creek LRMP.

Moose were evaluated for two potential cumulative effects – habitat loss and disruption of movement. To date, approximately 5% of late winter habitat has been removed, largely by infrastructure, roads and mining, and 3.5% has been altered, mostly by forestry and seismic lines. If all projects go ahead in the future, then approximately 6% of habitat will be lost and 7.3% will be altered, for a total of approximately 13% lost or altered. Approximately 5.7% and 5.2% have been lost and altered to date in the MMRMZ and this will increase to 9.8% and 14.2%, respectively, if all projects go ahead. As a consequence, both effects were rated as cumulative residual effects on moose.

**Table 21.12-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wildlife and Wildlife Habitat**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effect | Comments |
|---|---|---|---|---|---|---|
| Past | Historical | Hasler Coal Mine | 1941 - 1945 | Hasler Creek Coal Company | - | No spatial overlap with the RSA |
| | | Sukunka (Bullmoose) Mine | 1972 – 1975 | BP Exploration Canada Ltd. | - | No spatial overlap with the RSA |
| | Recent | Bullmoose Mine | 1983 – 2003 | Teck Corporation | M | Small area of spatial overlap with the RSA |
| | | Dillon Coal Mine | 2004 – 2007 | Walter Energy / Western Coal | - | No spatial overlap with the RSA |
| | | Quintette (Babcock) Mine | 1983 - 2000 | Teck Corporation | M | Adjacent to the Murray River Project, across the river |
| | | Quintette (MESA Pit) Mine | 1983 - 2000 | Teck Corporation | M | Adjacent to the Murray River Project, across the river |
| | | Willow Creek Mine | 2000 - 2013 | Walter Energy | - | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | L | |
| | | Roads/Gravel Pits | | | M | |
| | | Oil and Gas Footprints | | | M | |
| | | Oil and Gas Seismic Lines | | | L | |
| Present | | Brule Mine | 2005 - 2016 | Walter Energy | - | No spatial overlap with the RSA |
| | | Trend Mine | 2003 - 2016 | Peace River Coal | M | |
| | | Quality Wind Project | 2013 - unknown | Capital Power | L | |
| | | Peace Canyon Dam | 1980 – unknown | BC Hydro | - | No spatial overlap with the RSA |

*(continued)*

**Table 21.12-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wildlife and Wildlife Habitat (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effect | Comments |
|---|---|---|---|---|---|---|
| Present (*cont'd*) | | Wolverine Mine (Perry Creek) and EB Pit | 2004 - 2016 | Walter Energy | M | |
| | | WAC Bennett Dam | 1961 – unknown | BC Hydro | - | No spatial overlap with the RSA |
| | | Major Forest Licensees | | | L | |
| | | Roads/ Oil and Gas Footprints | | | M | |
| | | Seismic Lines | | | L | |
| | | Community of Tumbler Ridge | | | M | |
| | | Tumbler Ridge Community Forest | | | L | |
| Future | Certain | Hermann Mine | 2014 - 2025 | Walter Energy | M | |
| | | Quintette Mine | 2013 - 2025 | Teck Corporation | M | |
| | | Roman Mine Project | 2013 - 2024 | Peace River Coal | M | |
| | | Thunder Mountain Wind Park | 2014 – unknown | Aeolis Wind | L | |
| | | Tumbler Ridge Wind Project | 2013 - unknown | Pattern Energy Group | L | |
| | | Wartenbe Wind Project | 2014 - unknown | Avro Wind Energy Inc. | - | No spatial overlap with the RSA |

*(continued)*

**Table 21.12-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wildlife and Wildlife Habitat (continued)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effect | Comments |
|---|---|---|---|---|---|---|
| Future (*cont'd*) | Certain (*cont'd*) | Major Forest Licensees | | | L | |
| | | Roads | | | M | |
| | | Oil and Gas Footprints | | | M | |
| | | Oil and Gas Sesimic Lines | | | M | |
| | | Tumbler Ridge Community Forest | | | L | |
| | Reasonably Foreseeable | Echo Hill Mine | 2015 - 2029 | Hillsborough Resources Ltd. | - | No spatial overlap with the RSA |
| | | Coastal Gaslink Project | 2015 – 2048 | TransCanada Pipelines | - | No spatial overlap with the RSA |
| | | Horizon Mine | 2015 - 2038 | Peace River Coal | M | |
| | | Meikle Wind Energy Project | 2015 – 2041 | Meikle Wind Energy Partnership | - | No spatial overlap with the RSA |
| | | Northern Gateway Pipeline | 2016 – 2068 | Enbridge Northern Gateway Pipelines | M | |
| | | Rocky Creek Energy Project | 2015 – unknown | Rupert Peace Power Corporation | - | No spatial overlap with the RSA |
| | | Site C Clean Energy Project | 2015 – unknown | BC Hydro | - | No spatial overlap with the RSA |
| | | Sukunka Coal Mine Project | 2015 – 2038 | Glencore | - | No spatial overlap with the RSA |
| | | Sundance Wind Project | 2015 - unknown | EDF Energies Nouvelles | - | No spatial overlap with the RSA |
| | | Wildmare Wind Energy Project | 2015 – unknown | Pattern Energy Group | - | No spatial overlap with the RSA |

*(continued)*

**Table 21.12-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Wildlife and Wildlife Habitat (completed)**

| Timeframe | | Name of Action | Dates Active | Proponent (if applicable) | Potential Cumulative Effect | Comments |
|---|---|---|---|---|---|---|
| Future (*cont'd*) | Hypothetical | Babcock Creek Wind Project | Unknown | Babcock Ridge Wind Limited Partnership | L | |
| | | Belcourt Saxon Coal Project | Unknown | Xstrata Coal Canada Ltd. | - | No spatial overlap with the RSA |
| | | Huguenot Mine | Unknown | Colonial Coal International | - | No spatial overlap with the RSA |
| | | Moose Lake Wind Power | Unknown | Moose Lake Wind Power Corporation | - | No spatial overlap with the RSA |
| | | Septimus Creek Wind Power Project | Unknown | Zero Emission Energy Developments | - | No spatial overlap with the RSA |
| | | Suska Mine | Unknown | Xstrata Coal Canada Ltd. | - | No spatial overlap with the RSA |
| | | Wapiti River Coal Project | Unknown | Canadian Dehua International Mines Group Inc. | M | Small area of spatial overlap with the RSA |

*Notes:*

- *No spatial or temporal overlap.*

*O* *No interaction anticipated.*

*L* *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*

*M* *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*

*H* *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

Grizzly bear were evaluated for one potential cumulative effect - disruption of movement in the MRRMZ. Grizzly bear preferentially use low elevation areas in the spring, such as the Murray River valley – of which 11.2% of high-quality habitat has been lost and 34% has been altered for forestry in the MRRMZ to date. If all projects go ahead, this will result in 17% lost and 42% altered. Grizzly bears typically avoid human activities and fragmented habitats, and may have their movement disrupted in the Murray River valley as a consequence. This effect was therefore rated as a residual cumulative effect.

Fisher, as a proxy for furbearers, was evaluated for two potential effects – habitat loss and alteration and disruption of movement. The high-quality habitat areas lost and altered in the RSA are currently 4.3% and 4.8%, respectively, and will rise to 5.5% and 7.6% if all projects proceed. Habitat loss and alteration in the MRRMZ is currently 5.7% and 4.2%, respectively, and will rise to 9% and 9.7% if all projects go ahead. Fisher are sensitive to habitat fragmentation and alteration, but have some ability to adjust to relatively low levels of disturbance, as appears to be the case in the RSA and MRRMZ. In addition, the types of habitat used by fisher during the birthing (winter) season is more extensive than moose winter habitat and they are less likely to affected by developments in their range. Fisher also do not undergo large-scale seasonal movements in the same way that moose do, and are more restricted to a home range and therefore not as susceptible to disruption of movement. Hence, neither habitat loss and alteration, nor disruption of movement was evaluated as residual effects for fisher.

#### *21.12.3.3 Mitigation Measures for Cumulative Effects on Moose and Grizzly Bear*

The Wildlife Mitigation and Management Plan (Section 24.12) describe the mitigation and management activities that are designed to reduce or eliminate potential effects to wildlife due to the Project. Mitigation measures specific to moose and grizzly bear are described in the following sections. It is assumed that other current and future projects will be using similar mitigation measures for moose and grizzly bears, which are industry-standard best practices.

Mitigation for Habitat Loss and Alteration

Mitigation for direct habitat loss and alteration on moose and/or grizzly bears will include, but is not limited to:

- avoidance of important habitat where practical alternatives are available (e.g., habitat loss and alteration was minimized through Project design);
- maintain known and potential mineral licks in a natural state and ensure ungulates have access to them during the season when they are most used;
- no destruction or disruption of areas that contain known wallows, particularly during the ungulate breeding season during site clearing in the construction phase and during Construction and Operation; and
- re-vegetation of some reclaimed components during Decommissioning and Reclamation.

Mitigation for Disruption of Movement

The effects of disruption to movement on all wildlife will be minimized through mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Section 24.12). The effect of disruption of

movement will largely be mitigated by the same mitigation measures for habitat loss (Section 13.7.10.1) and sensory disturbance (Section 13.7.10.2). Additional mitigation measures for the disruption of movements for grizzly bears and moose will include but are not limited to maintaining a 1 km buffer along the Murray River wherever possible (500 m to other side of the river).

#### *21.12.3.4 Characterization of Residual Cumulative Effects for Habitat Loss and Alteration on Moose*

Past and present developments in the RSA have resulted in the loss and alteration of 4.9% and 3.5% of moose habitat, respectively. The Murray River project is located at low elevation, in moose winter and will remove and alter an additional 0.2% and 0.7% of late winter habitat. Additional future projects will remove and alter an additional 0.9% and 3.1% of moose late winter habitat. The majority of future effects are due to, in decreasing order: wind power projects, oil and gas, and mining.

Approximately 540 ha (32%) of the area affected has been due to forestry operations, which produce good quality habitat for moose. Future forestry operations are difficult to predict, but will likely continue as a similar proportion of the total development in the RSA. This would result in a future scenario where approximately 1/3 of development may be increasing the quality of moose habitat (Yukon Department of Renewable Resources 1996; Serrouya and D'Eon 2002). This may be higher, if the right of way for future oil and gas pipelines is considered. The total area of habitat removed due to all past, present and future activities is 1,178 ha of winter habitat, or 5.9% of the high quality habitat in the RSA. Assuming a moose density of 0.003 moose/ha, this area is equivalent to the home ranges of 3.5 moose.

The magnitude was rated as minor due to a relatively small amount of cumulative habitat loss and the fact that several forms of habitat alteration are beneficial to the moose population. The definition for minor magnitude in the assessment is: "differs from the average value for baseline conditions to a small degree (e.g., within the range of natural variation of the local population and well below a guideline or threshold value)."

The extent of the effect is landscape, as it is limited to the RSA. The duration is far future, because not all habitat will be reclaimed and it will take several decades for effective habitat to be produced in reclaimed areas. The frequency of the events leading to habitat loss (i.e., vegetation clearing) is sporadic.

The effect is reversible as both forestry and most mining operations are suitable for reclamation post-closure. The resiliency of the moose population to disturbed and fragmented habitat is relatively high. The moose population in WMU 7-21 was stable between 1993 and 2006 (Rowe 2006); however, the population has not been surveyed since 2006 and the current status is unknown. The ecological context of the moose population is neutral – moose are common throughout BC, but some populations in BC are known to be in decline.

Due to this minor rating for the magnitude of habitat removal and alteration, the cumulative effect of habitat loss and alteration for moose is assessed as **not significant (minor)**.

The probability of the effect occurring is high for the loss of habitat in the RSA – most of the habitat loss and alteration has already occurred. The confidence in the significance rating is medium due to uncertainty in predicting future development scenarios. There is also uncertainty in the current moose population status.

### *21.12.3.5 Characterization of Residual Cumulative Effects for Alteration of Movement on Moose*

The distribution of infrastructure along Murray River due to mining and forestry operations was evaluated as a residual cumulative effect on the disruption of movement of moose north and south through the Murray River corridor. The Wolverine River corridor will be relatively unaffected by the Project, with the exception of rail traffic twice a day. The combination of all past, present and future activities on the MRRMZ will result in the removal of 9.8% (155 ha) of winter habitat and the further alteration of an additional 14.2% (224 ha) of habitat. Altered habitat includes forestry operations, the subsidence zone of the Murray River Project and cleared pipeline rights of way. These areas are generally not considered impediments to moose movement. After mitigation, the residual effect of disruption of moose movements is expected to have a minor magnitude. The extent of this effect will be at the landscape scale because moose north and south of the Project area may be affected as they travel along the Murray River corridor.

The duration will be far future because it will take several decades for reclaimed areas from several Projects to recover into useful moose habitat that will facilitate movement. The frequency will be sporadic, as movements by moose may only be disrupted when moose are travelling through this developed portion of the Murray River. The effect will be reversible long term because of reclamation activities of development areas along the Murray River. The resiliency of the moose population to disturbed and fragmented habitat is relatively high. The ecological context of the moose population is neutral – moose are common throughout BC, but some populations in BC are known to be in decline. The cumulative effect of disruption of moose movement is assessed as **not significant (minor)**.

The likelihood that the cumulative effects of the Projects will reduce movements of moose along the river is medium – moose are known to avoid crossing open areas with human activity. The confidence that moose are using the Murray River as a movement corridor is moderate because it is a good assumption that these valleys are movement corridors for moose.

### *21.12.3.6 Characterization of Residual Cumulative Effects for Alteration of Movement on Grizzly Bear*

Roads and infrastructure may act as barriers to grizzly bear movements, reducing connectivity between seasonal habitats. Grizzly bears frequently alter their behaviour and avoid areas with human activity (such as high-use roads) and periods when humans are most active (Mueller 2001). Bears use a variety of habitats for movement, from riparian in the spring to alpine in the summer and fall. Since grizzly bear are more sensitive to human presence than other wildlife VCs, the potential for the all the Projects to disrupt movement of bears along the Murray River was rated as a cumulative residual effect. Currently, 11.2% of grizzly bear spring habitat has been lost in the MRRMZ, largely due to transportation corridors and 34.3% has been altered, largely by forestry. The addition of the Murray River project would remove an additional 2.3% and alter an additional 1.2% of spring habitat for grizzly bears in the MRRMZ. Additional future projects, largely oil and gas, may cause the loss and alteration of an additional 3.4% and 6.7% of spring habitat for a total of 17% lost and 42% altered. Note that the altered habitat is largely forestry cutblocks and pipeline rights of way, which grizzly bears may use to forage or movements (Nielsen et al. 2004). Due to the relatively high proportion of habitat lost and altered in the MRRMZ, the magnitude of the effect is rated as medium.

This effect is mitigated, to some degree, by the movement habits of grizzly bears. Bears have very large home ranges and move across the landscape continuously and have a variety of habitats that they use for movement, including riparian, mid elevation and alpine. The effect was evaluated for the spring, when grizzly bears preferentially use low elevation habitats (where the Murray River Project is located) but they also use mid and high elevation habitats for movement. It is not expected that this effect will have local or regional population-scale effects.

The geographic extent of this effect will be landscape because the effect will be tied to the population of bears in the RSA. The duration will be far-future.

The frequency will be sporadic as grizzly bears encounter facilities and altered habitat in the MRRMZ. The effect will be reversible in the long term once the projects end. Bears may temporarily avoid habitats where there is a barrier to their movement, but are expected to re-occupy the habitat once the disturbance is removed. The resiliency of grizzly bear populations to anthropogenic effects are generally considered to be low. Grizzly bears have low reproductive rates and are known to avoid human activity and so have population-level effects in anthropogenically-modified landscapes. The context is neutral for grizzly bears due to uncertainty regarding the status of the grizzly bear population in this region, but suitable habitat in the RSA is abundant.

The cumulative effect of disruption to grizzly bear movement is assessed as **not significant (moderate).**

The likelihood of this effect occurring is high for the MRRMZ. The confidence is medium because no data exist on how often, and to what degree grizzly bears rely on using the MRRMZ as a movement corridor.

Table 21.12-3 and Table 21.12-4 summarize the residual effects on moose and grizzly bear, respectively identified in Section 21.12.1. These residual effects are then evaluated for significance in Sections 21.12.4 through 6.

## 21.13 ECONOMIC

Table 21.13-1 summarizes the Project-related residual effects, mitigation strategies and significance for economics. Two Project-related residuals effects were identified in the assessment of the effects on economics. The residual effects on economics include a decrease in employment and income at Decommissioning and Reclamation and an increase in competition for labour and wage during Construction and Operation. Both of these effects are considered not significant.

The residual Project effect, *Increased Competition for Labour and Wage Inflation*, was carried forward from the Project-specific assessment and was considered in combination with the residual effects of other past, present, and future human actions. The residual effect of a decrease in employment and income at Decommissioning and Reclamation is not expected to interact cumulatively with the effects of other projects or human actions and, thus, is not discussed further. The cumulative effects on economic VCs are discussed in detail in Chapter 14.

**Table 21.12-3. Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Moose**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Habitat Loss and Alteration | Minor | Far Future | Sporadic | Landscape | Reversible Long-term | High | Not Significant (minor) | High | Medium |
| Disruption of Movement | Minor | Far Future | Sporadic | Landscape | Reversible Long-term | High | Not Significant (minor) | Medium | Medium |

**Table 21.12-4. Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Grizzly Bear**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Disruption of Movement | Medium | Far Future | Sporadic | Landscape | Reversible Long-term | Low | Not Significant (moderate) | High | Medium |

**Table 21.13-1. Summary of Residual Effects, Mitigation, and Significance**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| **Employment and Income** | | | |
| Decrease in Employment and Income at Decommissioning and Reclamation | Decommissioning and Reclamation | Recruitment, Training and Employment Plan, Procurement Strategy, Workforce Transition Plan and continued engagement with First Nations and communities. | Not Significant |
| **Economic Activity** | | | |
| Increased Competition for Labour and Wage Inflation | Construction, Operation | Recruitment, Training and Employment Plan, Procurement Strategy, and continued engagement with First Nations and communities. | Not Significant |

## 21.13.1 Cumulative Effects Assessment Boundaries for Economics

### *21.13.1.1 Spatial Boundaries*

The spatial boundary for the assessment of cumulative effects on economics is the Peace River Regional District (PRRD). The PRRD was selected as an appropriate boundary for the assessment of effects on economics because it reflects the spatial extent of the regional labour market and economic activities that may be affected by the Project in combination with other human actions. The following communities reside within the PRRD:

- District of Tumbler Ridge;
- City of Dawson Creek;
- District of Chetwynd;
- City of Fort St. John;
- West Moberly Lake IR 168A (WMFN);
- East Moberly Lake IR 169 (SFN); and
- McLeod Lake IR 1 (MLIB).

## 21.13.2 Cumulative Effects Assessment on Economics

### *21.13.2.1 Identification of Potential Cumulative Interactions*

Several present and future (certain and foreseeable) developments are expected to have a spatial and temporal overlap with the residual effects of the Project (Table 14.11-1). A matrix identifying the potential cumulative effect interactions for economic VCs is provided in Table 21.13-2.

The present coal mines include the Brule Mine, the Trend Mine and the Wolverine-Perry Creek Mine (Table 14.11-1). The Brue Mine is a surface (open pit) metallurgical coal mine in Northeast British Columbia coalfields; the mine employs 416 people. The Trend Mine is an open pit coal mine located

approximately 25 km south of Tumbler Ridge; an estimated 350 people are employed at the mine. Similarly, the Wolverine-Perry Creek mine in an open pit coal mine that employed 477 people. All three mines were expected to be in operation until 2016; however, on April 15, 2014 Walter Energy announced the idling of the Wolverine Coal Mine and the Brue Mine (Carter 2014). The Brule Mine will continue to operate past July 2014, the initial shut down date (Carter 2014). Consequently, it is unlikely that the mines will compete for labour with the Murray River Coal Project (Table 14.11-1). It would be rather expected that workers with transferable skills will seek employment at the Murray River Coal Project; this will work to reduce the cumulative competition for skilled workers and reduce inflationary pressures on wages. There is no cumulative interaction on the effect of the *Decrease in Employment and Income at Decommissioning and Reclamation* as the identified mines will close before Operation of the Project commences.

The Hermann, EB Pit, Quintette and Roman Mine projects are all coal mines in the economic RSA that are certain to be in operation in the future (Table 14.11-1). The Hermann Mine will be an open pit mine expected to be in operation for ten years (2014 to 2025) with 43 to 94 workers during the operation phase. The EB Pit is a proposed expansion of the Wolverine Mine. The Quintette Mine is a proposed expansion to the former Quintette Mine, expected to be in operation until 2025 with a workforce of 565 people. Finally, the Roman Mine will also be an open pit mine in operation until 2024, employing 100 workers – a total of 450 when combined with the Trend Mine. Given the projected construction timelines, these mines are expected to be constructed before the Construction phase of the Murray River Coal Project. Therefore, the mines are unlikely to compete for construction labour or services assuming that the predicted timelines hold. Further, their operation will cease years before Decommissioning and Reclamation of the Murray River Coal Project. Consequently, the mines are not expected to cumulatively contribute to the effect of a *Decrease in Employment and Income at Decommissioning and Reclamation*.

The Hermann, EB Pit, Quintette and Roman projects are expected to contribute to the change in the demand for skilled labour that can also result in potential wage inflation pressures. This effect of *Increased Competition for Labour and Wage Inflation* is expected to be moderate as the skillset required for the Hermann, EB Pit, Quintette and Roman Mine projects is mostly associated with surface mining. The Murray River Project, that is an underground mine, will offer surface positions as well (coal washing plant, rail loadout, and maintenance); however, as only 140 of the 764 Project-related positions are expected to be on the surface, there will be a limited number of opportunities. The effect of the *Increased Competition for Labour and Wage Inflation* is further expected to be felt in the mining sector as well as in other industries. As described in Section 14.7.3, skilled workers may leave their current employment in hopes of obtaining higher wages associated with Project-related opportunities. This may further lead to wage inflation pressures as employers in other industries increase wages to retain skilled workers in order to compete for local labour with the mining sector.

Eco Hill Mine, Sukunka Coal Mine, and the Horizon Mine are the only reasonably foreseeable future mines considered in the CEA because of the potential to interact with the Project. Eco Hill Mine will be a coal mine located 44 km north of Tumbler Ridge. Coal will be extracted by a combination of contour and highwall auger mining with progressing reclamation. The mine is estimated to be in operation from ten to 14 years, projected to employ 80 workers.

**Table 21.13-2. Screening for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Employment and Income and Economic Activity**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| Decrease in Employment and Income at Decommissioning and Reclamation | - | - | - | - | - | - | O | O | O | O | O | O | O | O | O | O | O | O |
| Increased Competition for Labour and Wage Inflation | - | - | - | - | - | - | L | L | O | O | M | O | M | M | M | O | O | O |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | Hypothetical | | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| Decrease in Employment and Income at Decommissioning and Reclamation | O | L | O | O | O | O | O | O | O | O | O | O | O | O | O | O | O | O |
| Increased Competition for Labour and Wage Inflation | M | O | M | O | O | O | O | M | O | O | O | M | M | O | O | M | M | |

*Notes:*

| | |
|---|---|
| *(-)* | *No spatial or temporal overlap.* |
| O | *Spatial and temporal overlap, but no interaction is anticipated, no further consideration warranted.* |
| L | *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.* |
| M | *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.* |
| H | *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.* |

The Sukunka Coal Mine will be an integrated surface and underground mining operation located 55 km south of Chetwynd with a lifespan of 20 years; the mine will employ up to 700 workers during operation. Horizon Mine, located about 20 km southeast of the Project, will be an open pit mine with a lifespan of 20 years; the mine is expected to require 200 workers during operation. The construction of the Echo Hill Mine may overlap with the construction of the Murray River Coal Mine. However, given the projected timelines, the mines will cease operations years before the Decommissioning and Reclamation phase of the Murray River Coal Project (Table 14.11-1). Consequently, although the mines will not cumulatively interact with the effect of the *Decrease in Employment and Income at Decommissioning and Reclamation*, they may contribute to the demand for skilled workers in the region. Thus, there is the potential for contributing to an adverse cumulative effect on *Increased Competition for Labour and Wage Inflation*.

The Belcourt Saxon Coal Project (open pit coal mine), the Huguenot Mine (open pit coal mine), the Suska Mine (open cut coal mine) and the Wapiti River Coal Project (underground coal mine) are also expected to be in the proximity to the Murray River Coal Project; however, as the projects are not yet in the application phase, little is known of the planned construction or operation phases and workforce requirements (Table 14.11-1). It would be expected, however, that if the projects were to take place, there could be some change in the demand for skilled labour, both in the mining sector and in other industries. For this reason it is speculated that there is the potential for a moderate adverse cumulative effect on *Increased Competition for Labour and Wage Inflation* associated with these hypothetical projects.

Finally, the Coastal Gaslink Project is a proposed 650 km long natural gas pipeline running from near Dawson Creek in northeastern BC to the proposed LNG Canada export facility near Kitimat. The project is expected to have a lifespan of 30 years with a workforce of 15 to 20 people. Due to the nature of the project and the skillset required it is not expected that the project will cumulatively contribute to the competition for skilled labour. However, as the closure of the project is expected to coincide with Decommissioning and Reclamation of the Murray River Coal Project, the Coastal Gaslink project may cumulatively contribute to the effect of the *Decrease in Employment and Income at Decommissioning and Reclamation*. The small workforce projected for the Coastal Gaslink Project will, however, make this effect negligible to minor.

Due to the very different nature of the required construction and operation activities, all other energy projects (dams, wind energy projects, and other energy projects; identified in the Assessment Methodology, Chapter 5) are not expected to cumulatively interact with the adverse economic effects of the Murray River Coal Project. The Project could contribute to the increased demand for services but this effect will overall be beneficial as it will promote business growth and development in the region.

#### *21.13.2.2 Description of Potential Cumulative Effects*

The Hermann, EB Pit, Quintette, Roman, Eco Hill, Sukunka Mine and the Horizon Mine projects as well as the potential developments of the Belcourt Saxon Coal Project, the Hugeuenot Mine, the Suska Mine and the Wapiti River Coal Project are expected to interact cumulatively with the Murray River Coal Project on the effect of *Increased Competition for Labour and Wage Inflation*. Changes to the number of workers and skills necessary to complete activities at various projects in the region may result in

increased competition for labour and wage inflation within the mining sector and in other industries. Further, changes in wage expectation in the available labour market may impact the ability of local businesses and service providers to attract and retain workers. Consequently, the effect of *Increased Competition for Labour and Wage Inflation* is expected to result in a residual cumulative effect. For the effect of *Decrease in Employment and Income at Decommissioning and Reclamation*, given the proposed timelines for projects in the region, no interaction or only negligible to minor interactions are expected. Consequently, the effect of the *Decrease in Employment and Income at Decommissioning and Reclamation* is not anticipated to be a residual cumulative effect; no further mitigation measures are recommended and the effect is not carried forward for further assessment. No other interactions of the Murray River Coal Project with other projects in the region are expected.

#### *21.13.2.3 Mitigation Measures to Address Cumulative Effects on Economics*

Mitigation measures for the residual cumulative effect of the *Increased Competition for Labour and Wage Inflation* are described in Section 14.7.4. The mitigation measures comprise several actions as defined by:

- the Recruitment, Training and Employment Plan;
- the Procurement Strategy; and
- continued engagement with First Nations and local communities.

There are no specific mitigation or management measures expected from other projects or activities to address the availability of skilled labour and wage inflation; however, it is expected that other large resource development projects would adopt similar mitigation and management measures to address the labour and skill requirements for existing and future projects.

Despite the implemented mitigation measures, it is expected that the development of the Murray River Coal Project, and its cumulative interaction with other future projects, may result in competition for labour and wage inflation. Consequently, a residual cumulative effect of *Increased Competition for Labour and Wage Inflation* is expected.

#### *21.13.2.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence*

The adverse residual effect of the Project on the economic environment is assessed as being moderate in magnitude as the development of other future projects is expected to increase regional demand for workers substantially above baseline conditions but it is not historically unprecedented (Table 21.13-3). The effect is assessed as short- to medium-term in duration (the expected temporal overlap of the cumulative interaction is less than 50 years), regional in geographic extent (extending across the PRRD), and reversible in the short term (removal of project employment demands results in a near immediate removal of the effect). Both residual effects are rated not significant. There is a high level of probability and confidence in the effect of *Decrease in Employment and Income at Decommissioning and Reclamation*. The probability of effects is medium and the confidence in the effect of *Increased Competition for Labour and Wage Inflation* is medium.

**Table 21.13-3. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Economics**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| Increased Competition for Labour and Wage Inflation | Moderate | Medium-term | Continuous | Regional | Reversible Short-term | Neutral | Not Significant (moderate) | Medium | Medium |

## 21.14 SOCIAL

Table 21.14-1 summarizes the Project-related residual effects, mitigation strategies and significance on social. The residual effects assessment identified two residual effects for one VC. Project hiring will result in residual effects for childcare services, including reduced access to childcare services and reduced quality of childcare services rendered. Given the size and nature of residual effects, as assessed above, both residual effects on childcare services are not significant (minor). All three residual effects are brought forward into the cumulative effects assessment below. The cumulative effects on Social VCs are discussed in detail in Chapter 15.

**Table 21.14-1. Summary of Social Residual Effects, Mitigation, and Significance for Childcare Services**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| LSA community members will have reduced access to child care services | Construction, Operation | The Proponent will share information about its projected workforce needs with elected officials and childcare service providers. | Not significant (minor) |
| Children in child care facilities will experience decreased quality of child care services | Construction, Operation | | Not significant (minor) |

### 21.14.1 Cumulative Effects Assessment Boundaries for Social

#### *21.14.1.1 Spatial Boundaries*

Spatial boundaries for the CEA are identical with the LSA defined for the effects assessment. While in principle social effects may interact with other human actions to create cumulative effects on a regional scale, the residual effects resulting from the effects assessment will be experienced at a community level.

The spatial boundary for the Social CEA includes communities that could experience effects of the Murray River Coal Project in relation to past, present, or future human actions.

Tumbler Ridge is likely to experience social effects as it will house Project employees. Chetwynd is within commuting distance to the Project, so may also experience local effects.

Dawson Creek and Fort St. John are excluded from the LSA. While these communities may experience a degree of population growth due to indirect and induced employment, this growth is expected to be a small percentage of their existing population.

West Moberly First Nations and Saulteau First Nations communities are also within commuting distance to the Project, and also rely on Chetwynd for social services. Consequently, these two Aboriginal communities are included in the LSA.

Aboriginal groups other than West Moberly First Nations and Saulteau First Nation are excluded from the LSA as they are located too far away from the Project to experience employment effects and related population effects.

The list of LSA communities includes:

- District of Tumbler Ridge;
- District of Chetwynd;
- West Moberly First Nations; and
- Saulteau First Nations.

### 21.14.2 Cumulative Effects Assessment on Social

#### *21.14.2.1 Identification of Potential Cumulative Interactions on Social*

Human actions considered in the CEA are presented in Table 21.14-2. There is no potential for the Project to create cumulative effects to access to childcare services and quality of childcare services with other projects that do not or will not have a workforce in LSA communities. Projects with current or future workforces outside of LSA communities include: Peace Canyon Dam, WAC Bennett Dam, Coastal Gaslink Project, Northern Gateway Pipeline, and Site C Clean Energy Project. Project residual effects are not likely to interact with any past projects as the effects are not expected to continue beyond project closure.

**Table 21.14-2. List of Human Actions Considered in the Murray River CEA for Social**

| INDUSTRIAL PROJECTS | | | | |
|---|---|---|---|---|
| **Timeframe** | | **Name of Action** | **Dates Active** | **Proponent (if applicable)** |
| **Past** | **Historic** | Hasler Coal Mine | 1941 - 1945 | Hasler Creek Coal Company |
| | | Sukunka (Bullmoose) Mine | 1972 – 1975 | BP Exploration Canada Ltd. |
| | **Recent** | Bullmoose Mine | 1983 – 2003 | Teck Corporation |
| | | Dillon Coal Mine | 2004 – 2007 | Walter Energy / Western Coal |
| | | Quintette (Babcock) Mine | 1983 - 2000 | Teck Corporation |
| | | Willow Creek Mine | 2000 - 2013 | Walter Energy |
| **Present** | | Brule Mine | 2005 - 2016 | Walter Energy |
| | | Trend Mine | 2003 - 2016 | Peace River Coal |
| | | Quality Wind Project | 2013 - unknown | Capital Power |
| | | Peace Canyon Dam | 1980 – unknown | BC Hydro |
| | | Wolverine Mine (Perry Creek) and EB Pit | 2004 - 2016 | Walter Energy |
| | | WAC Bennett Dam | 1961 – unknown | BC Hydro |
| **Future** | **Certain** | Hermann Mine | 2014 - 2025 | Walter Energy |
| | | Quintette Mine | 2013 - 2025 | Teck Corporation |
| | | Roman Mine Project | 2013 - 2024 | Peace River Coal |
| | | Thunder Mountain Wind Park | 2014 – unknown | Aeolis Wind |
| | | Tumbler Ridge Wind Project | 2013 - unknown | Pattern Energy Group |
| | | Wartenbe Wind Project | 2014 - unknown | Avro Wind Energy Inc. |

*(continued)*

**Table 21.14-2. List of Human Actions Considered in the Murray River CEA for Social (completed)**

| INDUSTRIAL PROJECTS | | | | |
|---|---|---|---|---|
| **Timeframe** | | **Name of Action** | **Dates Active** | **Proponent (if applicable)** |
| **Future (*cont'd*)** | **Reasonably Foreseeable** | Echo Hill Mine | 2015 - 2029 | Hillsborough Resources Ltd. |
| | | Coastal Gaslink Project | 2015 – 2048 | TransCanada Pipelines |
| | | Horizon Mine | 2015 - 2038 | Peace River Coal |
| | | Meikle Wind Energy Project | 2015 – 2041 | Meikle Wind Energy Partnership |
| | | Northern Gateway Pipeline | 2016 – 2068 | Enbridge Northern Gateway Pipelines |
| | | Rocky Creek Energy Project | 2015 – unknown | Rupert Peace Power Corporation |
| | | Site C Clean Energy Project | 2015 – unknown | BC Hydro |
| | | Sukunka Coal Mine Project | 2015 – 2038 | Glencore |
| | | Sundance Wind Project | 2015 - unknown | EDF Energies Nouvelles |
| | | Wildmare Wind Energy Project | 2015 – unknown | Pattern Energy Group |
| | **Hypothetical** | Babcock Creek Wind Project | Unknown | Babcock Ridge Wind Limited Partnership |
| | | Belcourt Saxon Coal Project | Unknown | Xstrata Coal Canada Ltd. |
| | | Huguenot Mine | Unknown | Colonial Coal International |
| | | Moose Lake Wind Power | Unknown | Moose Lake Wind Power Corporation |
| | | Septimus Creek Wind Power Project | Unknown | Zero Emission Energy Developments |
| | | Suska Mine | Unknown | Xstrata Coal Canada Ltd. |
| | | Wapiti River Coal Project | Unknown | Canadian Dehua International Mines Group Inc. |
| **OTHER LAND USE ACTIVITIES** | | | | |

- Aboriginal harvest (fish, animals, and plants)
- Agriculture and range
- Forestry and manufacturing
- Industrial roads
- Coal and mineral exploration
- Oil and gas drilling and exploration
- Other fishing and trapping (commercial and recreational)
- Recreation and tourism
- Transportation (road and rail access and traffic)

### *21.14.2.2 Description of Potential Cumulative Effects on Social*

Cumulative effects are expected to be negligible for projects having relatively small employment projections, including: three certain projects (Thunder Mountain Wind Park, Tumbler Ridge Wind Project, Wartenbe Wind Project); four reasonably foreseeable projects (Meikle Wind Energy Project, Rocky Creek Project, Sundance Wind Project, and Wildmare Wind Energy Project); and three hypothetical projects (including Babcock Creek Wind Projects, Moose Lake Wind Power, and Septimus Creek Wind Power Project).

The Project is expected to create moderate cumulative effects on access to and quality of childcare services in LSA communities due to interaction with one present project (Trend Mine), three certain future projects (Herman Mine, Quintette Mine, and Roman Mine Project), three reasonably foreseeable projects (Echo Hill Mine, Horizon Mine, and Sukunka Coal Mine Project), and four hypothetical projects (Belcourt Saxon Coal Project, Huguenot Mine, Suska Mine, and Wapiti River Coal Project).

These projects are located close to LSA communities and require sizable workforces for construction and operations. Current and future projects hire local workers and induce population growth in the LSA communities, resulting in increased demands on childcare services. If childcare service capacity has not been increased in LSA communities by the time that future projects begin construction, the increased demand on childcare services produced by them will combine with the increased demand on childcare services produced by the Murray River Coal Project, resulting in a moderate cumulative effect during the life of the Murray River Coal Project. The cumulative effect is predicted to be moderate rather than major as LSA communities will be aware of increased childcare needs before projects commence and can plan to increase capacity. For example, a Tumbler Ridge District Council task force is currently assessing childcare needs and seeking options to increase capacity.

#### *21.14.2.3 Mitigation Measures to Address Cumulative Effects on Social*

In order to help LSA communities plan their childcare services, the Proponent will share information about its own projected workforce needs. Depending on the ability of LSA communities to increase childcare capacity to match projected future demand, there may be residual cumulative effects on access to and quality of childcare services. Table 15.11-3 describes these potential residual effects.

#### *21.14.2.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Social*

The Project has the potential to affect childcare in LSA communities. Project-related population growth and increased employment in these communities will increase demand on already limited childcare services, thereby reducing the ability of primary caregivers to secure childcare spaces for their children. Increased demand on childcare services could also reduce the quality of services rendered, as it will adversely impact the childcare giver-to-child ratio, which is a determinant of childcare outcomes. Moreover, LSA communities are aware of current childcare strains and are actively seeking to address them. Consequently, this assessment finds that residual effects of the Project on childcare access and quality will be not significant (minor).

This Project effect could interact with other current and planned projects that will increase population and employment in LSA communities to create cumulative effects on childcare access and quality. To address these potential effects, the Proponent will provide information about its projected workforce needs to elected officials and childcare services providers. This information will help communities to further plan for their childcare service needs. The residual cumulative effect of the Project on access to and quality of child care services will be not significant (minor; Table 21.14-3). The residual cumulative effect will be low in magnitude, given the Project's relatively small contribution to childcare demand in LSA communities. The effect would persist continuously throughout the life of the mine, but would be reversible upon closure. The effect would not extend beyond the LSA communities, so will be sub-regional in extent.

**Table 21.14-3. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood on Social**

| Residual Cumulative Effect | Effect Characterization | | | | | | Significance | Probability | Confidence |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | | |
| LSA community members may have reduced access to child care services | Minor | Medium-term | Continuous | Sub-regional | Reversible Short-term | Low | Not Significant (minor) | High | High |
| Children in child care facilities may experience decreased quality of child care services | Minor | Medium-term | Continuous | Sub-regional | Reversible Short-term | Neutral | Not Significant (minor) | Medium | Medium |

Given the low magnitude of potential cumulative effects on childcare access and quality, as well as its sub-regional extent and reversibility, the significance of these potential effects is assessed as not significant (minor).

## 21.15 NON-TRADITIONAL LAND USE

Table 21.15-1 summarizes the Project-related residual effects, mitigation strategies and significance for non-traditional land use VCs.

**Table 21.15-1. Summary of Residual Effects, Mitigation, and Significance on Non-traditional Land Use**

| Residual Effects | Project Phase(s) | Mitigation Measures | Significance |
|---|---|---|---|
| **Harvesting** | | | |
| Change in harvest locations for guide outfitters (licences 701254 and 701258) and traplines (TR0721T003 and T0R0721T005) due to a change in abundance and distribution of wildlife | Construction, Operation, Decommissioning and Reclamation | Wildlife Mitigation and Monitoring Plan, Noise Management Plan | Not significant (minor) |
| **Industrial Use** | | | |
| Economic impact on overlapping tenure holders | Operation, Decommissioning and Reclamation | Longwall exclusion zone, Subsidence Management Plan | Not significant (minor) |

One residual effect on harvesting is identified:

- Change to harvest locations for holders of guide outfitter licences 701254 and 701258 and holders of traplines TR0721T003 and TR0721T005 during the Construction, Operation, and Decommissioning and Reclamation phases of the Project due to a change in the abundance and distribution of wildlife harvested by these tenure holders.

One residual effect on industrial use was identified:

- Potential economic impacts on overlapping tenures due to damage to infrastructure from subsidence during the Operation and Decommissioning and Reclamation phases.

None of the residual effects were rated as being significant due to the Project. Residual effects on Non-traditional Land Use were carried forward from the Project-specific assessment and are considered in combination with the residual effects of past, present, and future human actions in the following sections. The cumulative effects on non-traditional land use VCs are discussed in detail in Chapter 16.

### 21.15.1 Cumulative Effects Assessment Boundaries for Non-traditional Land Use

#### *21.15.1.1 Spatial Boundaries*

The spatial boundary for the non-traditional land use CEA is based on the RSA used for the Project-specific land use effects assessment, and includes the total area of guide outfitter licences 701254 and

701258 and trap-line licences TR0721T003 and TR072T005 (Figure 16.11-1). The total area of the CEA Spatial Boundary is 445,780 ha.

## 21.15.2 Cumulative Effects Assessment on Non-traditional Land Use

### *21.15.2.1 Identification of Potential Cumulative Interactions on Non-traditional Land Use*

Table 21.15-2 summarizes the anticipated cumulative interactions of other past, present and future Projects and other land use activities with the Project, and the type of potential cumulative effect predicted. As shown by the cumulative interaction table, there are no other present or reasonably foreseeable future projects that are expected to produce subsidence from their operations. Therefore, no cumulative interactions between the Project and any other Projects are anticipated and, subsequently, no cumulative effects to industrial tenure holders due to damage to infrastructure are expected, and this will not be carried forward into the CEA.

### *21.15.2.2 Description of Potential Cumulative Effects on Non-traditional Land Use*

Cumulative Effects to Harvesting

Guide outfitters and trappers rely on resources provided by the wilderness environment in order to carry out their business. Development of the Project is expected to result in residual effects to wildlife populations of moose, grizzly bear, and fisher (as a proxy for furbearers) in the Wildlife RSA as a result of habitat loss and alteration and disruption of wildlife movement. This effect is relevant to guide outfitters licences 701254 and 701258 and trappers TR0721T003 and TR0721T005. No residual effects are predicted on direct mortality.

Habitat loss will occur in the Project footprint, while habitat alteration will occur in the cleared areas surrounding the Project and may occur in the subsidence zone. It is predicted that subsidence would have little effect on wildlife habitat, largely mediated by effects on hydrology and the drying or creation of wetland areas that are important for wildlife. It should be noted that the area evaluated for habitat loss includes the entire footprint, and was not reduced to account for reclamation at closure. This results in a conservative assessment of the Project effects.

Disruption of movement was evaluated by examining the habitat loss in the Murray River Resource Management Zone (MRRMZ), which defines the riparian area and a buffer surrounding the Murray River. Wildlife, particularly those species with a preference for low elevation habitat during some parts of the year, are likely using the MRRMZ as a movement corridor. The proportion of habitat lost to the Project and other human activities was used as a metric for determining disruption of movement. Other present and foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively on wildlife, resulting in a nibbling loss of habitat and additive disruption of movement in the RSA. The number of project interactions with each guide outfitter and trapline licence have the potential to cumulatively impact the overall use of these tenures. For example, guide outfitting licence 701254, which overlaps nine past, present and future projects, in addition to the Murray River Project, may be more likely to experience cumulative effects compared guide outfitting licence 701258, which overlaps four additional projects. However, the magnitude of the cumulative effect may be influenced by the size of the guide outfitter or trapline licence and the cumulative residual effects on habitat of harvested wildlife species.

**Table 21.15-2. Screening for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Non-Traditional Land Use**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| Change ito harvest locations due to a change in the abundance and distribution of wildlife harvested by guide outfitter licences 701254 and 701258 and trappers TR0721T003 and TR0721T005. | O | L | L | O | L | O | O | M | L | L | M | L | M | M | M | L | L | - |
| Economic impacts on overlapping tenures. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | | Hypothetical | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| Change to harvest location due to a change in the abundance and distribution of wildlife harvested by guide outfitter licences 701254 and 701258 and trappers TR0721T003 and TR0721T005. | O | O | M | L | L | O | L | L | O | - | | L | O | O | - | - | - | L |
| Economic impacts on overlapping tenures. | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Other Land Use Activities | | | | | | | | |
| | Aboriginal Harvest | Agriculture and Range | Forestry and Manufacturing | Industrial Roads | Coal and Mineral Exploration | Oil and Gas Drilling and Exploration | Other Fishing and Trapping | Recreation and Tourism | Transportation |
| Change to harvest location due to a change in the abundance and distribution of wildlife harvested by guide outfitter licences 701254 and 701258 and trappers TR0721T003 and TR0721T005. | L | - | M | M | M | M | L | - | L |
| Economic impacts on overlapping tenures. | - | - | - | - | - | - | - | - | - |

*Notes:*

- *No spatial or temporal overlap.*

O *Spatial and temporal overlap, but no interaction anticipated; no further consideration warranted.*

L *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.*

M *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*

H *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

The cumulative residual effects of habitat loss for moose was given a minor magnitude rating (Section 13.11.2) because of the relatively small area of late winter habitat lost to human activities (5.9%) of that available in the RSA. This is an area equivalent to the home range of 3.5 moose. All four tenures overlap the RSA and therefore the 5.9% habitat loss may occur in a combination of one, some or all of the four tenures.

The effects of disruption of movement for moose, grizzly bear and furbearers were predicated to occur primarily along the Murray River Resource Management Zone (MRRMZ). Guide outfitter 701254 and traplines TR0721T003 and TR0721T005 are within the MRRMZ and will likely experience cumulative effects from disruption of movement. Guide outfitter 701258 is outside of the MRRMZ and cumulative effects from disruption of movement are not anticipated in his license area.

No cumulative residual effect on fisher was predicted (Section 13.11.4). With a conclusion that cumulative effects from multiple projects would not have a cumulative residual effect on the population of fisher in the cumulative effects assessment area, no residual effect is predicted for the harvest of fisher by trappers, and thus no cumulative residual effects are predicted for TR0721T003 and TR0721T005.

The wildlife cumulative effects assessment rated the two potential cumulative effects on moose (habitat loss and disruption of movement) as **not significant (minor;** Table 13.11-9 in Section 13.11.6). The cumulative effect on grizzly bear from disruption of movement was also rated as **not significant (moderate)**.

Guide outfitters typically adjust the location of guided hunts based on wildlife movement. Guide outfitters will continue to be able to hunt moose and grizzly bear in other areas of their licence.

#### *21.15.2.3 Mitigation Measures to Address Cumulative Effects on Non-traditional Land Use*

Management plans, monitoring, and adaptive management will be implemented to mitigate disturbances and changes caused by the Project on land use as outlined in Section 16.7.2. No additional Project mitigation is anticipated other than that the mitigation identified in Section 16.7.2. It is anticipated that other large resource development projects would adopt mitigation and management measures similar to those of the Project.

#### *21.15.2.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence on Non-traditional Land Use*

Table 21.15-3 summarizes the assessment of cumulative residual effects on harvesting. The lack of data on the timing and design of reasonably foreseeable future projects has required a conservative approach to assessing significance to cumulative residual effects. In other words, the assessment is based on a scenario of high development versus low development.

**Table 21.15-3. Characterization of Residual Cumulative Effects, Significance, Confidence, and Likelihood Non-traditional Land Use**

| Residual Cumulative Effect | Effect Characterization | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Resiliency | Significance | Probability | Confidence |
| Change in harvest locations due for guide outfitters (licences 701254 and 701258) in the CEA area. | Minor | Far Future | Regular | Landscape | Reversible Long-term | Neutral | Not Significant (moderate) | High | High |

Change in Harvest Locations due to Change in the Distribution and Abundance of Resources

The wildlife CEA concluded that low level effects on the population of moose and grizzly bears, hunted by guide outfitters (licences 701254 and 701258). No cumulative residual effects were predicted for furbearers. In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in the abundance and distribution of resources as a result of the activities of these projects will increase the magnitude and duration of the effect on harvesting. Much of the change in magnitude is based on increased habitat loss and fragmentation and disruption of movement of wildlife in the Murray River corridor. The amount of Project traffic anticipated, or the amount of wilderness opened up by the Project is small compared to the total amounts of each anticipated by the development scenario predicted in this assessment.

The likelihood of cumulative effects to harvest locations from changes in the abundance and distribution of resources is **medium** because of the fact that industrial developments all inevitably produce noise and other disturbances in order to operate; and because of the predictable responses of certain wildlife harvested by guide outfitters to sensory disturbances. Wildlife habitat will be destroyed or altered as a result of site clearing and infrastructure development for all of the projects.

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative residual effect of change in the abundance and distribution of resources on harvesting, even with the Project, will be **not significant (minor)**. The CEA for wildlife (Section 13.11) determined that no significant adverse cumulative residual effects to moose or grizzly bear were anticipated. Therefore, the cumulative adverse residual effects to the abundance and distribution of wildlife resources were also characterized as not significant. The confidence in the assessment of cumulative residual effects is **high** as the guide outfitters can harvest in other areas of their tenures.

## 21.16 CURRENT USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

Two residual effects are predicted for fishing opportunities and practices, including reduced quality of fishing experience (SFN and HLFN) and reduced perceived reduced quality of fish harvested in the LSA (SFN and HLFN). Four residual effects are predicted for hunting opportunities and practices, including: reduced quality of hunting and trapping experience due to noise and visual changes in the LSA (SFN, WMFN, and KLMSS); reduced hunting and trapping success in preferred areas affected by the Project, for moose (MLIB, WMFN, BRFN, HLFN, SFN, and KLMSS), and grizzly bear and fisher (SFN and KLMSS); and reduced perceived quality of wildlife resources harvested in the LSA (SFN, WMFN, and KLMSS). Three residual effects are predicted for gathering opportunities and practices, including: reduced quality of the gathering experience due to noise and visual changes in the LSA (SFN); reduced gathering success for blueberries, firewood, and medicinal plants in preferred gathering areas affected by the Project (SFN); and reduced perceived quality of resources gathered in the LSA (SFN). One residual effect is predicted for use of habitations, trails, and cultural and spiritual sites: reduced quality of the experience at these sites due to noise and visual changes in the LSA (SFN). Table 21.16-1 summarizes the Project-related residual effects, mitigation strategies and significance on Current Aboriginal Use, grouped by effect type.

None of the residual effects were rated as being significant due to the Project. Residual effects on Current Aboriginal Use were carried forward from the Project-specific assessment and are

considered in combination with the residual effects of past, present, and future human actions in the following sections. The cumulative effects on Current Aboriginal Use are discussed in detail in Chapter 17.

**Table 21.16-1. Summary of Residual Effects, Mitigation, and Significance on Current Aboriginal Use**

| Residual Effects | Project Phase | Mitigation Measures | Significance |
|---|---|---|---|
| Reduced quality of experience while fishing (SFN and HLFN), hunting (SFN, WMFN, and KLMSS), gathering (SFN), and while using habitations, trails, and cultural and spiritual sites (SFN) | Construction, Operation, Decommissioning and Reclamation | Noise Management Plan; Provision of information about expected noise characteristics and timing to Aboriginal groups; Commitment to undertake a visual impact assessment ("visual simulation"), develop visual quality objectives with Aboriginal groups, and engage in monitoring | Not significant (moderate) |
| Reduced harvesting success in preferred areas for moose (MLIB, WMFN, BRFN, HLFN, SFN and KLMSS), grizzly bear (SFN and KLMSS) and fisher (SFN and KLMSS), and blueberries, firewood, and medicinal plants (SFN) | Construction, Operation, Decommissioning and Reclamation | Wildlife Mitigation and Monitoring Plan, Noise Management Plan, Subsidence Management Plan; Provision of information regarding expected effects to harvestable resources in the vicinity of the Project to Aboriginal groups | Not significant (moderate) |
| Perceived reduction in quality of resources harvested in the LSA, including fish (SFN and HLFN), wildlife (SFN, WMFN and KLMSS), and plants and berries (SFN) | Construction, Operation, Decommissioning and Reclamation | Regular communication and sharing of information, including results of the proposed environmental monitoring programs; Inclusion of Aboriginal groups in ongoing monitoring programs | Not significant (moderate) |

## 21.16.1 Cumulative Effects Assessment Boundaries for Current Aboriginal Use

### *21.16.1.1 Spatial Boundaries*

The spatial boundary for the Current Aboriginal Use CEA corresponds to the boundary of Treaty 8 within British Columbia (Figure 17.10-1), since the Application/EIS can only assess effects within British Columbia, and the MLIB, SFN, WMFN, BRFN, and HLFN are all Treaty 8 First Nations. The total area of the CEA spatial boundary is 278,688 km$^2$.

## 21.16.2 Cumulative Effects Assessment on Current Aboriginal Use

### *21.16.2.1 Identification of Potential Cumulative Interactions*

Table 21.16-2 summarizes the anticipated cumulative interactions of other past, present and future Projects and other land use activities with the Project, and the type of potential cumulative effect predicted.

**Table 21. 16-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Current Aboriginal Use**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame | | | | | | | | | | | | | | | | | |
| | Past | | | | | | Present | | | | | | Future | | | | | |
| | Historic | | Recent | | | | | | | | | | Certain | | | | | |
| | Hasler Coal Mine | Sukunka (Bullmoose) Mine | Bullmoose Mine | Dillon Coal Mine | Quintette (Babcock) Mine | Willow Creek Mine | Brule Mine | Trend Mine | Quality Wind Project | Peace Canyon Dam | Wolverine Mine (Perry Creek) and EB Pit | WAC Bennett Dam | Hermann Mine | Quintette Mine | Roman Mine Project | Thunder Mountain Wind Park | Tumbler Ridge Wind Project | Wartenbe Wind Project |
| Change in location and timing of MLIB, SFN, WMFN, BRFN, HLFN and KLMSS wildlife harvests, reduced availability of wildlife, displacement of hunting in the LSA and RSA due to change in the abundance and distribution of resources. | 0 | 0 | 0 | 0 | 0 | 0 | M | M | N | M | M | M | M | M | M | N | N | - |
| Displacement of SFN harvesting activities, inability to use SFN habitation sites due to a change in access or ability to access or use land use areas. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time Frame *(cont'd)* | | | | | | | | | | | | | | | | |
| | Future *(cont'd)* | | | | | | | | | | | | | | | | |
| | Reasonably Foreseeable | | | | | | | | | | Hypothetical | | | | | | |
| | Echo Hill Mine | Coastal Gaslink Project | Horizon Mine | Meikle Wind Energy Project | Northern Gateway Pipeline | Rocky Creek Energy Project | Site C Clean Energy Project | Sukunka Coal Mine Project | Sundance Wind Project | Wildmare Wind Energy Project | Babcock Creek Wind Project | Belcourt Saxon Coal Project | Huguenot Mine | Moose Lake Wind Power | Septimus Creek Wind Power Project | Suska Mine | Wapiti River Coal Project |
| Change in location and timing of MLIB, SFN, WMFN, BRFN, HLFN and KLMSS wildlife harvests, reduced availability of wildlife, displacement of hunting in the LSA and RSA due to change in the abundance and distribution of resources. | M | M | M | N | N | N | M | M | N | - | N | M | M | - | - | M | M |
| Displacement of SFN harvesting activities, inability to use SFN habitation sites due to a change in access or ability to access or use land use areas. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

*(continued)*

**Table 21. 16-2. Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Current Aboriginal Use (completed)**

| Murray River Coal Project Residual Effect | Potential for Cumulative Effect with Other Human Actions *(cont'd)* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Other Land Use Activities | | | | | | | | |
| | Aboriginal Harvest | Agriculture and Range | Forestry and Manufacturing | Industrial Roads | Coal and Mineral Exploration | Oil and Gas Drilling and Exploration | Other Fishing and Trapping | Recreation and Tourism | Transportation |
| Change in location and timing of MLIB, SFN, WMFN, BRFN, HLFN and KLMSS wildlife harvests, reduced availability of wildlife, displacement of hunting in the LSA and RSA due to change in the abundance and distribution of resources. | N/A | M | M | M | M | M | M | - | N |
| Displacement of SFN harvesting activities, inability to use SFN habitation sites due to a change in access or ability to access or use land use areas. | - | - | - | - | - | - | - | - | - |

*Notes:*
*0 = no interaction anticipated; N = negligible to minor; M = moderate; K = key interaction*
*- = no spatial or temporal overlap; N/A = not applicable*
*Color legend:* ☐ = *No interaction anticipated.*
■ = *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
■ = *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*
■ = *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

As shown by the cumulative interaction table, there are other present or reasonably forseeable future projects that could interact with changes to the abundance and distribution to wildlife caused by the Project and harvested by MLIB, SFN, WMFN, BRFN, HLFN and KLMSS.

### *21.16.2.2 Cumulative Effects to Fishing Opportunities and Practices*

The Project may result in residual adverse effects to Aboriginal groups' fishing opportunities and practices, including: reduced quality of fishing experience due to noise and visual changes (SFN and HLFN); and reduced perceived quality of fishing resources (SFN and HLFN).

Change in Quality of Experience of the Natural Environment

SFN and HLFN members who fish within visual and auditory range of the Project, if any, may experience adverse effects to the quality of their experience due to auditory and visual changes associated with the Project.

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by adding to the visual and auditory changes in the LSA. This is a spatial/temporal crowding effect in that it reduces the number of fishing locations in the LSA considered to be free of auditory or visual disturbances.

Change in Perceived Quality of Resources

SFN and HLFN members may perceive reduced quality of fish harvested in the LSA, despite a prediction of no residual effects on country foods.

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by reducing the number of streams or watercourses thought to be free of contamination by Aboriginal groups. This is a nibbling loss effect in that it reduces the number of fishing locations perceived to be available for use, and potentially putting additional strain on the fish resources available in those water courses.

### *21.16.2.3 Cumulative Effects to Hunting and Trapping Opportunities and Practices*

Change in Quality and Experience of the Natural Environment

The quality of hunting and trapping experience for SFN, WMFN, and KLMSS hunters and trappers may be adversely affected by noise and changes to visual quality, depending on the specific location of their hunting and trapping sites (Section 17.6.2.2).

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by adding to the visual and auditory changes in the LSA. This is a spatial/temporal crowding effect in that it reduces the number of hunting and trapping locations in the LSA considered to be free of auditory or visual disturbances.

Change in Harvesting Success

MLIB, SFN, WMFN, BRFN, HLFN and KLMSS hunters and trappers rely on wildlife to hunt and trap. Development of the Project is expected to result in residual effects to wildlife populations of moose, grizzly bear, and fisher (as a proxy for furbearers) in the LSA as a result of habitat loss and alteration and disruption of wildlife movement. No residual effects are predicted on direct mortality.

Habitat loss will occur in the Project footprint, while habitat alteration will occur in the cleared areas surrounding the Project and may occur in the subsidence zone. Subsidence is predicted to have little effect on wildlife habitat, largely mediated by effects on hydrology and the drying or creation of wetland areas that are important for wildlife. It should be noted that the area evaluated for habitat loss includes the entire footprint, and was not reduced to account for reclamation at closure. This results in a conservative assessment of the Project effects.

Disruption of movement was evaluated by examining the habitat loss in the Murray River Resource Management Zone (MRRMZ), which defines the riparian area and a buffer surrounding the Murray River. Wildlife, particularly those species with a preference for low elevation habitat during some parts of the year, are likely using the MRRMZ as a movement corridor. The proportion of habitat lost to the Project and other human activities was used as a metric for determining disruption of movement.

Other present and foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively on wildlife, resulting in a nibbling loss of habitat and disruption of movement in the RSA.

The cumulative effects assessment for wildlife included three wildlife VCs (moose, grizzly bear, and fisher). Two potential effects were evaluated for these VCs (habitat loss and disruption of movement). These residual effects are predicted because the Project is situated in low elevation valley-bottom habitat, which is preferred by moose and fisher, and because the Project occurs in the MRRMZ, which is likely a movement corridor for wildlife species. Grizzly bear were also included as a VC with residual effects due to disruption of movement because they preferentially use low elevation habitat in the spring and their movements are sensitive to human disturbance and infrastructure.

These residual effects were incorporated into Section 17.6.2: Key effects on hunting and trapping opportunities. This section evaluated the overall effect of change in the abundance and distribution of wildlife resources, which was rated as a residual effect for the potential to affect harvesting success (Section 17.6.2.4). The justification for a residual effect is detailed in the following sections for each wildlife VC evaluated in the wildlife cumulative effects assessment.

*Moose*

The cumulative effects assessment for moose evaluated two potential effects: 1) habitat loss and alteration; and 2) disruption of movement (Section 13.11.2). Habitat loss was given a minor magnitude rating because of the relatively small area of late winter habitat lost to human activities (5.9%) of that available in the RSA. This is an area equivalent to the home range of 3.5 moose.

Disruption of movement along the Murray River corridor was also given minor magnitude rating. All projects combined will remove approximately 9.8% of late winter habitat for moose, with an

additional 14.2% altered by forestry operations and the subsidence due to the Project. Note that low elevation habitats that have been altered from closed canopy conifer forest, are typically converted to an earlier successional stage of a more open canopy and more shrub and herbaceous vegetation, which is a benefit to moose and through which moose will readily travel.

The wildlife cumulative effects assessment rated each of these two potential cumulative effects on moose as not significant (Table 13.11-9 in Section 13.11.6.4).

Moose are currently hunted in the Murray River corridor and around Tumbler Ridge, where forestry roads and boats give access into the high quality moose range in the Murray River valley. Given the conclusions of the wildlife cumulative effects chapter, and the mitigation planned by the Project, the potential cumulative effects on moose in CEA spatial boundary, and therefore on the harvesting success of MLIB, SFN, WMFN, BRFN, HLFN and KLMSS harvesters is predicted to be a residual, but small effect.

*Grizzly Bear*

One potential effect on grizzly bear was evaluated in the wildlife cumulative effects assessment, disruption of movement. Disruption of movement was evaluated by examining the amount of high quality spring habitat removed and altered by the Project, and other human activities in the Murray River Resource Management Zone (MRRMZ), which is likely a movement corridor for grizzly bear.

The wildlife cumulative effects assessment evaluated this effect as a residual cumulative effect and provided a medium magnitude rating because a relatively large proportion of spring bear habitat would be affected by human activities; both lost (17%) by road networks and mining, and altered (42%) by forestry. Note, though, that early spring habitat altered by forestry may not be an entirely negative effect for grizzly foraging in the spring, since they are looking for herbaceous and wetland plants at this time of year. These areas altered by forestry also do not necessarily represent a barrier to movement by grizzly bears. This potential cumulative effect was rated as not-significant in the wildlife cumulative effects assessment.

Hunting and trapping opportunities and practices are unlikely to be affected in the CEA spatial boundary because the grizzly bear population is considered large and robust in this area, potential effects of cumulative development were evaluated as non-significant, and there is little evidence of MLIB, SFN, WMFN, BRFN, HLFN and KLMSS harvesting grizzly bears in the Project LSA.

*Fisher*

The effects assessment identified two potential residual effects for fisher; habitat loss and alteration and disruption of movement (Section 13.7.12). Additional future activities include habitat loss from other proposed mines (109 ha) and habitat alteration by wind projects (123 ha) and oil and gas projects (100 ha). This loss of habitat is not considered a residual cumulative effect for fisher.

Disruption of movement was evaluated against other past, present or reasonably foreseeable future Project along the Murray River movement corridor. Habitat loss causing disruption of movement is concentrated at or near the Murray FSR bridge over the Murray River. However, past, present and future developments plan to leave a 400 to 500 m buffer between project footprints and the river.

This 1-km wide corridor is likely able to satisfy the movement requirements of fisher along the Murray River. As a consequence, this effect is not rated as a residual effect for fisher.

There is no evidence that fisher are actively harvested by MLIB, SFN, WMFN, BRFN, HLFN or KLMSS in the Project LSA. With a conclusion that cumulative effects from multiple projects would not have a cumulative residual effect on the population of fisher in the CEA spatial boundary, no residual effect was predicted for the harvest of fisher by these Aboriginal groups.

Change in Perceived Quality of Resources

SFN and WMFN members may perceive reduced quality of wildlife harvested in the LSA, despite a prediction of no residual effects on country foods (Section 17.6.2.4)

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by reducing the number of wildlife harvesting areas thought to be free of contamination by Aboriginal groups. This is a nibbling loss effect in that it reduces the number of hunting and trapping locations perceived to be available for use, and potentially putting additional strain on the wildlife resources available in those areas.

### *21.16.2.4 Cumulative Effects to Gathering Opportunities and Practices*

Change in Quality and Experience of the Natural Environment

The quality of gathering experience for SFN members may be adversely affected by noise and changes to visual quality, depending on the specific location of their gathering sites (Section 17.6.3.2).

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by adding to the visual and auditory changes in the LSA. This is a spatial/temporal crowding effect in that it reduces the number of gathering locations in the LSA considered to be free of auditory or visual disturbances.

Change in Harvesting Success

The success of SFN's gathering activities in the LSA may be adversely affected due to loss and alteration of harvestable plants in the LSA (Section 17.6.3.3).

Other present and foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively on harvestable resources, resulting in a nibbling loss and alteration of habitat. This could in impact the location and effort involved in seeking out new locations to collect harvestable plants.

The assessment of effect to Terrestrial Ecology (Section 11.12.2.2) states that the cumulative loss and alteration to harvestable plant habitat is difficult to accurately characterize because the location, type and quantity of harvestable plants within the region is unknown. Many of the ecosystems within the region can provide suitable habitat for harvestable plants and as such harvestable plant habitat was

assessed in relation to effects on forested ecosystems. However, the effects to harvestable plant habitat are expected to be considerably less in extent than the loss and alteration reported for forested ecosystem. Furthermore, in certain cases, human derived alteration will increase the amount of harvestable plant habitat.

Loss and alteration of harvestable plants are considered not significant (Section 11.12.5.4). The magnitude of the direct effects to harvestable plants is considered moderate because although 33.7% of the available habitat could be lost or altered by cumulative effects, some of the human derived alteration will increase the amount of harvestable plants. Development activities such as timber harvesting can favour berry production by increasing the light available to plants and by reducing competing vegetation. Other cumulative effects to harvestable plants include nibbling loss of relevant habitat, physical transport of invasive plant propagules, spatial and temporal crowding in areas where multiple project effects intersect with harvestable plant habitat as well as additive effects from the accumulation of metals in some soils and subsequent plant uptake as well as growth inducing effects due to the creation of new edges. All of the effects are considered regional in extent and reversible in the long term. The duration of effects are expected to occur over the medium to long term depending on the relevant plant and its associated habitat requirements. In an ecological context, harvestable plants are considered neutral as they have some unique attributes, particularly to the local communities (discussed further in Chapter 16, Land Use). There is a medium level of confidence in the analyses because the effects to harvestable plants are generally well understood; however, uncertainty exists regarding the magnitude of alteration.

Change in Perceived Quality of Resources

SFN members may perceive reduced quality of resources gathered in the LSA, despite a prediction of no residual effects on country foods (Section 17.6.3.4).

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by reducing the number of plant harvesting areas thought to be free of contamination by Aboriginal groups. This is a nibbling loss effect in that it reduces the number of plant harvesting locations perceived to be available for use, and potentially putting additional strain on the harvestable plant resources available in those areas.

### *21.16.2.5 Cumulative Effects to Use of Habitations, Trails, Cultural and Spiritual Sites*

Change in Quality and Experience of the Natural Environment

The quality of experience for SFN members using habitations, trails, and cultural and spiritual sites may be adversely affected by noise and changes to visual quality, depending on the specific location of these sites (Section 17.6.4.3).

Other foreseeable future mining, hydroelectric, and other commercial activities, such as oil and gas exploration have the potential to act cumulatively with the Project by adding to the visual and auditory changes in the LSA. This is a spatial/temporal crowding effect in that it reduces the number of locations in the LSA considered to be free of auditory or visual disturbances.

### *21.16.2.6 Mitigation Measures to Address Cumulative Effects on Current Aboriginal Use*

Change in Quality of Experience of the Natural Environment

A Noise Management Plan (Chapter 24, Section 24.3) has been developed to provide measures to control the noise sources (i.e., to reduce the overall noise from the Project). A monitoring program will be undertaken to make sure that noise levels propagated from the Project will meet the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008), and the Environmental Code of Practice for Metal Mines (Environment Canada 2009; Chapter 24, Section 24.3). Periodic noise monitoring will be performed to assess noise levels at sensitive receptor locations and should include monitoring of overnight noise, instantaneous noise, vehicle pass-by noise, and interior noise levels at production facilities. It is assumed any future projects will also develop similar noise mitigation measures and adhere to established guidelines.

The Proponent will manage visual quality in the Murray River/Murray FSP Scenic Area, per Section 3.6 of the Dawson Creek LRMP. It is assumed any future projects will take into consideration the goals and objectives outlined in the Dawson Creek LRMP.

Change in Harvesting Success

*Hunting and Trapping Opportunities and Practices*

Management plans, monitoring, and adaptive management will be implemented to mitigate impacts of the Project on hunting and trapping opportunities and practices as outlined in Section 17.6.2.6 including:

- Section 24.3, Noise Management Plan;
- Section 24.12, Wildlife Management Plan; and
- Section 24.15, Subsidence Management Plan.

With respect to moose and furbearer habitat loss and alteration, measures include:

- avoiding important habitat where practical alternatives are available (e.g., habitat loss and alteration was minimized through Project design);
- maintaining known and potential mineral licks in a natural state and ensure ungulates have access to them during the season when they are most used;
- minimizing the destruction or disruption of areas that contain known wallows, particularly during the ungulate breeding season during site clearing in the construction phase and during Construction and Operation; and
- minimizing the destruction or disruption of active fisher or marten dens during site clearing in the construction phase and during Construction and Operation.

With respect to disruption of movement for moose, grizzly bear and fisher, measures include:

- giving wildlife the right-of-way along access roads and the highway; and
- enforcing speed limits along on-site Project roads.

No additional Project mitigation has been identified other than measures discussed in Section 17.6.2.6, to address cumulative effects to hunting and trapping opportunities and practices due to change in harvesting success. It is expected that other large resource development projects would adopt mitigation and management measures similar to those of the Murray River Coal Project.

*Gathering Opportunities and Practices*

Ecosystem management and mitigation plans are designed to avoid and minimize adverse effects to ecosystems and plants resulting from project activities within the feasible limits of project design and activities. It is assumed any present and future projects will take into consideration the goals and objectives outlined in the Dawson Creek LRMP. It is also assumed that the following general mitigation measures will be common amongst any present and future projects or activities:

- avoid and minimize detrimental effects to terrestrial ecosystems and wetlands through strategic planning;
- minimize all clearing dimensions during any construction activities;
- minimize soil degradation through best management practices for soil stripping, handling and stockpiling;
- minimize soil loss and degradation (i.e., compaction, erosion, and soil horizon mixing);
- avoid the introduction and spread of invasive plants;
- avoid and minimize detrimental effects to rare plants and lichens, including rare plant and lichen habitat;
- avoid and minimize loss or alteration of ecosystem functions due to clearing activities, dust deposition, fragmentation, edge effects, windthrow, and altered hydrology;
- ensure clearing activities are coordinated with other management plans; and
- maintain natural levels of plant and lichen biodiversity through avoidance, offsetting, and other mitigation strategies;
- avoid direct harm to rare plant and lichen populations through realignment of footprint boundaries when possible;
- avoid use of all herbicide sprays within 200 m of rare plant and lichen populations and limit such use to direct application rather than broadcast sprays; and
- create exclusion zones around priority rare plant and lichen (e.g., red-listed and globally rare species) habitats to avoid direct disturbance and to minimize effects related to fugitive dust transport, weed invasion, and vehicular activities.

Collaborative approaches to address cumulative effects to the terrestrial ecology receptor VC have been initiated through data sharing agreements between some proponents regionally. Further collaborative efforts with additional proponents, and to maximize the effectiveness of monitoring programs and other biodiversity initiatives should be pursued.

Change in Perceived Quality of Resources

The Proponent will continue to consult with Aboriginal groups to address any concerns regarding country foods contamination, including sharing the results of the proposed environmental monitoring programs. Regular communication and sharing of information has been shown in other studies to provide increased certainty about the Aboriginal groups' ability to safely harvest resources (Poirier and Brooke 2000). The Proponent will also work to include Aboriginal group members in ongoing monitoring so that members will be able to assess wildlife resource quality first hand and report back to other SFN and HLFN members.

It is expected that other large resource development projects would adopt mitigation and management measures similar to those of the Murray River Coal Project.

#### *21.16.2.7 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence*

Table 21.16-3 summarizes the assessment of cumulative residual effects for Current Aboriginal Use. The lack of data on the timing and design of reasonably foreseeable future projects has required a conservative approach to assessing significance to cumulative residual effects. In other words, the assessment is based on a scenario of high development versus low development.

Cumulative Residual Effects Characterization for Fishing Opportunities and Practices

*Change in Quality and Experience of the Natural Environment*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in fishing opportunities and practices as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on fishing opportunities and practices. The amount of Project traffic anticipated, or the amount of wilderness opened up by the Project is small compared to the total amounts of each anticipated by the development scenario predicted in this assessment. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Change in Perceived Quality of Resources*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in fishing opportunities and practices as a result of the activities of these projects will increase the geographic extent of the effect on fishing opportunities and practices. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Significance*

Cumulative residual effects on fishing opportunities and practices (SFN and HLFN) are assessed as **not significant (moderate)**. The residual effects are of minor magnitude, regional extent, medium duration, and occur continuously. The residual effects will result in discernible, but not consequential, changes in Aboriginal groups' overall fishing practices.

**Table 21.16-3. Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence**

| Cumulative Residual Effects | Cumulative Residual Effects Characterization Criteria | | | | | | Significance of Adverse Cumulative Residual Effects | Likelihood and Confidence | |
|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Context | | Probability | Confidence |
| Cumulative reduction in quality of experience while fishing (SFN and HLFN), hunting (SFN, WMFN, and KLMSS), gathering (SFN), and while using habitations, trails, and cultural and spiritual sites (SFN) | Minor | Medium | Continuous | Regional | Reversible long-term | Moderate | Not significant (moderate) | Medium | Medium |
| Cumulative reduction in harvesting success in preferred areas for moose (MLIB, WMFN, BRFN, HLFN, SFN and KLMSS), grizzly bear (SFN and KLMSS) and fisher (SFN and KLMSS), and blueberries, firewood, and medicinal plants (SFN) | Minor | Medium | Continuous | Regional | Reversible long-term | Moderate | Not significant (moderate) | Medium | Medium |
| Reduced perceived quality of resources harvested in additional locations in the LSA, including fish (SFN and HLFN), wildlife (SFN, WMFN and KLMSS), and plants and berries (SFN) | Minor | Medium | Continuous | Regional | Reversible long-term | Moderate | Not significant (moderate) | High | Medium |

*Probability*

The likelihood that a cumulative residual effect on quality of fishing experience will occur is **medium**. While an established literature on the quality of harvesting experience supports prediction of the effect on Aboriginal fishers, auditory and visual interactions constitute one of several dimensions affecting quality of experience.

The likelihood that a cumulative residual effect on perceived quality of fish resources will occur is **high**. Comparable projects (e.g., Quintette) have established the cause-and-effect relationship.

*Confidence*

The confidence in the prediction of a cumulative residual effect on quality of fishing experience is **medium**. While Aboriginal groups have expressed concerns about potential effects on the quality of fishing experience, little data exists on Aboriginal fishers' specific fishing sites or Aboriginal fishers' current quality of fishing experience.

The confidence in the prediction of a cumulative residual effect on perceived quality of fish resources is **medium**. While Aboriginal groups have expressed concerns about potential effects on perceived quality of fishing resources, little data exists on Aboriginal fishers' specific fishing sites or Aboriginal fishers' current perception of fish resource quality in the vicinity of the Project.

Cumulative Residual Effects Characterization for Hunting and Trapping Opportunities and Practices

*Change in Quality and Experience of the Natural Environment*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in hunting and trapping opportunities and practices as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on hunting and trapping opportunities and practices. The amount of Project traffic anticipated, or the amount of wilderness opened up by the Project is small compared to the total amounts of each anticipated by the development scenario predicted in this assessment. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Change in Harvesting Success*

The wildlife CEA concluded that low level effects on the population of moose, grizzly bears, furbearers and other wildlife hunted by MLIB, SFN, WMFN, BRFN, HLFN, and KLMSS. These changes may or may not be detectible through wildlife monitoring, since wildlife monitoring activities often have large uncertainties. In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in harvesting success as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on hunting and trapping opportunities and practices. Much of the change in magnitude is based on increased habitat loss and fragmentation and disruption of movement of wildlife in the Murray River corridor, resulting in a reduction of harvesting areas available to Aboriginal harvesters and the displacement of harvesting activity into other areas of Treaty 8. The amount of Project traffic anticipated, or the amount of wilderness opened up by the Project is small compared to the total amounts of each

anticipated by the development scenario predicted in this assessment. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Change in Perceived Quality of Resources*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in hunting and trapping opportunities and practices as a result of the activities of these projects will increase the geographic extent of the effect on hunting and trapping opportunities and practices. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Significance*

Cumulative residual effects on hunting and trapping opportunities and practices (SFN, WMFN, MLIB, BRFN, HLFN, KLMSS) are assessed as **not significant (moderate)**. The residual effects are of minor magnitude, regional in extent, medium duration, and occur continuously. The residual effects will result in discernible, but not consequential, changes in Aboriginal groups' overall hunting and trapping practices.

*Probability*

The likelihood that a cumulative residual effect on quality of hunting and trapping experience will occur is **medium**. While an established literature on the quality of harvesting experience supports prediction of the effect on Aboriginal hunters and trappers, auditory and visual interactions constitute one of several dimensions affecting quality of experience. The likelihood that a cumulative residual effect on hunting and trapping success will occur is **medium**. While the abundance and distribution of harvested resources is a key factor affecting hunting and trapping success, other factors which may also contribute to success (e.g., hunter skill and quality of trapping equipment) have not been considered in the assessment. The likelihood that a cumulative residual effect on perceived quality of hunting and trapping resources will occur is **high**. Comparable projects (e.g., Quintette) have established the cause-and-effect relationship.

*Confidence*

The confidence in the prediction of a cumulative residual effect on quality of hunting and trapping experience is **medium**. While Aboriginal groups have expressed concerns about potential effects on the quality of hunting and trapping experience, little data exists on Aboriginal harvesters' specific hunting and trapping sites or Aboriginal harvesters' current quality of hunting and trapping experience. The confidence in the prediction of a cumulative residual effect on hunting and trapping success is **medium**. While information is available about predicted effects on the abundance and distribution of harvestable resources, little data exists on current Aboriginal harvesters' success rates. The confidence in the prediction of a cumulative residual effect on perceived quality of wildlife resources is **medium**. While Aboriginal groups have expressed concerns about potential effects on perceived quality of wildlife resources, little data exists on Aboriginal harvesters' specific hunting and trapping sites or Aboriginal harvesters' current perception of wildlife resource quality in the vicinity of the Project.

## Cumulative Residual Effects Characterization for Gathering Opportunities and Practices

### *Change in Quality of Experience of the Natural Environment*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in gathering opportunities and practices as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on gathering opportunities and practices. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

### *Change in Harvesting Success*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in harvesting success as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on gathering opportunities and practices. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

### *Change in Perceived Quality of Resources*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in perceived quality of resources as a result of the activities of these projects will increase the geographic extent of the effect on gathering opportunities and practices. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

### *Significance*

Cumulative residual effects on gathering opportunities and practices (SFN) are assessed as **not significant (moderate)**. The residual effects are of minor magnitude, regional in extent, medium duration, and occur continuously. The residual effects will result in discernible, but not consequential, changes in Aboriginal members' overall gathering practices.

### *Probability*

The likelihood that a cumulative residual effect on quality of gathering experience will occur is **medium**. While an established literature on the quality of harvesting experience supports prediction of the effect on Aboriginal gatherers, auditory and visual interactions constitute one of several dimensions affecting quality of experience. The likelihood that a cumulative residual effect on gathering success will occur is **medium**. While the abundance of harvested resources is a key factor affecting gathering success, other factors which may also contribute to success (e.g., gatherer knowledge and time) have not been considered in the assessment. The likelihood that a cumulative residual effect on perceived quality of plant and berry resources will occur is **high**. Comparable projects (e.g., Quintette) have established the cause-and-effect relationship.

*Confidence*

The confidence in the prediction of a cumulative residual effect on quality of gathering experience is **medium**. While Aboriginal groups have expressed concerns about potential effects on the quality of gathering experience, little data exists on Aboriginal harvesters' specific gathering sites or Aboriginal gatherers' current quality of gathering experience. The confidence in the prediction of a cumulative residual effect on gathering success is **medium**. While information is available about predicted effects on the abundance of harvestable resources, little data exists on current Aboriginal harvesters' success rates. The confidence in the prediction of a cumulative residual effect on perceived quality of plant and berry resources is **medium**. While Aboriginal groups have expressed concerns about potential effects on perceived quality of plant and berry resources, little data exists on Aboriginal harvesters' specific gathering sites or Aboriginal harvesters' current perception of plant and berry resource quality in the vicinity of the Project.

Cumulative Residual Effects Characterization for Use of Habitations, Trails, Cultural and Spiritual Sites

*Change in Quality and Experience of the Natural Environment*

In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative change in quality and experience of the natural environment as a result of the activities of these projects will increase the magnitude and geographic extent of the effect on use of habitations, trails, and cultural and spiritual sites. The potential incremental contribution of the Project to this effect is expected to be small, given the relatively small footprint and underground nature of the Project design. Consequently, the future case for this residual effect is expected to be substantially similar with and without the Project.

*Significance*

Residual effects on use of habitations, trails, and cultural and spiritual sites are assessed as **not significant (moderate)**. The residual effects are of minor magnitude, regional in extent, medium duration, and occur continuously. The residual effects will result in discernible, but not consequential, changes in Aboriginal members' overall use of these sites.

*Probability*

The likelihood that a cumulative residual effect on quality of experience while using habitations, trails, and cultural and spiritual sites will occur is **medium**. While an established literature on the quality of experience while on the land supports prediction of the effect on Aboriginal users, auditory and visual interactions constitute one of several dimensions affecting quality of experience.

*Confidence*

The confidence of the assessment of the cumulative residual effect to SFN use of the habitation site and sacred site due to a change in access or ability to access is **medium**, due to the lack of information provided by SFN regarding the nature and use of the sacred site.

## 21.17 HUMAN HEALTH

### 21.17.1 Summary of Project-specific Residual Effects on Human Health

The potential for Project-related effects to human health was assessed by determining the potential for changes in air quality, drinking water quality, country foods quality, or noise in relation to human health. Quantitative information was used wherever possible in the assessment, including the outputs from the air quality, water quality, soil quality, and noise predictive models.

The potential effects to human health in relation to drinking water, air, country foods and noise are described in Section 18.7. Mitigation measures to minimize or avoid the potential for Project-related effects to human health are also described in Section 18.7. Predictive models included consideration of the mitigation measures proposed as part of the Project, such that data outputs reflect the best estimate of potential Project effects on air quality, water quality, soil quality, and noise.

After considering mitigation measures, no residual effects on human health due to changes in drinking water quality, air quality, country foods, or noise were identified though predictive, quantitative assessments, as described in Section 18.8. Based on the quantitative modelling conducted to support the environmental assessment, effects on human health due to potential Project-related changes on drinking water quality, air quality, country foods quality, or noise are not predicted. Given that no Project-related residual effects were identified, no significance determination was conducted and no residual effects on human health were carried forward to cumulative effects assessment.

Table 21.17-1 summarizes the results of the characterization of residual effects on human health. The determination of Project-related residual effects are discussed in detail in Chapter 18.

## 21.18 HERITAGE RESOURCES

### 21.18.1 Summary of Project-specific Residual Effects on Heritage Resources

The assessment of Project-related residual effects on archaeology and paleontological resources are based on the effects assessment described in Chapter 19. The assessment takes into account mitigation and management measures that will be conducted in response to anticipated impacts to heritage resources. These mitigations and management measures include site avoidance, education for Project personnel, additional archaeological impact assessments (AIAs) within the subsidence area and within any Project infrastructure footprints not assessed, implementation of the Archaeological Resources Management Plan (Section 24.14), and continued use of a Project Chance Find Procedure. Once mitigation and management measures have been conducted and/or established prior to Project effects, the residual effects on heritage resources will be reduced to negligible and not significant. Therefore residual effects on heritage resources are not discussed further.

Given that no Project-related residual effects were identified, no residual effects on heritage resources were carried forward to cumulative effects assessment.

**Table 21.17-1. Summary of Residual Effects on Human Health**

| Valued Component | Project Phase | Project Component / Physical Activity | Description of Cause-Effect | Description of Mitigation Measure(s) | Description of Residual Effect |
|---|---|---|---|---|---|
| Human health (potential effects due to drinking water quality) | All Project phases | Site construction/preparation activities; Water management activities (e.g., seepage collection, discharge to the receiving environment); Decommissioning/ reclamation of Project infrastructure | Changes in water quality due to the Project could affect human health through changes in drinking water quality | Water Management Plan; Spill Management Plan; Erosion and Sedimentation Control Plan | No residual effect is predicted |
| Human health (due to changes in air quality) | All Project phases | Underground Mine Coal Processing Site; Shaft Site; Secondary Shafts Site; Heavy Machinery; Traffic and Transportation | Changes in air quality due to the Project could affect human health through inhalation of air contaminants | Emission reduction measures; Fugitive dust reduction measures; Air Quality and Dust Control Plan | No residual effect is predicted |
| Human health (due to changes in quality of country foods) | All Project phases | Underground Mine Coal Processing Site; Shaft Site; Secondary Shafts Site; Heavy Machinery; Traffic and Transportation; Site construction/preparation activities; Water management activities (e.g., seepage collection, discharge to the receiving environment); Decommissioning/ reclamation of Project infrastructure | Project-related changes in environmental media (i.e., soil, water) quality could affect the quality of country foods, which could affect the health of human consumers of country foods | Fugitive dust reduction measures; Air Quality and Dust Control Plan; Water Management Plan; Spill Management Plan; Erosion and Sedimentation Control Plan | No residual effects are predicted. |
| Human health effects due to noise | All Project phases | Construction equipment, road activities, mining activities | Project noise sources are predicted to increase noise levels, which could affect human health. | Noise Management Plan (Section 24.3) | No residual effects predicted |

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