8.6.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on fish and fish habitat indicators were identified in Section 7.2.7 and are listed in Table 8.6-4 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.6-4

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON FISH AND FISH HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on riparian habitat.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative increase in riparian habitat disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.
2. Combined effects of the Project on instream habitat.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative increase in instream habitat disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.
3. Combined effects of the Project on fish mortality and injury.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative effects on fish mortality and injury. Project contribution to cumulative effects associated with blockage of fish movements.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.

TABLE 8.6-4 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined effects of the Project on indicator species (Alberta: Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye; and BC: bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead).	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative effects on Arctic grayling. Project contribution to cumulative effects on Athabasca rainbow trout and bull trout. Project contribution to cumulative effects on burbot. Project contribution to cumulative effects on northern pike and walleye. Project contribution to cumulative effects on bull trout/Dolly Varden. Project contribution to cumulative effects on Chinook salmon, coho salmon and cutthroat trout. Project contribution to cumulative effects on rainbow trout/steelhead.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.

Note: 1 RSA = Aquatics RSA.

8.6.3 Significance Evaluation of Potential Cumulative Effects

A quantitative analysis was undertaken to evaluate the significance of the Project's contribution to cumulative effects for the disturbance of riparian habitat and instream habitat indicators as these changes were quantifiable. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria for fish and fish habitat indicators, significance was assessed qualitatively based on the professional judgment of the assessment team.

Table 8.6-5 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on fish and fish habitat indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.6-5

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON FISH AND FISH HABITAT

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Fish and Fish Habitat Indicator – Riparian Habitat									
1(a) Project contribution to cumulative increase in riparian habitat disturbance.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
2. Fish and Fish Habitat Indicator – Instream Habitat									
2(a) Project contribution to cumulative increase in instream habitat disturbance.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
3. Fish and Fish Habitat Indicator – Fish Mortality and Injury									
3(a) Project contribution to cumulative effects on fish mortality and injury.	Negative	RSA	Immediate to long-term	Occasional to periodic	Long-term	Low	High	High	Not significant
3(b) Project contribution to cumulative effects associated with blockage of fish movements.	Negative	RSA	Immediate to short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant
4. Fish and Fish Habitat – Indicator Species									
4(a) Project contribution to cumulative effects on Arctic grayling.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(b) Project contribution to cumulative effects on Athabasca rainbow trout and bull trout.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(c) Project contribution to cumulative effects on burbot.	Negative	RSA	Immediate to long-term	Isolated to periodic	Long-term	Low	High	High	Not significant
4(d) Project contribution to cumulative effects on northern pike and walleye.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(e) Project contribution to cumulative effects on bull trout/Dolly Varden.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(f) Project contribution to cumulative effects on Chinook salmon, coho salmon and cutthroat trout.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(g) Project contribution to cumulative effects on rainbow trout/steelhead.	Negative	RSA	Immediate to long-term	Isolated to periodic	Long-term	Low	High	High	Not significant
5. Project Contribution to Combined Cumulative Effects on Fish and Fish Habitat									
5(a) Project contribution to combined cumulative effects on the fish and fish habitat indictors (1[a]-4[g]).	Negative	RSA	Immediate to long-term	Isolated to periodic	Immediate to long-term	Low	High	High	Not significant

Notes: 1 RSA = Aquatics RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.6.3.1 Fish and Fish Habitat Indicator – Riparian Habitat

Riparian habitat plays an important role in the maintenance of healthy aquatic environments. Riparian vegetation stabilizes streambanks, buffers streams from sedimentation contained in surface runoff, contributes food and nutrients such as insects and organic matter, provides woody debris which contribute to stream diversity, provides shade to help regulate stream temperature, and provides cover that affords safe habitat for smaller fish.

Clearing or disturbance of riparian habitat can affect fish and instream habitat through an increase in sedimentation in the watercourse, decreased bank and approach stability, reductions in stream shading potential and the loss of instream and overhead cover. The degree to which fish can be affected depends upon, among other influences, the total area of disturbed riparian habitat.

The area of riparian habitat disturbance can be used as a quantitative measure of possible bank disturbance, sediment yield and overall watershed health, thereby allowing the Project's contribution to

cumulative effects to be estimated (Anderson 1996, Beaudry 1998, CAPP *et al.* 2005, Haas 2001, Hughes *et al.* 2004, Salmo *et al.* 2003, Sawyer and Mayhood 1998, Scrimgeour *et al.* 2003, Sloat *et al.* 2001). Project facilities and activities are located in 8 watersheds within the Athabasca and North Saskatchewan river drainages in Alberta and 13 watersheds within the Fraser, Thompson and Columbia river drainages, and 1 coastal watershed in BC. Watersheds crossed by the Project reflect a broad range of riparian habitat conditions due to past land use activities (Fisheries [Alberta] Technical Report and Fisheries [BC] Technical Report of Volume 5C).

Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. The potential area of riparian habitat lost or altered was calculated for existing activities, the Project and reasonably foreseeable development activities. Criteria, which are based on channel width, exist for protecting riparian areas from development activities (*e.g.*, riparian management areas in the *Environmental Protection and Management Regulation* of the *Oil and Gas Activities Act* that range from 100 m for large, fish-bearing watercourses to 20 m for small, nonfish-bearing watercourses). For this desktop analysis, it was necessary to assume a standardized riparian width of 30 m for all waterbodies in riparian disturbance calculations because it was not practical to determine the channel width and fish-bearing status of all waterbodies in the Aquatics RSA (AESRD 2012). Disturbance of riparian areas from the Project, existing and reasonably foreseeable development activities, were estimated. Note that riparian disturbance attributed to reasonably foreseeable development is underestimated because spatial data on future harvesting and associated roads was not available.

Existing activities that have disturbed riparian habitat include agriculture (including grazing), rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational activities, and oil and gas exploration and development (*e.g.*, seismic cutlines and pipelines). It is anticipated that the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1, 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1) have the potential to act cumulatively to increase riparian disturbance within the Aquatics RSA in both Alberta and BC. Characterization of the Project's contribution to cumulative effects on riparian disturbance relied on available hazard ratings and the professional judgment of the assessment team. Hazard levels assigned based on the BC Interior Watershed Assessment Procedure (BCFS and BCE 1995) were:

- low hazard: 0-9% disturbed;
- medium hazard: > 9-18% disturbed; and
- high hazard: > 18% disturbed.

Results of riparian disturbance estimates are provided in Tables 8.6-6 and 8.6-7 for each watershed crossed by the proposed pipeline corridor, since potential cumulative effects on fish and fish habitat are most appropriately considered at the watershed scale. From an aquatics perspective, land use features are concentrated in the eastern half of the Alberta Aquatics RSA, (*i.e.*, Sturgeon, Pembina, Upper/Mid/Lower Saskatchewan river watersheds) and in the central portion of the BC Aquatics RSA (*i.e.*, Lower North and South Thompson rivers, the Thompson River and the Lower Nicola River watersheds). Currently, forest harvesting and agriculture are the largest contributors to riparian disturbance in the Aquatics RSA (Table 8.6-1). Alberta TEK participants specifically noted the decrease in water quality and fish populations over the past 30 years in the Edmonton to Hinton region, which they consider to be due to the cumulative effects of pollution and industrial development. As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no riparian habitat in the greenbelt is affected by this reasonably foreseeable development or the Project. Effects of the Project on riparian habitat were addressed in Section 7.2.7.

Cumulative effects hazard resulting from riparian disturbance is currently:

- low in the Upper Fraser River, Canoe Reach and Clearwater River watersheds (*i.e.*, 1.50-3.65%);

- moderate in the Upper North Thompson River, Fraser Canyon, Harrison River, Chilliwack River, and Upper McLeod River watersheds (*i.e.*, 11.79-14.89%); and

- high in all remaining watersheds, ranging from 19.03-75.63%.

Existing disturbance of riparian areas is highest in the Lower North Saskatchewan River watershed and is due primarily to agriculture. Cumulative effects hazard is projected to increase incrementally in all watersheds as a result of reasonably foreseeable developments and the Project (*i.e.*, 0.49% increase for Alberta and 0.19% for BC), and is projected to remain the highest in the Lower North Saskatchewan River watershed. The largest incremental increase is projected to occur in the Upper McLeod River watershed and is due primarily to reasonably foreseeable developments (*i.e.*, proposed coal mine developments). The incremental increase in riparian disturbance does not affect the hazard rating in any of the assessed watersheds.

The Project may contribute < 0.01- 0.15%, or an average of 0.05%, to total riparian habitat disturbance in the Aquatics RSA. The mitigation measures outlined in Section 7.2.7.4 (*e.g.*, seeding disturbed riparian areas with the appropriate native seed mix, along with a quick establishing cover crop and additional revegetation efforts, such as planting trees or shrubs at select locations), will limit the Project's contribution to cumulative effects. In addition, it is expected that many other land users will implement riparian habitat protection measures to reduce incremental effects of their activities, as recommended in federal and provincial guidelines and best management practices discussed in Section 7.1.1.2 of the Fisheries (BC) Technical Report, Section 7.1.2 of the Fisheries (Alberta) Technical Report and in activity-specific guidance documents for grazing, back-country tourism and off-roading (BC MFLNRO 2011, BC MFR 2008, BC MOE 2006, Fraser 2009). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed to be warranted.

TABLE 8.6-6

ESTIMATED DISTURBANCES OF RIPARIAN AREAS WITHIN THE ALBERTA AQUATICS RSA

Riparian Disturbance Assessment Scenario	Area (ha) and Percentage of Riparian Disturbance for Each Watershed[1] in Alberta Aquatics RSA							
	Sturgeon River	Lower N. Saskatchewan River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta RSA Total
Total Riparian Area in each Watershed	17,771.6	21,765.7	30,340.3	40,239.2	38,947.5	27,409.8	16,708.0	193,182.1
Existing Riparian Disturbance								
Existing Disturbance of Riparian Area[2,3]	(12,531.2) 70.51	(16,462.5) 75.63	(13,668.0) 45.05	(18,131.5) 45.06	(4,593.1) 11.79	(5,362.7) 19.57	(3,178.8) 19.03	(73,927.8) 38.27
Future Riparian Disturbance								
Amount of Disturbance of Riparian Area Attributed to the Project (Project)[2]	(8.1) 0.05	(1.4) 0.01	(7.8) 0.03	(19.3) 0.05	(3.1) 0.01	(6.1) 0.02	(17.3) 0.10	(63.1) 0.03
Amount of Disturbance of Riparian Area Attributed to Reasonably Foreseeable Developments (Likely Future)[2,3]	(23.5) 0.13	(106.4) 0.49	(115.3) 0.38	(71.8) 0.18	(508.8) 1.31	(12.0) 0.04	(56.3) 0.34	(894.1) 0.46
Cumulative Effects								
Total Cumulative Riparian Disturbance (Existing+Project+Likely Future)	(12,562.8) 70.69	(16,570.3) 76.13	(13,791.1) 45.46	(18,222.6) 45.29	(5,105.0) 13.11	(5,380.8) 19.63	(3,252.4) 19.47	(74,885.0) 38.76
Total Cumulative Riparian Disturbance without Project (Existing+Likely Future)	(12,554.7) 70.64	(16,568.9) 76.12	(13,783.3) 45.43	(18,203.3) 45.24	(5,101.9) 13.10	(5,374.7) 19.61	(3,235.1) 19.36	(74,821.9) 38.73
Total Cumulative Riparian Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(12,539.3) 70.56	(16,463.9) 75.64	(13,675.8) 45.08	(18,150.8) 45.11	(4,596.2) 11.80	(5,368.8) 19.59	(3,196.1) 19.13	(73,990.9) 38.30

Notes:
1 The Middle North Saskatchewan River watershed is not included because Project riparian disturbance in this watershed is located within the City of Edmonton, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).
2 Calculations based on an average of 30 m riparian area on each bank at all waterbodies.
3 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

TABLE 8.6-7

ESTIMATED DISTURBANCES OF RIPARIAN AREA WITHIN THE BC AQUATICS RSA

Riparian Disturbance Assessment Scenario	Area (ha) and Percentage of Riparian Disturbance for Each Watershed[1] in the BC Aquatics RSA												
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Similkameen	Fraser Canyon	Harrison River	Chilliwack River	BC RSA Total
Total Riparian Area in each Watershed	85,022.8	31,699.2	58,720.3	45,771.3	56,233.3	46,169.6	39,756.2	43,981.4	8,329.4	62,402.8	34,261.9	12,398.8	52,4747.0
Existing Riparian Disturbance													
Existing Disturbance of Riparian Area[2,3]	(2,706.9) 3.18	(1,157.6) 3.65	(6,201.4) 10.56	(688.0) 1.50	(13,658.0) 24.29	(9,089.7) 19.69	(10,074.1) 25.34	(8,746.6) 19.89	(1,908.6) 22.91	(8926.9) 14.30	(5101.1) 14.89	(1553.3) 12.53	(69812.2) 13.31
Future Riparian Disturbance													
Amount of Disturbance of Riparian Area Attributed to the Project (Project)[2]	(12.3) 0.01	(5.7) 0.02	(78.0) 0.13	(0.3) <0.01	(41.2) 0.07	(4.2) 0.01	(10.7) 0.03	(69.9) 0.15	(2.5) 0.03	(28.6) 0.05	(15.6) 0.05	(2.5) 0.02	(271.5) 0.05
Amount of Disturbance of Riparian Area Attributed to Reasonably Foreseeable Developments (Likely Future)[2,3]	(47.5) 0.06	(0.0) 0.00	(27.8) 0.05	(0.0) 0.00	(231.0) 0.41	(76.7) 0.17	(110.4) 0.28	(47.0) 0.11	(4.4) 0.05	(104.0) 0.17	(76.9) 0.22	(15.3) 0.12	(741.0) 0.14
Cumulative Effects													
Total Cumulative Riparian Disturbance (Existing+Project+Likely Future)	(2,766.7) 3.25	(1,163.3) 3.67	(6,307.2) 10.74	(688.3) 1.50	(13,930.2) 24.77	(9,170.6) 19.87	(10,195.2) 25.65	(8,863.5) 20.15	(1,915.5) 22.99	(9,059.5) 14.52	(5,193.6) 15.16	(1,571.1) 12.67	(70,824.7) 13.50
Total Cumulative Riparian Disturbance without Project (Existing+Likely Future)	(2,754.4) 3.24	(1,157.6) 3.65	(6,229.2) 10.61	(688.0) 1.50	(13,889.0) 24.70	(9,166.4) 19.86	(10,184.5) 25.62	(8,793.6) 19.99	(1,913.0) 22.96	(9,030.9) 14.47	(5,178.0) 15.11	(1,568.6) 12.65	(70,553.2) 13.45
Total Cumulative Riparian Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(2,719.2) 3.20	(1,163.3) 3.67	(6,279.4) 10.69	(688.3) 1.50	(13,699.2) 24.36	(9,093.9) 19.70	(10,084.8) 25.37	(8,816.5) 20.04	(1,911.1) 22.94	(8,955.5) 14.35	(5,116.7) 14.94	(1,555.8) 12.55	(70,083.7) 13.36

Notes:
1 The Lower Fraser River and Squamish watersheds are not included because Project riparian disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).
2 Calculations based on an average of 30 m riparian area on each bank at all waterbodies.
3 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

Given that the Project is adjacent to existing linear disturbances and clearings, where practical, and the Project's contribution is 0.05% of combined riparian disturbance, the Project's contribution to total watershed riparian disturbance is of low magnitude. The cumulative effect of clearing riparian vegetation is considered to be reversible in the medium to long-term, depending on the pre-existing vegetation community (*e.g.*, grasses and shrubs regenerate within several years, but tree canopy regrowth is expected to extend into the long-term) (Table 8.6-5, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on riparian habitat is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities causing disturbance of riparian vegetation occurs during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project's contribution to cumulative changes in riparian habitat occurs during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.
- Reversibility: medium to long-term – depending upon the pre-construction vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the extent of clearing or alteration of riparian vegetation required for maintenance activities.
- Magnitude: low – the Project's incremental contribution represents 0.05% of the combined riparian disturbance; for comparison purposes a change in the hazard index of 0.1 is equivalent to a 3% increase in riparian disturbance as per the BC Interior Watershed Assessment Procedure. The Project will implement federal and provincial guidance recommendations and the proposed pipeline corridor will follow existing linear disturbances for approximately 89% of its length to reduce watershed-scale riparian disturbance.
- Probability: high – clearing or disturbance of riparian vegetation is expected to occur at all trenched watercourse crossings and any existing activities and/or reasonably foreseeable developments within the Aquatics RSA occurring in proximity to watercourses, having the potential to cause changes in riparian habitat.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.2 Fish and Fish Habitat Indicator – Instream Habitat

Fish need spawning, incubation, rearing, adult feeding and overwintering habitats over their lifetime. The importance of these habitats varies between species and populations and the availability of one or more components may be limiting. Migrant populations must pass through several distinct habitats while moving between feeding, breeding and overwintering areas; these migration corridors are also important habitat features (Meehan 1991).

Direct habitat loss occurs where the bed or banks of waterbodies are disturbed and recovery to preconstruction conditions does not occur. This reduces the quantity of habitat for specific species and life history stages. In extreme cases like stream diversions and channel dewatering, habitat for all aquatic species may be lost. Urban or agricultural development on lakeshores such as dykes, docks, marinas and vegetation removal can alter the physical structure of inshore habitats, rendering them unsuitable for spawning or rearing (Ford *et al.* 1995).

Habitat alteration occurs where waterbodies are disturbed and habitat attributes such as substrate and depth are deliberately or inadvertently changed. In cases where recovery of existing habitat units is allowed or encouraged, the effect of habitat alteration will occur only until the pre-construction conditions are re-established at watercourse crossings. Long-term or permanent habitat alteration can occur where recovery or restoration of different habitat units is accepted (*e.g.*, converting shallow riffle areas to deeper pools). Habitat may also be altered by the introduction of non-native or exotic vegetation that modifies substrate, banks or trophic relationships. Grazing where cattle have direct access to stream channels can

disturb instream substrates, negatively impact streambank structure, and result in deposition of manure and urine in the stream.

Changes in water quality and temperature may occur downstream of industrial and municipal stormwater and cooling pond discharges. Indirect introduction of chemical contaminants may also occur where compounds are adsorbed to sediment, deposited from the atmosphere, or released during accidents and malfunctions. Finally, water level control structures, water withdrawals and direct or indirect changes in seasonal flow patterns and peak and minimum flows (*e.g.*, from forest clearing, road networks and hydrostatic testing) can alter instream habitat.

Construction and maintenance of road, transportation, and utility watercourse crossings and other clearing or disturbance of riparian habitat can alter the physical characteristics of a watercourse's bed and banks, result in short-term or chronic erosion that affects water quality and substrate composition, and cause inadvertent inflow of road salt and contaminants from accidental spills. The continued use of these rights-of-way for stream access can exacerbate this concern. The influence of these combined changes on instream habitat depends upon several factors, including: natural variability in channel structure and water quality; season, the volume and extent of contamination or sedimentation; and the type of habitat lost or altered and its use by each species and life cycle stage.

The combined area of instream habitat disturbance was used as a measure of the potential direct disturbance within a stream channel, thereby allowing the Project's contribution to cumulative effects to be estimated. Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. The area of instream habitat potentially lost or altered by existing activities, the Project, and linear reasonably foreseeable developments were calculated (linear features as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1). GIS hydrology data available for Alberta and BC only provides an indication of channel width for major rivers (*i.e.*, Freshwater Atlas [FWA] of BC river dataset and Base Features hydrology dataset for Alberta). Consequently, Project-specific watercourse crossing data were used to calculate an average channel width on a provincial basis for all streams not included in the major river datasets. Assumptions in the calculation of instream disturbance include:

- it was assumed that instream disturbance would occur at only 50% of mapped crossings, recognizing that only a limited number of existing crossings may continue to contribute to instream disturbance (Harper and Quigley 2000); and

- crossings by transmission lines and cutlines were assumed to not contribute to instream disturbance.

Existing activities that have potentially resulted in disturbed instream habitat include agriculture, rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational use of linear features, and oil and gas pipelines. It is expected that the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1) will have the potential to act cumulatively to increase instream disturbance within the Aquatics RSA. Note that instream disturbance attributed to reasonably foreseeable development is underestimated because spatial data on future harvesting and associated roads was not available.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no instream habitat in the greenbelt is affected by this reasonably foreseeable development or the Project. Effects of the Project on instream habitat were addressed in Section 7.2.7.

Instream disturbance estimates for existing activities, the Project, and reasonably foreseeable developments are provided in Tables 8.6-8 and 8.6-9, for each watershed crossed by the Project. If practical, approximately 22 watercourses along the proposed pipeline corridor will be crossed using a trenchless crossing technique. Therefore, Tables 8.6-8 and 8.6-9 provide the following two estimates of instream disturbance arising from construction of the Project: assuming all proposed trenchless crossings are implemented, and assuming none of the proposed trenchless crossings are implemented.

TABLE 8.6-8

ESTIMATED DISTURBANCES OF INSTREAM AREA WITHIN THE ALBERTA AQUATICS RSA

Instream Disturbance Assessment Scenario	Area (ha) and Percentage of Instream Disturbance for each Watershed[1] in Alberta Aquatics RSA							
	Sturgeon River	Lower N. Saskatchewan River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta RSA Total
Total Instream Area in each Watershed	472.25	1,081.22	4,790.75	2,723.17	3,016.75	2,777.99	2,483.98	17,346.11
Existing Instream Disturbance								
Existing Disturbance of Instream Area[2]	(4.30) 0.91	(11.50) 1.06	(13.66) 0.29	(10.04) 0.37	(7.23) 0.24	(7.25) 0.26	(6.67) 0.27	(60.65) 0.35
Future Disturbance								
Area of Instream Disturbance Attributed to the Project, Assuming No Trenchless Crossings (Project)[2]	(0.06) 0.01	(0.01) < 0.01	(0.07) < 0.01	(0.26) 0.01	(0.02) < 0.01	(0.33) 0.01	(0.18) 0.01	(0.93) < 0.01
Area of Instream Disturbance Attributed to the Project, Assuming Trenchless Crossings are Constructed (Project)[2]	(0.06) 0.01	(0.01) < 0.01	(0.07) < 0.01	(0.18) 0.01	(0.02) < 0.01	(0.04) < 0.01	(0.18) 0.01	(0.56) < 0.01
Area of Instream Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[2]	(0.24) 0.05	(3.55) 0.33	(0.48) 0.01	(1.85) .07	(0.27) < 0.01	(0.45) 0.02	(0.10) < 0.01	(6.94) 0.04
Cumulative Effects (Assuming no Trenchless Crossings by Proposed Project)								
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(4.60) 0.97	(15.06) 1.39	(14.21) 0.30	(12.15) 0.45	(7.52) 0.25	(8.03) 0.29	(6.95) 0.28	(68.52) 0.40
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(4.54) 0.96	(15.05) 1.39	(14.14) 0.30	(11.89) 0.44	(7.50) 0.25	(7.70) 0.28	(6.77) 0.27	(67.59) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(4.36) 0.92	(11.51) 1.06	(13.73) 0.29	(10.30) 0.38	(7.25) 0.24	(7.58) 0.27	(6.85) 0.28	(61.58) 0.36
Cumulative Effects (Assuming all Proposed Project Trenchless Crossings are Constructed)								
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(4.60) 0.97	(15.06) 1.39	(14.21) 0.30	(12.07) 0.45	(7.52) 0.25	(7.74) 0.28	(6.95) 0.28	(68.15) 0.39
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(4.54) 0.96	(15.05) 1.39	(14.14) 0.30	(11.89) 0.44	(7.50) 0.25	(7.70) 0.28	(6.77) 0.27	(67.59) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(4.36) 0.92	(11.51) 1.06	(13.73) 0.29	(10.22) 0.38	(7.25) 0.24	(7.29) 0.26	(6.85) 0.28	(61.21) 0.35

Notes: 1 The Middle North Saskatchewan River watershed is not included because Project instream disturbance in this watershed is located within the City of Edmonton, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

2 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

TABLE 8.6-9

ESTIMATED DISTURBANCES OF INSTREAM AREA WITHIN THE BC AQUATICS RSA

Instream Disturbance Assessment Scenario	Area (ha) and Percentage of Instream Disturbance for each Watershed[1] in BC Aquatics RSA											
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Fraser Canyon	Harrison River	Chilliwack River	BC RSA Total
Total Instream Area in each Watershed	6,116.78	1,385.25	4,652.93	2,522.38	5,565.26	4,160.23	2,781.32	2,131.11	5,350.18	7,506.40	753.19	42,925.03
Existing Instream Disturbance												
Existing Disturbance of Instream Area[2]	(7.31) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.46) 1.01	(24.00) 0.45	(24.57) 0.33	(3.60) 0.48	(168.02) 0.39
Future Disturbance												
Area of Instream Disturbance Attributed to the Project, Assuming No Trenchless Crossings (Project)[2]	(0.48) 0.01	(0.17) 0.01	(2.21) 0.05	(0.25) 0.01	(0.59) 0.01	(1.18) 0.03	(0.16) 0.01	(1.06) 0.05	(0.95) 0.02	(0.49) 0.01	(0.05) 0.01	(7.59) 0.02
Area of Instream Disturbance Attributed to the Project, Assuming Trenchless Crossings are Constructed (Project)[2]	(0.48) 0.01	(0.17) 0.01	(0.52) 0.01	(0.0) 0.00	(0.52) 0.01	(0.06) < 0.01	(0.16) 0.01	(0.81) 0.04	(0.75) 0.01	(0.49) 0.01	(0.05) 0.01	(4.01) 0.01
Area of Instream Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[2]	(0.17) < 0.01	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.07) < 0.01	(0.78) 0.01	(0.14) < 0.01	(0.13) 0.02	(1.29) < 0.01
Cumulative Effects (Assuming no Trenchless Crossings by Proposed Project)												
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(7.96) 0.13	(1.42) 0.10	(17.58) 0.38	(2.87) 0.11	(25.22) 0.45	(24.76) 0.60	(19.79) 0.72	(22.59) 1.06	(25.73) 0.48	(25.20) 0.34	(3.78) 0.51	(176.90) 0.41
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(7.48) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.53) 1.01	(24.78) 0.46	(24.71) 0.33	(3.73) 0.50	(169.31) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(7.79) 0.13	(1.42) 0.10	(17.58) 0.38	(2.87) 0.11	(25.22) 0.45	(24.76) 0.60	(19.79) 0.72	(22.52) 1.06	(24.95) 0.47	(25.06) 0.34	(3.65) 0.49	(175.61) 0.41
Cumulative Effects (Assuming all Proposed Project Trenchless Crossings are Constructed)												
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(7.96) 0.13	(1.42) 0.10	(15.89) 0.34	(2.62) 0.10	(25.15) 0.45	(23.64) 0.57	(19.79) 0.72	(23.34) 1.05	(25.53) 0.48	(25.20) 0.34	(3.78) 0.51	(173.32) 0.40
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(7.48) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.53) 1.01	(24.78) 0.46	(24.71) 0.33	(3.73) 0.50	(169.31) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(7.79) 0.13	(1.42) 0.10	(15.89) 0.34	(2.62) 0.10	(25.15) 0.45	(23.64) 0.57	(19.79) 0.72	(22.27) 1.04	(24.75) 0.46	(25.06) 0.34	(3.65) 0.49	(172.03) 0.40

Notes:

1 The Lower Fraser River and Squamish watersheds are not included because Project instream disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

The Similkameen watershed is not included because there is no Project instream disturbance in this watershed.

2 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

Potential instream disturbance currently ranges from 0.09-1.06 % with the highest proportion in the Lower North Saskatchewan River watershed, as was the case for riparian disturbance. The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally in all watersheds (*i.e.*, increase of 0.04% in Alberta and 0.02% in BC), with greatest total disturbance predicted to remain highest in the Lower North Saskatchewan watershed. The Project's overall contribution to combined instream habitat disturbance would be < 0.01% in Alberta and 0.02% in BC; the Project's contribution to instream disturbance is projected to be highest in the Upper North Thompson and Lower Nicola river watersheds at 0.05%. The Project's effect on instream disturbance would be reduced if all proposed trenchless crossings are constructed, particularly in BC, to approximately 0.01% of available habitat.

Trenched pipeline crossings, the installation, use and removal of temporary vehicle crossings, and hydrostatic testing associated with the Project will likely result in a temporary disruption of instream habitat function; however, some existing and reasonably foreseeable developments can be expected to cause long-term, continuous effects on water quality and flow characteristics. The Project's contribution to changes in instream habitat function will be reduced through the use of trenchless crossings where practical, and the implementation of industry-standard mitigation measures provided in Section 7.0 and the Pipeline EPP (Volume 6B), which have been recommended by industry as well as provincial and federal agencies (*e.g.*, CAPP *et al.* 2005) as effective measures to reduce the loss and alteration of instream habitat. A fish habitat compensation/offset plan may be developed to ensure serious harm to fish or any permanent alteration to, or destruction of, fish habitat does not result. Water quality monitoring will be conducted to document potential sediment loading from instream activities where sensitive fish habitat is present. In addition, it is anticipated that many other land users will implement mitigation measures prescribed by legislation or identified in federal and provincial guidance documents to reduce incremental effects of their activities (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6D) are deemed to be warranted to reduce the potential for cumulative effects on instream disturbance.

Given that the Project's contribution to combined instream disturbance is 0.01%, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to total watershed instream loss is concluded to be of low magnitude. The Project's contribution to cumulative effects on instream habitat loss and alteration is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential continued off-highway vehicle activity (Table 8.6-5, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on instream habitat is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to short-term – Project activities contributing to disturbance of instream habitat occur during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).

- Frequency: isolated to occasional – the Project events contributing to the cumulative changes to instream habitat occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.

- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and future flow regime, and potential continued stream access by off-highway vehicles.

- Magnitude: low – in addition to the construction of trenchless crossings where practical, alignment along existing rights-of-way where possible, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, will not substantially contribute to total instream disturbances in the Aquatics RSA.

- Probability: high – bank and instream activities at all trenched watercourse crossings and any existing activities and/or reasonably foreseeable developments within the Aquatics RSA occurring in proximity to watercourses have the potential to cause changes in instream habitat.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.3 Fish and Fish Habitat Indicator – Fish Mortality and Injury

Combined Effects on Fish Mortality and Injury Due to Sedimentation and Access

Fish population dynamics reflect the combined influence of physical, chemical and biotic factors and harvest on growth, survival and reproduction. As a result, observed population size and parameters vary greatly among populations and years (Hayes *et al.* 1996, Kocovsky and Carline 2001, Mosindy *et al.* 1987). Human sources of fish mortality and injury in the Aquatics RSA include commercial, recreational, and subsistence harvest, water withdrawals, sedimentation (due to instream construction and off-road vehicle fordings), and acute and chronic effects from approved or accidental discharge of contaminants.

The construction of new rights-of-way (*e.g.*, pipeline or transmission line) can result in increased access along the resulting corridors for a variety of other resource user groups (*e.g.*, off-highway vehicles, anglers). In turn, this can potentially result in negative effects on fishes and their habitat either through direct harvesting or indirect effects such as fish habitat degradation and sediment input resulting from vehicle fording. The introduction of fine sediment to watercourses, right-of-way runoff and erosion can have sub-lethal (*e.g.*, irritation of gill tissues) and lethal (*e.g.*, suffocation of developing embryos) effects on fish and can also cause downstream sediment deposition that alters substrate composition and modifies the availability and suitability of habitat (Anderson *et al.* 1996, Newcombe and MacDonald 1991).

Species of special concern or sensitive watersheds and fish populations are at a greater risk of over exploitation. Increased access may contribute to angler overharvest, which has been reported as one of the primary sources of fisheries declines in western Canada (Post and Johnston 2002). Restrictive harvest regulations are implemented in BC to protect sensitive species and reduce the potential for overharvest by anglers (BC MFLNRO 2011b). Stream crossing density was used as a quantifiable measure of erosion, habitat loss, and access hazard for aquatic ecosystems; thereby, allowing the Project's contribution to cumulative effects on fish injury and mortality to be estimated. Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. Stream crossing density due to existing activities, the Project and reasonably foreseeable developments were calculated.

Stream crossings in the RSA resulting from existing activities include railways, transmission lines, oil and gas features (*e.g.*, cutlines, pipelines), and primary, secondary, and tertiary roads. It is expected that the Project and reasonably foreseeable linear developments (as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1) will have the potential to act cumulatively to increase the stream crossing density within the Aquatics RSA.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no streams in the greenbelt are affected by this reasonably foreseeable development or the Project. Effects of the Project on fish mortality and injury were addressed in Section 7.2.7.

Results of the stream crossing density estimates are provided in Table 8.6.10 and 8.6.11 for each watershed crossed by the Project.

TABLE 8.6-10

ESTIMATED EXISTING AND FUTURE STREAM CROSSING DENSITY WITHIN THE ALBERTA AQUATICS RSA

Disturbance Assessment Scenario	Stream Crossing Density for Each Watershed[1] in Alberta Aquatics RSA (No. Crossings/km² WS)						
	Sturgeon River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta Aquatics RSA
Existing Disturbance							
Existing Stream Crossing Density	1.34	2.11	1.52	1.76	2.07	2.66	1.85
Future Disturbance							
Stream Crossing Density Attributed to the Project (Project)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01
Stream Crossing Density Attributed to Reasonably Foreseeable Developments (Likely Future)	< 0.01	0.01	0.01	0.01	< 0.01	0.01	0.01
Cumulative Effects							
Total Cumulative Stream Crossing Density (Existing+Project+Likely Future)	1.35	2.12	1.54	1.77	2.08	2.69	1.87
Total Cumulative Stream Crossing Density without Project (Existing+Likely Future)	1.35	2.12	1.53	1.77	2.08	2.67	1.86
Total Cumulative Stream Crossing Density Without Reasonably Foreseeable Development (Existing+Project)	1.35	2.11	1.53	1.76	2.07	2.68	1.86

Notes: 1 The Middle North Saskatchewan River watershed is not included because Project disturbance in this watershed is located within the city of Edmonton, and the city of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

The Lower North Saskatchewan River watershed is not included because there are no new stream crossing locations as a result of the Project in this watershed.

TABLE 8.6-11

ESTIMATED EXISTING AND FUTURE STREAM CROSSING DENSITY WITHIN THE BC AQUATICS RSA

Disturbance Assessment Scenario	Stream Crossing Density for each Watershed[1] in the BC Aquatics RSA (No. Crossings / km² WS)												
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Similkameen	Fraser Canyon	Harrison River	Chilliwack River	BC Aquatics RSA
Existing Disturbance													
Existing Stream Crossing Density	0.40	0.32	1.00	0.38	1.97	2.23	2.38	1.95	1.45	1.53	1.68	1.78	1.35
Future Disturbance													
Stream Crossing Density Attributed to the Project (Project)	0.01	0.01	0.05	< 0.01	0.02	< 0.01	0.01	0.05	0.01	0.01	0.02	< 0.01	0.02
Stream Crossing Density Attributed to Reasonably Foreseeable Developments (Likely Future)	0.03	0	0	0	0	< 0.01	0	0.04	0.02	0.06	0.07	0.07	0.02
Cumulative Effects													
Total Cumulative Stream Crossing Density (Existing+Project+Likely Future)	0.44	0.33	1.05	0.38	1.99	2.24	2.39	2.04	1.48	1.60	1.77	1.86	1.39
Total Cumulative Stream Crossing Density without Project (Existing+Likely Future)	0.44	0.32	1.00	0.38	1.97	2.24	2.38	1.99	1.47	1.59	1.75	1.85	1.37
Total Cumulative Stream Crossing Density Without Reasonably Foreseeable Development (Existing+Project)	0.41	0.33	1.05	0.38	1.99	2.24	2.39	2.00	1.46	1.54	1.70	1.79	1.37

Notes: 1 The Lower Fraser River and Squamish watersheds are not included because Project disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

Estimated fish mortality hazard, as measured using stream crossing density, currently ranges from 0.32 crossings/km^2 in the Canoe Reach watershed to 2.66 crossings/km^2 in the Athabasca River watershed, with an overall average of 1.54 crossings/km^2. Tertiary roads and cutlines account for more than 50% of the existing stream crossing density (Table 8.6-3). The Project and reasonably foreseeable developments would incrementally increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.01 crossings/km^2 in Alberta and 0.04 crossings/km^2 in BC), with combined values predicted to remain the highest in Athabasca watershed. In the BC Aquatics RSA, the Project and reasonably foreseeable developments contribute equally to this increase, whereas in Alberta, reasonably foreseeable developments have a greater effect. The Project contributes 0.01 crossings/km^2 to the combined stream crossing density in the watersheds in the Aquatic RSA. The mitigation measures outlined in Table 7.2.7.4 and provided in the Pipeline and Facilities EPPs (Volume 6B and 6C), including limiting the release of suspended sediment during instream activities and implementing access control measures on the pipeline right-of-way, will limit the potential cumulative effects arising from the Project. The alignment of the proposed pipeline corridor along existing rights-of-way as much as practical (*i.e.*, 89% of the total length) further limits the Project's contribution to increased access.

It is expected that many other land users will implement similar measures recommended in federal and provincial guidelines and best management practice documents identified in earlier sections. No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volume 6B and 6C) are deemed warranted (Table 7.2.7.4) to address the potential cumulative effects of fish injury and mortality.

The Project will apply mitigation to reduce construction-related effects, and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to total fish mortality and injury within the Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on fish mortality and injury is considered to be reversible in the long-term since harvester access will potentially continue along the right-of-way throughout operations (Table 8.6-5, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on fish mortality and injury due to sedimentation and access is provided below.

- Spatial Boundary: Aquatics RSA – Project disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to long-term – Project activities affecting fish mortality occur during construction (trench dewatering and sedimentation) and operations (access).
- Frequency: occasional to periodic – Project-related access changes to the combined effects on fish mortality occur intermittently and sporadically to repeatedly over the assessment period, depending on waterbody location and species present.
- Reversibility: long-term – harvester access will potentially continue throughout operations.
- Magnitude: low – the Project will be located adjacent to existing linear disturbances and clearings where practical which will create minimal new access for recreational fishermen and harvesters.
- Probability: high – it is likely that cumulative effects on fish mortality and injury will occur at the watershed scale.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Combined Effects Associated with Temporary Blockage of Fish Movements

Fish populations, particularly migrant populations, may pass through a number of distinct habitats while moving between feeding, breeding and overwintering areas. Consequently, migration corridors can be important habitat features (Meehan 1991).

Complete or partial blockage of fish movements has been documented for rail and road watercourse crossings (*e.g.*, 10-47% of culvert installations depending on the species; Burford *et al.* 2009,

MacPherson *et al.* 2012, Park *et al.* 2008). Temporary localized blockage of fish movements may occur during instream construction and affect the ability of fish to migrate upstream or downstream of crossings. Delays in the ability of fish to migrate can affect spawning migrations, increase likelihood of stress or injury, increase competition for food, and limit spatial separation between competing species (Lang *et al.* 2004). The timing (*i.e.*, an appropriate timing window and short duration) of the temporary stream blockage can limit the nature/extent of these potential effects.

Stream crossings contributing to this effect include existing and reasonably foreseeable road, rail and pipeline developments, the Project and those existing culverts that represent complete or partial movement barriers. Figures 8.6-1a, 8.6-1b and 8.6-1c show the Project, reasonably foreseeable development stream crossings and existing crossing locations.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no streams in the greenbelt are affected by this reasonably foreseeable development or the Project. Effects of the Project on fish mortality and injury were addressed in Section 7.2.7.

Given the short duration of a blockage event associated with a stream crossing, (*e.g.*, less than 2 days), the likelihood of overlap between such events (*i.e.*, between the Project and a reasonably foreseeable activity) within a watershed is limited. The Project's activities, including potential fish blockage at temporary vehicle crossings along temporary access and power lines, can also act cumulatively with existing crossings in the blockage of fish movement; however, the Project's contribution to fish passage barriers will be reduced by the mitigation measures outlined in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practice documents (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volume 6B and 6C) are deemed warranted.

The Project will apply mitigation to reduce construction-related effects, which include following least risk timing window recommendations and limiting the duration of fish blockage; consequently the Project's contribution to potential cumulative effects associated with blockage of fish movement within the Aquatics RSA is considered to be of low magnitude and reversible in the immediate to short-term (*i.e.*, once construction is completed) (Table 8.6-5, point 3[b]). A summary of the rationale for all of the significance criteria of combined cumulative effects on fish blockage is provided is provided below.

- Spatial Boundary: Aquatics RSA – Project disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to short-term – Project activities contributing to the potential cumulative effect occur during the construction phase (*i.e.*, instream pipeline construction and temporary vehicle crossings).

- Frequency: isolated – Project-related changes to the combined effects on fish movement occur during construction.

- Reversibility: immediate to short-term – once Project construction is complete; the temporary blockage will be removed (*i.e.*, immediate), and any blockage due to temporary vehicle crossings would be removed (*i.e.*, short-term).

- Magnitude: low – the Project's contribution to cumulative effects is expected to be low, because federal and provincial guidance recommendations will be implemented and permanent habitat loss will not occur.

- Probability: low – the potential for the Project's instream construction to act in a cumulative manner with other reasonably foreseeable developments is low.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.4 Fish and Fish Habitat Indicator – Indicator Species

Indicator species were identified for Alberta and BC which would reflect the regional differences in fish community composition, species abundance, and species of recreational, commercial and cultural importance, that could reasonably be encountered within watercourses in the Aquatics RSA. Six indicator species were selected for Alberta (*i.e.*, Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye), and five for BC (*i.e.*, bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead). A brief description of these species and their habitat requirements is provided in Section 5.7 as well as in Section 4.3 of the Fisheries (Alberta) Technical Report and Section 4.3 of the Fisheries (BC) Technical Report (Volume 5C). Distribution of indicator species within the Aquatics RSA is provided in Section 5.7. Section 7.2.7.6 provides a general discussion on the indicator selection process, distribution, status and potential effects for each species.

The watershed disturbance measures (*i.e.*, riparian disturbance, instream disturbance and stream crossings) as discussed in previous sections, were considered in the evaluation of potential cumulative effects on each indicator species allowing the Project's contribution to this potential cumulative effect to be estimated. Combined disturbance that has occurred due to existing activities within the Aquatic RSA as well as the expected disturbance attributed to the construction of the Project and reasonably foreseeable developments were identified by watershed in Tables 8.6-6 to 8.6-11 in the previous sections.

Arctic Grayling (Alberta Indicator Species)

As Section 7.2.7.6 indicates, some potential effects to Arctic grayling are likely (*e.g.*, alteration of riparian and instream habitat) while others are less likely to occur (*e.g.*, injury or mortality of Arctic grayling as a result of increased sedimentation). The distribution of Arctic grayling includes the Pembina, Lower McLeod and Upper McLeod river watersheds.

Cumulative effects hazard resulting from riparian disturbance is currently High in the Pembina and Lower McLeod river watersheds and Moderate in the Upper McLeod River watershed, ranging from 11.97-45.06%; a similar trend is apparent with instream disturbance. The Project and reasonably foreseeable developments would increase riparian disturbance incrementally in the three watersheds (*i.e.*, from 0.06-1.32%); this increase is largely due to reasonably foreseeable development. Project specific riparian disturbance ranges from 0.01-0.05% and is projected to be highest in the Pembina watershed.

The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally by < 0.01-0.08%. The projected Project-specific contribution ranges from < 0.01-0.01% and would be further reduced by the implementation of trenchless crossings in the Pembina and Lower McLeod watersheds.

The Project's contribution to the potential cumulative effects on Arctic grayling will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given the comparatively small increase in riparian and instream disturbance due to the Project as noted above, the alignment along existing rights-of-way where practical, and the implementation of mitigation to reduce construction and operation-related effects, including proposed trenchless crossings, the Project's contribution to potential cumulative effects associated with Arctic grayling within the Aquatics RSA is of low magnitude. The cumulative effect of disturbance is considered to be reversible in the medium to long-term, depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community (Table 8.6-5, point 4[a]). A summary of the rationale for all of the significance criteria of the combined cumulative effects of the Project on Arctic grayling is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to short-term – Project activities affecting Arctic grayling occur during the construction phase or maintenance during the operations phase (and lasting 2 days to less than 1 year).

- Frequency: isolated to occasional – the Project events contributing to the cumulative changes to instream and riparian habitat occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.

- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community, and the extent of clearing or alteration of riparian vegetation required for maintenance activities.

- Magnitude: low – in addition to the construction of trenchless crossings where practical, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, the Project's contribution to cumulative effects on Arctic grayling is expected to be low.

- Probability: high – it is likely that cumulative effects on Arctic grayling will occur.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

Athabasca Rainbow Trout and Bull Trout (Alberta Indicator Species)

In the indicator species discussions in Section 7.2.7.6, the loss or alteration of instream habitat is identified as the greatest contributor to combined effects for both Athabasca rainbow trout and bull trout. These species are present primarily in the western half of the Alberta RSA, namely the Lower McLeod, Upper McLeod and Athabasca river watersheds, though bull trout is distributed within the Pembina River watershed as well.

Current levels of disturbance of instream habitat ranging from 0.24-0.37%, with the highest level in the Pembina River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable development would increase instream disturbance incrementally by < 0.01-0.08%. The highest increase is projected to occur in the Pembina River watershed, and is due primarily to reasonably foreseeable development. The predicted Project-specific contribution ranges from < 0.01-0.01% and would be further reduced by the implementation of proposed trenchless crossings in the Pembina and Lower McLeod watersheds.

The Project's contribution to the potential cumulative effects on Athabasca rainbow trout and bull trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given that the Project's contribution to combined instream disturbance is < 0.1-0.01%, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to cumulative effects on Athabasca rainbow trout and bull trout is of low magnitude. The Project's contribution is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential continued off-highway vehicle activity (Table 8.6-5, point 4[b]). A summary of the rationale for all of the significance criteria of combined cumulative effects on Athabasca rainbow trout and bull trout is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to short-term – Project activities affecting Athabasca rainbow trout and bull trout occurs during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).

- Frequency: isolated to occasional – the Project's contribution to the combined effects on Athabasca rainbow trout and bull trout occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.

- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and future flow regime, and potential continued stream access by off-highway vehicles.

- Magnitude: low – in addition to the construction of trenchless crossings where practical, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, Project's contribution to cumulative effects on Athabasca rainbow trout and bull trout is expected to be low.

- Probability: high – it is likely that cumulative effects on Athabasca rainbow trout and bull trout will occur.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

Burbot (Alberta Indicator Species)

As discussed in Section 7.2.7.6, burbot have become more susceptible to natural and anthropogenic habitat disturbance than in the past (Stapanian *et al.* 2010), however, mortality or injury is the greatest contributor to combined effects for this species. Burbot is distributed across all Alberta watersheds in the Aquatics RSA.

Estimated fish injury and mortality hazard, as measured using stream crossing density, currently ranges from 1.52 crossings/km^2 in the Pembina River watershed to 2.66 crossings/km^2 in the Athabasca River watershed, with an overall average of 1.85 crossings/km^2 in the Alberta Aquatics RSA. The Project and reasonably foreseeable developments would slightly increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.01 crossings/km^2), with combined values predicted to remain the highest in Athabasca watershed.

The Project's contribution to the potential cumulative effects on burbot will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project will apply mitigation to reduce construction-related effects and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to effects associated with burbot within the Alberta Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on burbot is considered to be reversible in the long-term since harvester access will potentially continue throughout operations (Table 8.6-5, point 4[c]). A summary of the rationale for all of the significance criteria of combined cumulative effects on burbot is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to long-term – Project activities affecting burbot occur during construction (*e.g.*, trench dewatering) and operations (access).

- Frequency: isolated to periodic – Project-related access changes to the combined effects on burbot occur intermittently and sporadically to repeatedly over the assessment period, depending on waterbody location.

- Reversibility: long-term – harvester access will potentially continue throughout operations.

- Magnitude: low – the Project will be located adjacent to existing linear disturbances and clearings where practical which will create minimal new access for recreational fishermen and harvesters, and, consequently, the Project's contribution to cumulative effects on burbot is expected to be low.

- Probability: high – it is likely that cumulative effects on burbot will occur.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

Northern Pike and Walleye (Alberta Indicator Species)

Section 7.2.7.6 indicates that for both northern pike and walleye, weedy shoreline areas represent important habitat. Consequently, loss or alteration of riparian habitat is the greatest contributor to combined effects for these two species. Northern pike is distributed across all Alberta watersheds in the Aquatics RSA, whereas walleye is located in all but the Athabasca and Upper McLeod river watersheds.

The cumulative effects hazard based on riparian disturbance is currently moderate in the Upper McLeod River watershed (*i.e.*, 11.79%) and high in the rest of the Alberta Aquatics RSA, ranging from 19.03-75.63%. The highest level of existing riparian disturbance is in the Lower North Saskatchewan River watershed, and is due primarily to agriculture. Future aquatic cumulative effects hazard (including Project and reasonably foreseeable developments) incrementally increases in all watersheds, ranging from 0.06-1.32%, though the hazard levels will not be affected. The Project incrementally contributes to riparian disturbance from 0.01-0.10%, or an average of 0.03%.

The mitigation measures outlined in Section 7.2.7.4 (*e.g.*, seeding disturbed riparian areas with the appropriate native seed mix along with a quick establishing cover crop, and additional revegetation efforts, such as planting trees or shrubs at select locations), will limit the Project's contribution to cumulative effects. In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project's contribution to cumulative effects associated with northern pike and walleye is of low magnitude given that the Project's contribution is 0.03% of combined riparian disturbance and federal and provincial guidance recommendations will be implemented. The cumulative effect of clearing riparian vegetation is considered to be reversible in the medium to long-term, depending on the pre-existing vegetation community (Table 8.6-5, point 4[d]). A summary of the rationale for all of the significance criteria of combined cumulative effects on northern pike and walleye is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to short-term – Project activities affecting northern pike and walleye occur during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).

- Frequency: isolated to occasional – the Project's contribution to the events causing cumulative effects on northern pike and walleye occurs during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.

- Reversibility: medium to long-term – depending upon the pre-construction vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the extent of clearing or alteration of riparian vegetation required for maintenance activities.

- Magnitude: low – the Project's incremental contribution is 0.05% of the combined riparian disturbance and the Project will implement federal and provincial guidance recommendations to avoid permanent habitat loss, consequently the Project's contribution to cumulative effects on northern pike and walleye is expected to be low.

- Probability: high – it is likely that cumulative effects on northern pike and walleye will occur.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

Bull Trout/Dolly Varden (BC Indicator Species)

As discussed in Section 7.2.7.6, bull trout are susceptible to degraded water and habitat conditions from land disturbance such as roads and oil and gas disturbance (Alberta Sustainable Resource Development [ASRD] 2012, Brewin *et al.* 2001, Hammond 2004) and obstructions to movement (Hammond 2004) which makes contamination, loss or alteration of instream habitat the greatest contributor to combined effects for the bull trout/Dolly Varden indicator. This species has a broad distribution across the BC Aquatics RSA, being present in all but the South Thompson, Harrison and Squamish river watersheds.

Current levels of disturbance of instream habitat range from 0.09-1.01%, with the highest level in the Lower Nicola River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable development would increase instream disturbance incrementally by 0.02-0.05%. The highest increase is projected to occur in Lower Nicola and Upper North Thompson river watersheds, due primarily to the Project in both cases. The projected Project-specific contribution ranges from 0.01-0.05%, or an average of 0.02%, and the overall average would be further reduced to 0.01% with the implementation of trenchless crossings.

The Project's contribution to the potential cumulative effects on bull trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given that the Project's contribution to combined instream disturbance is 0.02% in the BC Aquatics RSA, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to cumulative effects associated with bull trout/Dolly Varden is of low magnitude. The Project's contribution to cumulative effects on this species is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential for continued off-highway vehicle activity (Table 8.6-5, point 4[e]). The significance rationale of combined effects on bull trout/Dolly Varden is considered to be similar to the rationale for combined effects provided above under the Athabasca rainbow trout and bull trout indicator.

Chinook and Coho Salmon and Cutthroat Trout (British Columbia Indicator Species)

Section 7.2.7.6 indicates that contamination, loss or alteration of instream and riparian habitat are equal contributors to combined effects for these three species, given their sensitivity to habitat degradation. Chinook and coho salmon have a broad distribution across the BC Aquatics RSA though cutthroat trout are limited to the western portion, from the Fraser Canyon westwards.

Cumulative effects hazard resulting from riparian disturbance is currently low in the Upper Fraser River, Canoe Reach and Clearwater River watersheds, moderate in the Upper North Thompson, Fraser

Canyon, Harrison, and Chilliwack river watersheds and high in all remaining watersheds, a similar trend is apparent with instream disturbance. The Project and reasonably foreseeable developments would increase riparian disturbance incrementally in all watersheds, from 0.0-0.48%, though will not affect the hazard level of any of the watersheds. Project-specific riparian disturbance ranges from < 0.01-0.15% and is projected to be highest in the Lower Nicola River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally by 0.01-0.05% across the watersheds in the BC Aquatics RSA. The projected Project-specific contribution ranges from 0.01-0.05%, for an average of 0.02 and would be further reduced by 0.01% with the implementation of trenchless crossings. The Project's contribution is highest in the Upper North Thompson and Lower Nicola river watersheds (0.05%), though trenchless crossings are proposed in both of these watersheds which would reduce the Project's influence if implemented.

The Project's contribution to the potential cumulative effects on Chinook and coho salmon and cutthroat trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given the level of riparian and instream disturbance due to the Project as noted above, alignment along existing rights-of-way where possible, and mitigation to reduce construction and operation-related effects, including trenchless crossings where practical, the Project's contribution to potential cumulative effects associated with Chinook and coho salmon and cutthroat trout within the Aquatics RSA is of low magnitude. The cumulative effect of disturbance is considered to be reversible in the medium to long-term, depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community (Table 8.6-5, point 4[f]). The significance rationale of combined effects on Chinook and coho salmon and cutthroat trout is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Rainbow Trout/Steelhead (British Columbia Indicator Species)

As discussed in Section 7.2.7.6, rainbow trout are migratory in nature and will move to new areas should habitat conditions change (Natural Resources Conservation Service 2000), therefore, mortality or injury is the greatest contributor to combined effects for this species. Rainbow trout is distributed across all BC watersheds in the Aquatics RSA.

Estimated fish injury and mortality hazard, as measured using stream crossing density, currently ranges from 0.32 crossings/km^2 in the Canoe Reach watershed to 2.38 crossings/km^2 in the South Thompson River watershed, with an overall average of 1.35 crossings/km^2 in the BC Aquatics RSA. The Project and reasonably foreseeable developments would incrementally increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.04 crossings/km^2 across the BC Aquatics RSA), with combined values estimated to remain highest in South Thompson River watershed. The Project contributes 0.02 crossings/km^2 to the combined stream crossing density in the watersheds in the BC Aquatic RSA, with the largest contribution projected in the Upper North Thompson and Lower Nicola river watersheds.

The Project's contribution to the potential cumulative effects on rainbow trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project will apply mitigation to reduce construction-related effects and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to cumulative effects associated with rainbow trout within the BC Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on rainbow trout is considered to be reversible in the long-term since harvester

access will potentially continue throughout operations (Table 8.6-5, point 4[g]). The significance rationale of combined effects on rainbow trout is considered to be similar to the rationale for combined effects provided above under the burbot indicator.

8.6.3.5 Combined Cumulative Effects on Fish and Fish Habitat

Disturbance from Project activities (*i.e.*, alteration of riparian habitat, alteration of instream habitat, effects on fish mortality and injury) may act in combination with existing and reasonably foreseeable developments to affect fish and fish habitat in the Aquatics RSA, as described above for species of management and public concern. The impact balance is considered negative. The implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) will reduce the severity of cumulative effects arising from the Project and other reasonably foreseeable developments. The combined cumulative effect of the Project on fish and fish habitat is of low magnitude, reversible in the immediate to long-term and of high probability (Table 8.6-5, point 5[a]). A summary of the rationale for all the significance criteria for Project's contribution to cumulative effects on the fish and fish habitat indicators is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA and, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to long-term – Project activities contributing to combined cumulative effects on fish and habitat occur during the construction phase (*e.g.*, sedimentation from instream activity) and extend to the operations phase (*e.g.*, access).

- Frequency: isolated to periodic – Project related activities contributing to combined cumulative effects on fish and habitat range from isolated activities (*e.g.*, blockage of fish movement during construction) to intermittent, but repeated events over the assessment period (*e.g.*, access related effects).

- Reversibility: immediate to long-term – certain Project effects are reversed immediately, such as removal of a temporary blockage event upon completion of instream work, while other Project-effects, such as disturbance of riparian areas, depend on the preconstruction-vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy re-growth is expected to extend into the long-term).

- Magnitude: low – the Project's contribution to combined cumulative effects on fish and fish habitat is expected to be low because the project will be located along existing linear disturbance where practical, will implement trenchless crossings where practical, and will implement recommended federal and provincial industry standard guidelines.

- Probability: high – it is likely that these cumulative combined effects will occur.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.4 Summary

As identified in Table 8.6-5, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on fish and fish habitat within the Aquatics RSA will be not significant.

8.7 Wetlands

The below subsection outlines how the Project may contribute to cumulative effects on the wetland loss or alteration indicator in combination with existing activities and reasonably foreseeable developments.

8.7.1 Reasonably Foreseeable Developments

Tables 8A.1-1, 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Wetland RSA considered in the evaluation of cumulative effects on the wetland loss or alteration indicator. Description of these developments is provided in Section 8.1.4 and shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. In the Wetland RSA, there are approximately 68 mapped reasonably foreseeable developments either fully within the Wetland RSA or, for some transmission lines and pipelines, partially within the Wetland RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 2,387 mapped reasonably foreseeable minor oil and gas developments in Alberta: 502 pipelines; 1,617 facilities; and 268 wells (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status, location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of disturbance due to existing activities within the Wetland RSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.7-1 and 8.7-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority).

TABLE 8.7-1

EXISTING AND NEW AREAL DISTURBANCE IN THE WETLAND RSA – ALBERTA

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Oil and Gas Pipelines	940.3	11.9	66	77.9	1,018.2
Primary Roads	252.8	0	0	0	252.8
Secondary Roads	476.2	0	0	0	476.2
Tertiary/Access Roads	174.5	0	0	0	174.5
Trails (Recreation/Wildlife)	0	0	0	0	0
Railways	22	0	0	0	22
Cut lines, Seismic Lines	2,488.8	0	0	0	2,488.8
Transmission/Power Lines	212	0	11.8	11.8	223.8
Oil and Gas Well Sites	558.2	0	4.9	4.9	563.1
Buried Utility Lines	20.8	0	0	0	20.8
Commercial/Industrial Features	717.4	0	112.1	112.1	829.5
Cities/Towns/Communities	672.1	0	0	0	672.1
Cutblocks	1,799.6	0	0	0	1,799.6
Quarries/Mines/Aggregates	969.3	0	183.9	183.9	1,153.2
Crop/Pasture Land	15,022.3	0	0	0	15,022.3
Buildings	369.9	0	0	0	369.9
Airports/Airfields	0.1	0	0	0	0.1
Recreation	7.1	0	0	0	7.1
Hydroelectric Infrastructure	0	0	0	0	0
Total	24,703.4	11.9	378.7	390.6	25,094.0
Total Area of Wetland RSA: 161,125.9 ha					

TABLE 8.7-2

EXISTING AND NEW AREAL DISTURBANCE IN THE WETLAND RSA – BC

Land Use Feature	Existing Areal Disturbance (ha)[1]	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Oil and Gas Pipelines	27.1	39.5	2.2	41.7	68.8
Primary Roads	24.5	0	0.1	0.1	24.6
Secondary Roads	28.5	0	0	0	28.5
Tertiary/Access Roads	19.7	0	0	0	19.7
Trails (Recreation/Wildlife)	0	0	0	0	0
Railways	18.8	0	0	0	18.8
Cut Lines, Seismic Lines	3.4	0	0	0	3.4
Transmission/Power Lines	39.3	0.4	3.5	3.9	43.2
Oil and Gas Well Sites	0	0	0	0	0
Buried Utility Lines	5.3	0	0	0	5.3
Commercial/Industrial Features	11.2	0	0.9	0.9	12.1
Cities/Towns/Communities	168.6	0	0	0	168.6
Cutblocks	940.1	0	0	0	940.1
Quarries/Mines/Aggregates	47.2	0	35.6	35.6	82.8
Crop/Pasture Land	455.9	0	0	0	455.9
Buildings	2.3	0	0	0	2.3
Airports/Airfields	0.4	0	0	0	0.4
Recreation	9.3	0	0	0	9.3
Hydroelectric Infrastructure	0	0	0	0	0
Total	1,801.5	39.9	41.0	80.9	1,882.4
Total Area of Wetland LSA: 32,755.8 ha					

Note: 1 Existing Areal Disturbance does not include the LMDA, but does include the Surrey Greenbelt.

8.7.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on the wetland loss or alteration indicator were identified in Section 7.11.1.8 and are listed in Table 8.7-3 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.7-3

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON WETLAND LOSS OR ALTERATION CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on wetland loss or alteration.	RSA	Pipeline Temporary Facilities Pump Stations Pipeline Reactivation	Past Development to Operation	Project contribution to cumulative increase in wetland disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including wetland substrate (*i.e.*, peat) salvaging, trenching, backfilling and reclamation, vehicle traffic, and temporary access road and shoo-fly installation and removal, and potential partial wetland infilling (*i.e.*, power line structures).

Note: 1 RSA = Wetland RSA.

8.7.3 Significance Evaluation of Potential Cumulative Effects

A quantitative analysis was conducted to evaluate the significance of the Project's contribution to cumulative environmental effects for the wetland function indicator as these changes over the existing data within the Footprint Study Area were quantifiable. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, a qualitative was used for determining the significance of the Project's contribution to cumulative environmental effects. The qualitative assessment for the wetland loss or alteration indicator relied on the professional judgment of the assessment team.

Table 8.7-4 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on the wetland loss or alteration indicator. The rationale used to evaluate the significance of the cumulative effect is provided below.

TABLE 8.7-4

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON WETLAND LOSS OR ALTERATION

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Wetland Loss or Alteration Indicator – Wetland Function									
1(a) Project contribution to cumulative increase in wetland disturbance.	Negative	RSA	Short to long-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant

Notes: 1 RSA = Wetland RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.7.3.1 Wetland Function

The proposed pipeline corridor travels through 4 ecozones and 11 ecoregions of Canada (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995), 5 wetland regions of Canada (Government of Canada 1986), 5 natural subregions of Alberta (Natural Regions Committee 2006) and 9 biogeoclimatic (BGC) zones of BC (BC MFLNRO 2012e, Meidinger and Pojar 1991). Wetlands within the wetland regions comprise between 5% and 40% of the land area (Natural Resources Canada [NRCan] 2009).

A quantitative cumulative effects approach was taken to determine the Project's wetland function disturbance. The wetland area determined for the Wetland LSA and RSA was based on the approximate area of wetlands. The quantitative assessment utilized existing databases (*i.e.*, CanVec for Alberta and the FWA for BC) in order to estimate the area of wetlands potentially disturbed by existing activities, Project-related and reasonably foreseeable developments.

CanVec is a data set that combines information from many databases such as the National Topographic Database, National Road Network and the National Hydrographic Network. CanVec maps approximately 90 different topographical entities. The hydrography level features include lakes, rivers and wetlands (NRCan 2012). When the wetlands identified through satellite imagery interpretation (1:10,000 scale) are overlaid by the CanVec wetland layer it appears that CanVec tends to pick up on larger wetland features that are wetter but misses smaller and often drier wetlands, which may underestimate the number of wetlands without standing water. The satellite imagery interpretation also suggested that CanVec may overestimate the area of some of these wetlands.

The BC FWA is a data set that maps the province's hydrologic features, based on the Terrain Resource Information Management base maps (1:20,000 scale). The BC FWA maps hydrologic features including streams, lakes and wetlands and is intended to be an authoritative source for inventory of freshwater resources in BC (Integrated Land Management Bureau 2010). Interpretation of satellite imagery (1:10,000 scale) overlaid by a BC FWA wetlands layer indicates that although the BC FWA classifies wetlands into only two categories (swamp and marsh), wetland classes such as fens are also captured within the two categories. Satellite imagery interpretation also suggested that the BC FWA underestimates wetland area. Wetlands identified through satellite imagery interpretation were typically at the same location as those in the BC FWA layer but the BC FWA consistently delineated a smaller area of wetland or missed smaller wetlands entirely. The BC FWA wetland features also tended to be centred on open water features or very wet areas, which potentially underestimates wetland areas without standing water.

It should be noted that these comparisons only focused on the areas within the Wetland LSA and not beyond.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis. The portion of the Golden Ears Connector development through a City of Surrey greenbelt was considered, but since no wetlands in the greenbelt are affected by this reasonably foreseeable development or the Project, it was also excluded from the analysis. Effects of the Project on wetlands were addressed in Section 7.2.8. Wetland function was evaluated at each wetland ecosystem encountered during the ground-based field work. Wetland functions documented during the existing (*i.e.*, pre-construction) evaluation will be compared to wetland functions observed along the reclaimed (*i.e.*, post-construction) construction right-of-way. The results of this comparison will be used to confirm the effectiveness and efficiency of mitigation and reclamation measures, and confirm the determination of loss or "no net loss" of wetland function included in the ESA.

Details on each of the wetland functional categories (*i.e.*, High, High-Moderate, Low-Moderate and Low Functional Conditions) can be found in Section 7.2.8.1.

Functional condition categories were documented for all wetlands ground-truthed during the 2012 and 2013 field programs. The sampling intensity determined to be appropriate for this Project is 100%. Of the wetlands identified to be crossed by the proposed pipeline corridor, 59% were ground-truthed during the 2012 and 2013 field programs. Functional assessments will be conducted at the remaining wetlands during supplemental studies. Based on the results of the functional assessments conducted during the

2012 and 2013 field programs and the professional judgment of the wetland assessment team, the functional condition categories were estimated for remaining wetlands within each segment along the proposed pipeline corridor. Categories are to be confirmed during the 2014 supplemental field program. The results of wetland functional condition categories along the proposed pipeline corridor were extrapolated out to the Wetland RSA to approximate wetland coverage and potential functional condition within this study area (Tables 8.7-5 and 8.7-6). Quantitative assessments were conducted for all pipeline segments. Following wetland surveys in 2014, once a final pipeline route has been determined, the assessment will be verified by comparing the 2014 field results to what was estimated during imagery review for the purposes of the cumulative effects assessment.

TABLE 8.7-5

FREQUENCY OF OCCURRENCE OF WETLANDS WITHIN THE PROPOSED PIPELINE CORRIDOR

Metric	Alberta	Alberta (minus Edmonton)	BC[1]	BC (minus LMDA)
Number and area of wetlands encountered (potential and ground-truthed)[2]	339; 382.5 ha	313; 364.8 ha	299; 206.9 ha	256; 191.8 ha
Number and area of wetlands encountered (ground-truthed)[2]	261; 318.2 ha	238; 300.8 ha	115; 122.1 ha	110; 120.1 ha
Number and area of wetlands of High Functional Condition	78; 176.9 ha	77; 174.8 ha	23; 59.3 ha	23; 59.3 ha
Frequency of wetlands of High Functional Condition (%)	29.9	32.4	20.0	20.9
Potential total number and area of wetlands of High Functional Condition	101; 75.7 ha	101; 118.2 ha	59; 41.0 ha	53; 39.7 ha
Number and area of wetlands of High-Moderate Functional Condition	142; 126.2 ha	125; 286.5 ha	74; 49.1 ha	74; 49.1 ha
Frequency of wetlands of High-Moderate Functional Condition (%)	54.4	52.5	64.3	67.3
Potential total number and area of wetlands of High-Moderate Functional Condition	184; 20.8 ha	164; 191.5 ha	191; 132.0 ha	171; 127.9 ha
Number and area of wetlands of Low-Moderate Functional Condition	41; 15.1 ha	396; 12.6 ha	17; 13.6 ha	12; 11.6 ha
Frequency of wetlands of Low-Moderate Functional Condition (%)	15.7	15.1	14.8	10.9
Potential total number and area of wetlands of Low-Moderate Functional Condition	53; 60.1 ha	47; 55.1 ha	44; 30.4 ha	28; 20.7 ha
Number and area of wetlands of Low Functional Condition[4,5]	0[5]; 0.0 ha	0; 0.0 ha	1; 0.1 ha	1; 0.1 ha
Frequency of wetlands of Low Functional Condition (%)[4,5]	0.0	0.0	0.9	0.9

TABLE 8.7-5 Cont'd

Metric	Alberta	Alberta (minus Edmonton)	BC[1]	BC (minus LMDA)
Potential total number and area of wetlands of Low Functional Condition	0; 0.0 ha	0.0	3; 1.9 ha	2; 1.7 ha

Notes:
1 Due to the low sampling frequency experienced along the BC segments as a result of limited land access, the number of wetlands has been combined together for this assessment.
2 Total number of wetlands encountered by the proposed pipeline corridor including potential wetlands and wetlands that have been ground-truthed during the 2012 and 2013 field programs.
3 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.
4 Based on the results of the ground-based field surveys it is anticipated that wetlands with Low Functional Condition along the Edmonton to Hinton Segment are not common.
5 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program. These observations do not conclude that wetlands with this functional condition are not present. These values will be updated following the 2014 supplemental surveys.

TABLE 8.7-6

AREA OF WETLANDS WITHIN THE WETLAND RSA

Province	Area of Wetland RSA (ha)[1]	Area of Wetland RSA (excluding Edmonton and LMDA) (ha)	Area of Wetlands of High Functional Condition (ha)	Area of Wetlands of High-Moderate Functional Condition (ha)	Area of Wetlands of Low-Moderate Functional Condition (ha)	Area of Wetlands of Low Functional Condition (ha)
Alberta	161,125.9	160,998.8	52,163.6	84,524.4	24,310.8	0.0
BC	32,755.8	28,959.4	5,994.6	19,315.9	3,127.6	260.6
Total	193,881.7	189,958.2	58,158.2	103,840.3	27,438.4	260.6

Note:
1 Areas of wetlands with the four functional conditions was determined based on the frequency of occurrence percentage documented in Table 8.7-5.

Permanent loss of wetland function is not anticipated to result from either the construction or operations phases of the proposed pipeline in trenched wetlands or at the pump stations; however, potential permanent loss of wetland function may occur as a result of the construction of the proposed power lines (*e.g.*, Kingsvale) if the placement of power line structures are within wetland boundaries and at a location that compromises overall wetland function The in-wetland structure placement will permanently reduce wetland area and this reduction may result in the overall loss of wetland function depending on the size of wetland and the type of lost habitat. Temporary alteration of wetland function may result during pipeline construction; however, best practices and mitigation measures will be employed to assist with the goal that no long-term or permanent alteration of wetland function will occur. No permanent disturbance to wetlands is anticipated to occur at pump stations.

At locations where wetland function may be lost due to the installation of the Kingsvale power line (*e.g.*, structures placed in wetlands), potential compensation will be discussed with Environment Canada.

Since surface disturbances affect wetland function, existing activities and the Project will act cumulatively to increase disturbance to wetland function in the Wetland RSA. The results of the quantitative analysis of disturbance of wetlands are summarized in Tables 8.7-7 and 8.7-8.

Within the Wetland RSA, approximately 24,576.3 ha (15.3%) of the wetlands have been affected through surface disturbance associated with existing activities in Alberta. It is estimated that 7,962.7 ha of these are wetlands of High Functional Condition, 12,902.6 ha of High-Moderate Functional Condition, 3,711 ha of Low-Moderate Functional Condition and 0.0 ha of Low Functional Condition. In combination with the Project and other reasonably foreseeable developments, the total cumulative disturbance of wetlands within the Wetland RSA in Alberta is predicted to be approximately 24,966.9 ha. This increases the

percentage of disturbance of wetlands in the Wetland RSA to 15.5% of which the Project contributes to 0.05% of the total cumulative disturbance of wetlands in the Wetland RSA in Alberta.

Within the Wetland RSA in BC, approximately 1,801.5 ha (6.2%) of the wetlands have been affected through surface disturbance associated with existing activities. It is estimated that 372.9 ha of these are wetlands of High Functional Condition, 1,201.6 ha of High-Moderate Functional Condition, 194.6 ha of Low-Moderate Functional Condition and 16.2 ha of Low Functional Condition. In combination with the Project and other reasonably foreseeable developments, the total cumulative disturbance of wetlands within the Wetland RSA in BC is predicted to be approximately 1,882.4 ha. This increases the percentage of disturbance of wetlands in the Wetland RSA to 6.5% of which the Project contributes to 2.1% of the total cumulative disturbance of wetlands in the Wetland RSA in BC.

TABLE 8.7-7

CUMULATIVE DISTURBANCE OF WETLANDS IN THE WETLAND LSA AND RSA EXCLUDING EDMONTON AND THE LMDA – ALBERTA

Wetland Disturbance Assessment Scenario	Total Area[2]	Area of Wetland RSA			
		High Functional Condition	High-Moderate Functional Condition	Low-Moderate Functional Condition	Low Functional Condition[3]
Existing Disturbance to Wetlands					
Area of Wetlands	160,998.8 ha	52,163.6ha	84,524.4 ha	24,310.8 ha	0.0 ha
Area of Wetland Disturbance Attributed to Existing Activities (Existing) [1]	24,576.3 ha (15.3%)	7,962.7 ha	12,902.6 ha	3,711.0 ha	0.0 ha
Estimated Future Wetland Disturbance					
Area of Wetland Disturbance Attributed to the Project (Project)	11.9 ha (0.01%)	3.9 ha	6.2 ha	1.8 ha	0.0 ha
Area of Wetland Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [1]	378.7 ha (0.2%)	122.7 ha	198.8 ha	57.2 ha	0.0 ha
Predicted Cumulative Wetland Disturbance					
Total Cumulative Wetland Disturbance (Existing + Project + Likely Future)	24,966.9 ha (15.5%)	8,089.3 ha	13,107.6 ha	3,770.0 ha	0.0 ha
% Contribution of Project to Cumulative Wetland Disturbance	0.05%	--	--	--	--

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.7-1 to 8.7-2 and are approximate.

2 Total Area excludes the City of Edmonton and LMDA.

3 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program in Alberta. However, wetlands of this functional condition are expected to occur within the Wetland LSA and RSA. These values will be updated following the 2014 supplemental surveys.

TABLE 8.7-8

CUMULATIVE DISTURBANCE OF WETLANDS IN THE WETLAND LSA AND RSA EXCLUDING EDMONTON AND THE LMDA – BC

Wetland Disturbance Assessment Scenario	Total Area[2]	Area of Wetland RSA			
		High Functional Condition	High-Moderate Functional Condition	Low-Moderate Functional Condition	Low Functional Condition[3]
Existing Disturbance to Wetlands					
Area of Wetlands	28,959.4 ha	5,994.6 ha	19,315.9 ha	3,127.6 ha	260.6 ha
Area of Wetland Disturbance Attributed to Existing Activities (Existing) [1]	1,801.5 ha (6.2%)	372.9 ha	1,201.6 ha	194.6 ha	16.2 ha
Estimated Future Wetland Disturbance					
Area of Wetland Disturbance Attributed to the Project (Project)	39.9 ha (0.1%)	8.3 ha	26.6 ha	4.3 ha	0.4 ha
Area of Wetland Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [1]	41 ha (0.1%)	8.5 ha	27.3 ha	4.4 ha	0.4 ha
Predicted Cumulative Wetland Disturbance					
Total Cumulative Wetland Disturbance (Existing + Project + Likely Future)	1,882.4 ha (6.5%)	389.7 ha	1255.5 ha	203.3 ha	17 ha
% Contribution of Project to Cumulative Wetland Disturbance	2.1%	--	--	--	--

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.7-1 to 8.7-2 and are approximate.

2 Total Area excludes the City of Edmonton and LMDA.

3 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program in Alberta. However, wetlands of this functional condition are expected to occur within the Wetland LSA and RSA. These values will be updated following the 2014 supplemental surveys.

The proposed standard and effective mitigation measures to be implemented during construction through wetlands crossed by the Project will reduce cumulative effects on wetland function. No mitigation measures beyond the Project-specific mitigation already proposed under the Wetland Loss or Alteration element in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to reduce cumulative effects on wetland function.

For any reasonably foreseeable developments that will also affect wetlands, it is anticipated that mitigation measures that are in accordance with industry standards and provincial and federal guidelines will be implemented by many proponents. In those instances where permanent disturbance to wetland function may be a result of these developments, it is anticipated that compensation would be conducted and will comply with provincial (*i.e.*, Alberta *Water Act*, the new Alberta *Wetland Policy* and the BC *Water Act*) and federal (*i.e.*, *Federal Policy on Wetland Conservation*) legislation.

The Project's contribution to combined disturbance of wetland function is considered to have a negative impact balance. The reversibility of this contribution on wetlands is considered medium to long-term depending on the recoverability of wetland function (*i.e.*, invasive plant species could potentially delay the recovery of native wetland species, and biogeochemical processes and hydrology may be adversely affected until vegetation cover is re-established). It is anticipated that the Project's contribution to cumulative effects on wetland function will be of low to medium magnitude and that the function of wetlands will be restored to the functional condition documented prior to disturbance (*i.e.*, High, High-Moderate, Low-Moderate and Low) (Table 8.7-6, point 1[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to combined cumulative effects on wetland function is provided below.

- Spatial Boundary: Wetland RSA – Project disturbance will be confined to the LSA, but may overlap with other reasonably foreseeable disturbances to extend to the RSA.

- Duration: short to long-term – Project activities that disturb wetlands and contribute to cumulative wetland function loss are anticipated to be conducted during the construction phase or completed within any one year during the operations phase (*i.e.*, short-term) except along segments of the proposed pipeline corridor where activities within wetlands will be prolonged beyond the first year of the operations phase (*e.g.*, potential disturbances to wetlands resulting from power line structure placement) or be initiated during the operations phase and extends for the life of the Project.

- Frequency: periodic – Project activities contributing to cumulative effects on wetland loss or alteration could occur intermittently, but repeatedly over the assessment period (*i.e.*, both construction and maintenance activities).

- Reversibility: medium to long-term – depending on the type of wetland (*e.g.*, shrubby vs. graminoid) and its resilience (*e.g.*, graminoid will quickly recover to graminoid whereas shrubby swamps will regenerate as emergent graminoid-dominant marshes initially), wetland function will be reduced until vegetation can be re-established, grade and natural flow patterns are restored, and sedimentation is controlled. The incremental effects of the power lines (*e.g.*, Kingsvale) on wetland function are expected to be reversible in the long-term following the potential completion of wetland compensation efforts, if required.

- Magnitude: low to medium – the Project's contribution to cumulative wetland disturbance is considered to be within environmental standards since industry standard, and federal and provincial recommended guidelines and/or mitigation measures will be implemented, as well the loss of wetland function resulting from the proposed power lines (*i.e.*, power line structures) may be potentially compensated and will be discussed with Environment Canada.

- Probability: high – disturbance of wetlands is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.

- Confidence: high – based on experience with similar projects within the Wetland RSA, the results of the wetland surveys and the professional experience of the assessment team.

8.7.4 Summary

As identified in Table 8.7-6, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on wetland function within the Wetland RSA will be not significant.

8.8 Vegetation

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on vegetation indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, vegetation communities of concern, plant and lichen communities of concern, and presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern).

Relevant regulatory guidelines, ATK, TEK, ecological context and residual Project effects were considered in the characterization of potential cumulative effects for vegetation indicators. TEK participants identified the potential long-term and cumulative impacts of pipeline construction on vegetation as a concern. Additional information on vegetation TEK collected during field studies for the Project is provided in the Vegetation Technical Report of Volume 5C.

8.8.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 provide a list of the reasonably foreseeable developments located within the Vegetation RSA considered in the evaluation of quantitative cumulative effects on the vegetation indicators. Descriptions of these developments are provided in Section 8.1.4 and shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. In the Vegetation RSA, there are approximately 15 mapped reasonably foreseeable developments either fully within the Vegetation RSA or, for some transmission lines and pipelines, partially within the Vegetation RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 42 mapped minor oil and gas developments proposed in Alberta: 14 pipelines; 21 facilities; and 7 wells (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status, location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of vegetation disturbance due to existing activities within the Vegetation RSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.8-1 and 8.8-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority).

TABLE 8.8-1

EXISTING AND NEW DISTURBANCE IN THE VEGETATION RSA – ALBERTA

Land Use Feature	Existing Disturbance (ha)	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	12,558.5	0	0	0	12,558.5
Airports/Airfields	9.7	0	37.4	37.4	47.1
Primary Roads	1,866	0	0	0	1,866
Quarries/Mines/Aggregates	684.8	0	12.8	12.8	697.6
Commercial/Industrial Features	546.1	1	47.7	48.7	594.8
Secondary Roads	564	0	0	0	564
Railways	229.6	0	0	0	229.6
Oil and Gas Well Sites	285.5	0	2.5	2.5	288

TABLE 8.8-1 Cont'd

Land Use Feature	Existing Disturbance (ha)	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Tertiary/Access Roads	195.5	0	0	0	195.5
Buildings	2,336.5	0	0	0	2,336.5
Recreation	110	0	0	0	110
Crop/Pasture Land	19,000.5	0	0	0	19,000.5
Cutlines, Seismic Lines	402.5	0	0	0	402.5
Transmission/Power Lines	650.6	0	113.9	113.9	764.5
Buried Utility Lines	107.2	0	0	0	107.2
Oil and Gas Pipelines	642.8	455	41.6	496.6	1,139.4
Hydroelectic Infrastructure	0	N/A	0	0	0
Trails (Recreation)	0	N/A	0	0	0
Cutblocks	1,260.6	0	0[1]	0	1,260.6
Total	41,450.4	456	255.9	711.9	42,162.3

Note: 1 Future harvesting activities are detailed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D but were not estimated here.

TABLE 8.8-2

EXISTING AND NEW DISTURBANCE IN THE VEGETATION RSA – BC

Land Use Feature	Existing Disturbance (ha)[1]	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	5,012.6	0	0	0	5,012.6
Airports/Airfields	21.6	0	0	0	21.6
Primary Roads	2,282.4	0	0.9	0.9	2,283.3
Quarries/Mines/Aggregates	916.2	0	258.4	258.4	1,174.6
Commercial/Industrial Features	90.8	3.6	3	6.6	97.4
Secondary Roads	943.1	0	0	0	943.1
Railways	884.8	0	0	0	884.8
Oil and Gas Well Sites	0	0	0	0	0
Tertiary/Access Roads	1,102.2	0	0	0	1,102.2
Buildings	111.6	0	0	0	111.6
Recreation	102.3	0	0	0	102.3
Crop/Pasture Land	4,891.5	0	0	0	4,891.5
Cutlines, Seismic Lines	22.1	0	0	0	22.1
Transmission/Power Lines	1,091.5	161.5	39.5	201	1,292.5
Buried Utility Lines	159.2	0	0	0	159.2
Oil and Gas Pipelines	841.5	1,437.2	6.1	1,443.3	2,284.8
Hydroelectric Infrastructure	0	0	4.1	4.1	4.1
Trails (Recreation)	0	0	0	0	0
Cutblocks	15,391.2	0	0[2]	0	15,391.2
Total	33,864.6	1,602.3	312	1,914.3	35,778.9

Notes: 1 The disturbance in the above table does not include the LMDA in BC, but does include the Surrey Greenbelt proposed disturbance.

2 Future harvesting activities are detailed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D.

8.8.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on vegetation indicators were identified in Section 7.11.1.9 and are listed in Table 8.8-3 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.8-3

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON VEGETATION CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on vegetation communities of concern.	RSA	Pipeline Temporary Facilities Pump Stations (Gainford, Hinton, Blackpool, Rearguard, Darfield, Black Pines, Kingsvale) Power lines (Black Pines, Kingsvale) Tanks (Sumas, Burnaby) Pipeline Reactivation	Construction to Operation	Project contribution to incremental increase in alteration or disturbance of native vegetation. Project contribution to incremental increase in alteration or disturbance of rare ecological communities. Project contribution to incremental increase in alteration or disturbance of grassland communities in the Bunchgrass (BG) BGC Zone.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA are listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, storing and replacement, grading, backfilling, seed mix selection, reclamation and operation (vegetation control, monitoring and maintenance).
2. Combined effects of the Project on plant and lichen species of concern.	RSA	Pipeline Temporary Facilities Pump Stations (Blackpool, Rearguard, Kamloops, Black Pines, Kingsvale) Pines, Kingsvale) Tanks (Sumas, Burnaby) Pipeline Reactivation	Construction to Operation	Project contribution to incremental increase in alteration or disturbance of rare plant and rare lichen populations, if mitigation does not completely protect the site.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, storing and replacement, grading, backfilling, seed mix selection and reclamation.
3. Combined effects of the Project on weeds and other non-native species.	RSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to weed introduction or spread.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities where equipment will operate or travel in areas lacking a vegetative cover including clearing, topsoil/root zone material salvaging, storing and replacement, seed mix selection, reclamation and operation (vegetation control, monitoring and maintenance).

Note: 1 RSA = Vegetation RSA.

8.8.3 Significance Evaluation of Potential Cumulative Effects

A quantitative approach was selected to determine the cumulative effect of the Project on the vegetation communities of concern indicator since the change to this parameter over existing conditions can be quantified. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, a qualitative method for determining the significance of the anticipated Project's contribution to cumulative environmental effects was applied. This qualitative evaluation of significance relied on the professional judgment of the assessment team.

Table 8.8-4 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on vegetation indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.8-4

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON VEGETATION

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Vegetation Indicator – Vegetation Communities of Concern									
1(a) Project contribution to incremental increase in alteration or disturbance of native vegetation.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Low to medium	High	High	Not significant
1(b) Project contribution to incremental increase in alteration or disturbance of rare ecological communities.	Negative	RSA	Short-term	Isolated	Medium to long-term	Medium	High	High	Not significant
1(c) Project contribution to incremental increase in alteration or disturbance of grassland communities in the BG BGC Zone.	Negative	RSA	Short-term	Isolated to periodic	Short to long-term	Medium	High	High	Not significant
1(d) Project contribution to combined incremental increase in alteration or disturbance of vegetation communities of concern.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Medium	High	High	Not significant
2. Vegetation Indicator – Plant and Lichen Species of Concern									
2(a) Project contribution to incremental increase in alteration or disturbance of rare plant and rare lichen populations, if mitigation does not completely protect the site.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Medium	High	High	Not significant
3. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern									
3(a) Project contribution to weed introduction or spread.	Negative	RSA	Short-term	Isolated to periodic	Short to medium-term	Low to medium	High	High	Not significant
4. Project Contribution to Combined Cumulative Effects on Vegetation									
4(a) Project contribution to cumulative effects on the vegetation indicators (1[d], 2[a] and 3[a]).	Negative	RSA	Short-term	Isolated to periodic	Short to long-term	Low to medium	High	High	Not significant

Notes: 1 RSA = Vegetation RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.8.3.1 Vegetation Indicator – Vegetation Communities of Concern

The following provides the evaluation of significance of the Project's contribution to cumulative effects on the vegetation communities of concern indicator.

Project Contribution to Incremental Increase in Alteration or Disturbance of Native Vegetation

Although some previous clearing has occurred in the Vegetation RSA for the Project, most of the vegetation communities within the Vegetation RSA in BC remain intact. The Project parallels existing disturbance for 89% of its length. The east and west ends of the Project are areas with a high level of anthropogenic disturbance (*i.e.*, Edmonton and LMDA). The land use in the Vegetation RSA along the Edmonton to Hinton Segment is mostly anthropogenic (*e.g.*, cultivation, pasture, roads) with between 25% and 39% native vegetation. The amount of native vegetation in the Vegetation RSA in BC is much higher than Alberta, with between 63% and 76% native vegetation. There are agricultural areas around Kamloops, but the degree of anthropogenic disturbance in the Vegetation RSA is comparatively low along the BC segments of the Project.

Since clearing activities involve the removal of trees, existing activities, the Project and reasonably foreseeable developments (as identified in Appendix 8.1) will act cumulatively to affect vegetation communities in the Vegetation RSA.

Existing activities that have resulted in the alteration of the composition of native vegetation include agriculture (including grazing), rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational activities as well as oil and gas exploration and development (*e.g.*, seismic cutlines, pipelines). The amount of disturbance to native vegetation and clearing in the area as a result of the Project is reduced by paralleling existing pipeline rights-of-way for approximately 89% of the Project length. Trans Mountain is expected to further reduce the amount of disturbance to native vegetation by using existing rights-of-way as temporary workspace and siting temporary facilities such as work camps and stockpile sites on existing disturbances, where feasible.

Reasonably foreseeable developments which involve clearing activities in the Vegetation RSA are identified in Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 and include oil and gas pipelines, facilities (*e.g.*, batteries, satellites) and wells. In Alberta, reasonably foreseeable developments are mostly minor oil and gas developments, with a few major developments such as the Vista Project. In BC, reasonably foreseeable developments are mostly proposed hydroelectric projects (*e.g.*, Deneau Creek project), with a few major developments such as the Ajax Project. Reasonably foreseeable developments in the Vegetation RSA, which may result a change to native vegetation, include the Edmonton to Hardisty Pipeline Project, the proposed Parkland Airport (Phase 1), the Vista Project, the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project, the Interior-Lower Mainland Transmission Project, the Merritt Area Transmission Project, the Deneau Creek Hydroelectric Project, the Emory Creek Hydroelectric Project, the Patterson Creek Nano Hydro Project, the Peers Creek Hydroelectric Project, the Ajax Project and the Gateway Program – Port Mann Bridge/Highway 1 Improvements – Golden Ears Connector (see Table 8A.1-1 of Appendix 8.1 for details). Construction activities for the Project and reasonably foreseeable developments will require clearing of lands supporting native vegetation. Consequently, existing activities, the Project and reasonably foreseeable developments will act cumulatively to affect the native vegetation community composition within the Vegetation RSA.

The results of the quantitative analysis of vegetation disturbance are summarized in Tables 8.8-1 and 8.8-2. The areas of disturbance were calculated using a disturbance layer on GIS imagery. Within the Vegetation RSA, approximately 41,450.4 ha in Alberta and 33,864.6 ha in BC, for a total of 75,315 ha of the vegetation has been removed or altered by disturbances associated with existing activities.

The Project is predicted to create approximately 456 ha of new disturbance in Alberta and 1,602 ha in BC, for a total of 2,058 ha of new disturbance. Disturbance attributable to reasonably foreseeable developments in Alberta is predicted to be approximately 256 ha and 312 ha in BC, for a total of 568 ha. Total predicted new disturbance is 2,626 ha. The Project is predicted to contribute 78% of the predicted total new disturbance of vegetation in the Vegetation RSA. This analysis is limited by the number of reasonably foreseeable developments with spatial data available (for example, cutblocks which are a large source of existing disturbance but for no spatial data were available for anticipated future tree harvest).

When existing disturbance is combined with the Project and reasonably foreseeable developments, the total cumulative disturbance of vegetation in the Vegetation RSA is predicted to be approximately

42,162 ha in Alberta and 35,779 ha in BC, for a total of 77,941 ha. The Project is predicted to contribute 3% of the predicted total cumulative (*i.e.*, existing plus Project and reasonably foreseeable developments) disturbance of vegetation.

The amount of disturbance to native vegetation as a result of the Project will be reduced by paralleling existing linear disturbances for approximately 89% of the proposed pipeline corridor and confining facility expansions to previously disturbed lands where feasible. Vegetation communities located along the Project Footprint will have the potential to be altered such that their overall abundance may be reduced, although different native vegetation communities (*e.g.*, early seral stage communities [forb and shrub]) will be established following revegetation.

Although proposed facilities for the Project have been located on previously disturbed lands to the greatest extent practical, clearing of approximately 166.1 ha of native vegetation will be necessary at the Gainford, Hinton, Rearguard, Kingsvale and Black Pines pump stations, as well as at the Sumas Terminal and along the Kingsvale and Black Pines power lines.

Many of the reasonably foreseeable developments are large-scale projects and are anticipated to be constructed and operated adopting best management practices and mitigation similar to those recommended for the Project. There are smaller-scale reasonably foreseeable developments, such as the hydroelectric projects, that are anticipated to be constructed using best management practices with similar objectives as the Project's mitigation. These small-scale projects will likely use equivalent mitigation that is appropriate to their size and scale. Consequently, most cumulative effects of the Project and reasonably foreseeable developments are primarily attributed to an alteration, rather than complete removal, of native vegetation.

TABLE 8.8-5

CUMULATIVE DISTURBANCE OF NATIVE VEGETATION IN THE VEGETATION RSA

Native Vegetation Disturbance Assessment Scenario	Area and Percentage of Vegetation RSA[1]
Existing Native Vegetation	
Area of the Vegetation RSA	202,722.2 ha
Amount of Native Vegetation	127,407.2 ha (63%)
Estimated Future Native Vegetation Disturbance	
Amount of Native Vegetation Disturbance Attributed to the Proposed Pipeline[2]	1,892.2 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Above Ground Facilities for the Project	4.6 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Power Lines for the Project	161.5 ha
Amount of Native Vegetation Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[3]	567.9 ha
Predicted Cumulative Native Vegetation Degradation	
Total Remaining Native Vegetation Following Cumulative Disturbance (Existing+Project+Likely Future)	124,781 ha
Total Remaining Native Vegetation Following Cumulative Disturbance without Project (Existing+Likely Future)	126,839 ha
% Contribution of Project to Cumulative Native Vegetation Disturbance in the Vegetation RSA	3%

Sources: Refer to Table 8.1-1 for data sources used for land use features.

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.8-1 and 8.8-2 and are approximate.

2 Calculation based on TEM.

3 The estimated area resulting from the construction of reasonably foreseeable developments within the Vegetation RSA for the Project (see Tables 8A.1-1 through 8A.1-4 of Appendix 8.1).

Cumulative change (*i.e.*, disturbance) estimates for native vegetation in the Vegetation RSA are summarized in Table 8.8-5. Native vegetation currently comprises approximately 127,407 ha (63%) of the Vegetation RSA. The total cumulative disturbance to native vegetation attributed to existing activities, the Project and reasonably foreseeable developments is predicted to be approximately 77,941 ha. Native vegetation disturbance from reasonably foreseeable developments is likely underestimated because spatial disturbance data were not available for most developments. The Project accounts for an incremental decrease of 3% to the remaining native vegetation in the Vegetation RSA.

None of the most affected native vegetation communities discussed in the Vegetation sections of Sections 5.0 through 7.0 are predicted to be affected by reasonably foreseeable developments. None of the reasonably foreseeable developments with spatial information available are located on any of the ecosites or variants identified in Tables 7.2.9-5 and 7.2.9-6. Therefore, the Project will be the only contribution to incremental alteration or disturbance of native vegetation within the identified ecosites or variants.

By preserving native vegetation using the mitigation suggested in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C), the Project will achieve the objectives of the land use plans for the areas traversed by the Project. Objectives of the management plans include maintaining natural vegetation throughout the development process, preserving natural vegetation including trees in all undeveloped and riparian areas and discouraging further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat (City of Kamloops 2004, 2011, Inter-Agency Planning Team 2009, Strathcona County 2007, TNRD 2000, 2011, Town of Edson 2006, Yellowhead County 2005, 2006, 2007). See Appendix 7.1 of Section 7.0 for more details of the land use plan objectives related to vegetation.

Disturbed areas through native vegetation will be allowed to naturally revegetate or will be seeded with the appropriate seed mix. The proposed standard and effective mitigation measures to be implemented during construction, through native vegetation crossed by the construction right-of-way, will reduce cumulative effects on native vegetation. Consequently, the Project's contribution to cumulative are primarily related to a change in vegetation rather than a loss of vegetation.

Permanent loss of native vegetation is not anticipated to result from either the construction or operation of the proposed pipeline; however, long-term loss of native vegetation may occur during the construction of the proposed pump stations (*e.g.*, Gainford, Hinton, Rearguard, Kingsvale and Black Pines), terminals (*i.e.*, Sumas) and associated power lines (*i.e.*, Black Pines, Kingsvale) depending on the placement of the pump stations, terminals and the power line towers. Temporary alteration of native vegetation may result during pipeline construction; however, mitigation measures described in Section 7.2.9 will be implemented to ensure that no long-term or permanent alteration of native vegetation will occur. Reasonably foreseeable developments in the Vegetation RSA which may result in long-term loss of native vegetation include the Vista Project, the Ajax Project, the Interior-Lower Mainland Transmission Project, the Merritt Area Transmission Project, the Deneau Creek Hydroelectric Project, the Emory Creek Hydroelectric Project, the Patterson Creek Nano Hydro Project, the Peers Creek Hydroelectric Project and the Gateway Program – Port Mann Bridge/Highway 1 Improvements – Golden Ears Connector depending on the placement of the pump stations, terminals and the power line towers. Permanent loss of native vegetation is not anticipated to result from either the construction or operation of the Edmonton to Hardisty Pipeline Project, the proposed Parkland Airport (Phase 1) (which is predicted to be located on agricultural lands) or the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project (see Table 8A.1-1 of Appendix 8.1 for details). No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are warranted.

The overall cumulative effects of the Project and reasonably foreseeable developments on native vegetation within the Vegetation RSA are considered to be reversible in the medium-term (*e.g.*, effects of proposed pipelines such as the Kingsvale/Oliver Natural Gas Pipeline Reinforcement Project or transmission lines) to long-term or permanent (*e.g.*, effects of facility developments), depending on the affected area (*e.g.*, forb versus tree) and of low to medium magnitude.

The Project is predicted to have a limited (3%) incremental contribution to cumulative alteration of native vegetation in the Vegetation RSA. Consequently, the Project's contribution to cumulative incremental change of native vegetation community composition within the Vegetation RSA is considered to be of low to medium magnitude and is considered reversible in the medium to long-term, depending on the associated land use, the type of activity (*i.e.*, temporary facility, power line, pump station) and the time required for various native species to regenerate following disturbance (Table 8.8-4, point 1[a]). A summary of the rationale for all the significance criteria of combined cumulative effects on native vegetation is provided below.

- Spatial Boundary: Vegetation RSA – the Project's contribution to cumulative effects on native vegetation may interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to vegetation composition in the RSA.

- Duration: short-term – Project's activities that contribute to cumulative changes to native vegetation composition would occur during the construction phase or be completed within any one year during the operations phase. Maintenance activities (*i.e.*, vegetation management on power line rights-of-way) may occur throughout the life of the Project.

- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the composition of native vegetation will occur during construction and intermittently but repeatedly during operations and maintenance activities.

- Reversibility: medium to long-term – depending upon the associated land use, the type of activity (*i.e.*, temporary facility, power line, pump station) and the growth time required for species in each affected area (*e.g.*, forb versus tree), the Project's contribution to changes to native vegetation community composition are considered reversible in the medium to long-term.

- Magnitude: low to medium – the Project's contribution to incremental cumulative change to native vegetation community composition is 3% of the Vegetation in the Vegetation RSA, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.

- Probability: high – it is likely that proposed clearing activities for the Project will combine with reasonably foreseeable developments and past clearing for existing activities to affect native vegetation.

- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

Project Contribution to Incremental Increase in Alteration or Disturbance of Rare Ecological Communities

Rare ecological communities with potential to occur in the Vegetation RSA are found on lands supporting native vegetation. The desktop review conducted prior to the vegetation surveys identified several previously identified rare ecological communities within the Vegetation RSA. Areas of native vegetation with high potential to support rare ecological communities are known to occur in the Vegetation RSA, and a low number of records of previously identified rare ecological communities may be a result of low survey effort in the area rather than an actual lack of rare ecological communities (Alberta Conservation Information Management System [ACIMS] 2013 or the BC Conservation Data Centre [BC CDC] 2012).

Rare plant surveys were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental ground-based rare plant surveys are planned to be conducted prior to construction in some areas with high potential habitat for rare ecological communities that were not surveyed in 2013, as well as in some areas where access was not available and sites where rare ecological communities need to be confirmed (see Section 9.0).

During the 2013 vegetation surveys, 25 occurrences of ACIMS and BC CDC-listed rare ecological communities (12 distinct rare ecological community types) were documented, as well as one unique ecological community not listed by ACIMS or the BC CDC. Protection measures and environmental management techniques for these rare ecological communities and any others discovered during supplemental studies are provided in Appendix C of the Pipeline and Facilities EPPs (Volumes 6B and 6C).

Indirect alteration of rare ecological communities adjacent to the Project may occur due to soil erosion. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with mulch, straw, crimping), the indirect alteration of native vegetation as a result of erosion will not measurably contribute to the overall effect of the Project on the alteration of rare ecological communities.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, indirect effects to vegetation are expected to persist until the pre-existing vegetation composition and structure is restored.

Since ground disturbance will be associated with the Project and reasonably foreseeable developments (as identified in Table 8.8-1), combined future disturbance could act cumulatively with existing activities to affect rare ecological communities in the Vegetation RSA.

Lands within the Vegetation RSA include approximately 127,407 ha (63%) of native vegetation, while the remaining areas have previously been converted to non-native cover types where rare ecological communities are unlikely to persist. Loss or alteration of native vegetation attributed to existing activities associated with land use change (*i.e.*, agricultural activities, rural and urban residential development) precludes the ability to determine the extent to which previously existing or remnant rare ecological communities in the Vegetation RSA have been altered. However, the potential for rare ecological communities is highest on lands with contiguous native vegetation and, therefore, construction activities for the Project and reasonably foreseeable developments may act cumulatively to alter remaining or previously unaffected rare ecological communities in the Vegetation RSA. Details of reasonably foreseeable developments that may act cumulatively with construction of the proposed pipeline and facilities are provided in Section 8.1.4 and Tables 8A.1-1 to 8A.1-6 of Appendix 8.1.

The presence and abundance of rare ecological communities along the proposed pipeline corridor were assessed during early and late-season vegetation surveys in 2013 (see the Vegetation Technical Report of Volume 5C). Implementation of site and species-specific mitigation measures outlined in Section 7.2.9 and the Pipeline EPP of Volume 6B is expected to reduce the magnitude and shorten the period of reversibility for residual effects to known rare ecological communities. Mitigation measures that were implemented during construction of the TMX Anchor Loop Project are similar to those that have been recommended for construction of this Project. Additionally, disturbed areas supporting native vegetation or wetlands will be left to naturally regenerate or will be seeded with an appropriate native seed mixture. Many of the reasonably foreseeable developments are large-scale projects and are anticipated to be constructed and operated adopting best practices and mitigation similar to those recommended for the Project. There are smaller-scale reasonably foreseeable developments, such as the hydroelectric projects, that are anticipated to be constructed using best management practices with similar objectives as the Project's mitigation. These small-scale projects will likely use equivalent mitigation that is appropriate to their size and scale. Consequently, additional mitigation measures to reduce combined cumulative effects are not warranted.

For any rare ecological communities identified along the proposed pipeline corridor during future rare plant surveys (see Section 9.0), appropriate site-specific protection measures outlined in the Plant Species and Ecological Communities of Concern Discovery Contingency Plan (Appendix B of the Pipeline EPP [Volume 6B]) will be implemented. The appropriate mitigation will be selected so that the rare ecological communities, particularly S1 communities if identified, are not placed at risk. To this end, Trans Mountain will report any rare ecological communities identified to the provincial conservation data centre (*i.e.*, BC CDC or ACIMS).

With proper implementation of the industry-accepted standard mitigation practices that are proposed, disruption of surface flow patterns and light levels following construction or maintenance activities is expected to be minor along the proposed pipeline corridor. However, construction activities may contribute to some localized alteration of sunlight levels and natural surface drainage patterns until trench settlement is complete and seeded vegetation has matured. No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B are deemed warranted.

Overall cumulative effects on rare ecological communities within the Vegetation RSA are considered to be reversible in medium to long-term and of medium magnitude. It may take more than one year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored to pipeline corridors (*e.g.*, Edmonton to Hardisty Pipeline Project), and it will take several years (medium-term) for vegetation to grow back to former heights, which will prevent increased light from

reaching surrounding plants in the ecological community. It may take more than 10 years (long-term) for natural drainage patterns to be restored to mine projects (*e.g.*, Ajax Project, Vista Project) and vegetation may not grow back for the life of these projects.

The Project's contribution to cumulative effects on rare ecological communities is considered to be reversible in the medium to long-term, depending on the species/communities affected and of medium magnitude (Table 8.8-4, point 1[b]). A summary of the rationale for all the significance criteria of combined cumulative effects on rare ecological communities is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on rare ecological communities could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to vegetation composition in the RSA.

- Duration: short-term – the Project's contribution to cumulative changes to disturbance or alteration of rare ecological communities would occur during the construction phase or be completed within any one year during the operations phase. Maintenance activities (*i.e.*, vegetation management on power line rights-of-way) may occur throughout the life of the Project, but once the native vegetation (which provides potential habitat for rare ecological communities) is cleared, there is a low probability of rare ecological communities revegetating the area. Therefore, maintenance activities completed more than one year after construction will not further disturb or alter rare ecological communities.

- Frequency: isolated – the Project's contribution to cumulative changes in the disturbance or alteration of rare ecological communities will occur during construction (*e.g.*, clearing native vegetation, which provides habitat for rare ecological communities).

- Reversibility: medium to long-term – depending on the component species (*e.g.*, western redcedar and amabilis fir [amabilis fir - western redcedar/devil's club community] will take years to grow to mature trees, compared to common cattails [common cattail marsh] or beaked sedge [beaked sedge marsh] which can recolonize or re-establish in one growing season if the seed bank and habitat is available), the type of development (*e.g.*, facility, power line, pipeline) and associated land use.

- Magnitude: medium – the Project's contribution to combined disturbance or alteration of a rare ecological community is of medium magnitude because best practices and past precedents typically require additional mitigation like those proposed for the Project to avoid unacceptable effects and reduce cumulative effects.

- Probability: high – the proposed pipeline corridor crosses 25 known occurrences of rare ecological communities and reasonably foreseeable developments are likely to cross areas of native vegetation with potential to support rare ecological communities.

- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of post-construction environmental monitoring of past pipeline projects under similar conditions.

Project Contribution to Incremental Increase in Alteration or Disturbance of Grassland Communities in the Bunchgrass Biogeoclimatic Zone

The proposed pipeline corridor was routed along the existing TMPL right-of-way and other linear disturbance to the extent practical. No pump stations or facilities are currently proposed in the Bunchgrass Biogeoclimatic Zone. The Merritt Area Transmission Project is the only reasonably foreseeable development with known spatial information located within the Vegetation RSA in the BG BGC Zone.

Since ground disturbance will be associated with the Project and reasonably foreseeable developments (*i.e.*, the Merritt Area Transmission Project), these combined future disturbances would act cumulatively with existing activities to affect bunchgrass vegetation communities in the Vegetation RSA (Table 8.8-6).

TABLE 8.8-6

CUMULATIVE DISTURBANCE OF NATIVE VEGETATION IN THE VEGETATION RSA WITHIN THE BG BGC ZONE

Native Vegetation Disturbance Assessment Scenario	Area of Vegetation RSA[1]
Existing Native Vegetation	
Amount of Native Grassland Vegetation (Variants BGxh1 and BGxh2) within the BG BGC Zone[2]	6,372.9 ha
Estimated Future Native Vegetation Disturbance	
Amount of Native Vegetation Disturbance Attributed to the Proposed Pipeline[2]	88.6 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Above Ground Facilities for the Project	0 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Power Lines for the Project	0 ha
Amount of Native Vegetation Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [3]	5.9 ha
Predicted Cumulative Native Vegetation Degradation	
Total Existing Disturbance in the BG BGC	2,069.4 ha
Total Remaining Native Vegetation Following Cumulative Disturbance (Existing+Project+Likely Future)	4,209.0 ha
Total Remaining Native Vegetation Following Cumulative Disturbance without Project (Existing+Likely Future)	4,297.6 ha
% Contribution of Project to Cumulative Native Vegetation Disturbance in the Vegetation RSA	4%

Source: Refer to Table 8.1-1 for data sources used for land use features.

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.8-1 and 8.8-2 and are approximate.

2 Calculation based on TEM.

3 The estimated area resulting from the construction of reasonably foreseeable developments within the Vegetation RSA for the Project (see Tables 8A.1-1 through 8A.1-4 of Appendix 8.1).

Cumulative change (*i.e.*, disturbance) estimates for native grassland vegetation in the Vegetation RSA within the BG BGC Zone are summarized in Table 8.8-6. Native grassland vegetation currently comprises approximately 6,372.9 ha of the Vegetation RSA in the BG BGC Zone. The total cumulative disturbance to native grassland vegetation in the BG BGC Zone attributed to existing activities, the Project and reasonably foreseeable developments is predicted to be approximately 2,163.9 ha. Native grassland vegetation disturbance from reasonably foreseeable developments is likely underestimated because spatial disturbance data were not available for most developments. The Project accounts for an incremental decrease of 4% to the remaining native grassland vegetation in the Vegetation RSA.

Although areas disturbed during construction and occasional maintenance activities will be allowed to naturally regenerate or revegetate with the appropriate native species, species composition in the disturbed Footprint will likely be altered as a result of the Project and the Merritt Area Transmission Project. The extent of altered vegetation communities from the Project will be limited by the implementation of mitigation measures outlined in Table 7.2.9-2 and reclamation measures will speed the recovery of grassland communities. The Merritt Area Transmission Project is expected to follow best practices and regional land use guidance and objectives. No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP (Volume 6B) are deemed warranted. Consequently, the overall cumulative effects on grassland communities within the BG BGC Zone is considered to be of medium magnitude given there are no standards or thresholds that would otherwise indicate loss or alteration of native grassland vegetation is unacceptable.

The Project's contribution to cumulative effects on grassland communities within the BG BGC Zone is limited to the Vegetation RSA, reversible in the short to long-term and of medium magnitude since indirect effects following mitigation will not be acute and the Project is routed along other linear corridors to the extent practical (Table 8.8-4, point 1[c]). A summary of the rationale for all the significance criteria of combined cumulative effects on grassland communities within the BG BC Zone is provided below.

- Spatial Boundary: Vegetation RSA – Project effects on grassland communities in the BG BGC Zone could interact with reasonably foreseeable developments (*i.e.*, the Merritt Area Transmission Project) within the Vegetation RSA to cause a cumulative alteration to grassland communities in the RSA.

- Duration: short-term – Project activities contributing to cumulative disturbance or alteration of bunchgrass vegetation communities will occur during the construction phase or be completed within any one year during the operations phase of the Project and reasonably foreseeable developments.

- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the composition of native vegetation in the BG BGC Zone will occur during construction and intermittently but repeatedly during operations or maintenance activities.

- Reversibility: short to long-term – the regeneration period for native vegetation depends on the growth time required for species in each area. Weed introduction can take years of management to remediate, depending on the non-native species (*i.e.*, non-native grasses) and the specificity of the herbicide.

- Magnitude: medium –the Project will contribute to a combined loss or alteration of native grassland vegetation, however, there are no standards or thresholds that would otherwise indicate loss or alteration of native grassland vegetation is unacceptable. Best practices, objectives and provincial guidelines will be followed. Minimal indirect impacts to vegetation communities will be caused by the Project since the Project parallels existing linear features to the extent practical.

- Probability: high – it is likely that proposed clearing activities for the Project will combine with reasonably foreseeable developments and past clearing for existing activities to affect bunchgrass vegetation communities.

- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

Project Contribution to Combined Incremental Increase in Alteration or Disturbance of Vegetation Communities of Concern

The following potential cumulative effects are likely to act in combination to result in overall effects on native vegetation:

- Project contribution to incremental increase in alteration or disturbance of native vegetation;

- Project contribution to incremental increase in alteration or disturbance of rare ecological communities; and

- Project contribution to incremental increase in alteration or disturbance of grassland communities in the BG BGC Zone.

The Project will contribute to a comparatively small loss or alteration of native vegetation (approximately 2,058 ha) when combined with existing activities (75,315 ha) plus reasonably foreseeable developments (approximately 568 ha for those for which spatial data could be located).

Alteration of remnant or previously unaffected rare ecological communities and grassland communities may primarily be attributed to construction of the Project acting cumulatively with reasonably foreseeable developments in areas of native vegetation. The Project is predicted to contribute the largest amount of clearing of native vegetation in the Vegetation RSA when compared with other reasonably foreseeable developments, including in the BG BGC Zone. Since rare ecological communities were observed in areas of native vegetation during 2013 surveys, the number of rare ecological communities affected by construction of the Project may be relatively more numerous than those potentially affected by reasonably foreseeable developments. Consequently, the number of rare ecological communities and grassland communities affected by the Project and reasonably foreseeable developments acting cumulatively may not be much greater than those predicted to be altered by the Project alone.

Standard industry practices will be applied by the Project in areas of native vegetation, including grasslands and rare ecological communities, to prevent the introduction and spread of weeds. Similar practices are anticipated for reasonably foreseeable developments, so no mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP (Volume 6B) are deemed to be warranted. The overall combined cumulative effects on vegetation communities of concern within the Vegetation RSA are considered to be of medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

While the Project's contribution to combined alteration and loss of native vegetation and rare ecological communities is considered to be comparatively limited in extent (3% of the native vegetation in the Vegetation RSA will be cleared due to the Project), this is considered to be of medium magnitude because some of these communities, such as grasslands and Red or Blue-listed communities, are of management concern and generally require site-specific mitigation. Depending on the development type and species affected, the Project's contribution to combined cumulative effects on vegetation communities of concern is considered to be reversible in the medium to long-term. The probability of the above-listed cumulative effects acting in combination is high (Table 8.8-4, point 1[d]). A summary of the rationale for all the significance criteria for the Project's contribution to combined cumulative effects on the vegetation communities of concern indicator is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on native vegetation and ecological communities of concern could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to native vegetation and ecological communities in the RSA.

- Duration: short-term – the Project's contribution to cumulative changes to native vegetation composition and alteration of rare ecological communities would occur during the construction phase or be completed within any one year during the operations phase.

- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the disturbance or alteration of native vegetation and rare ecological communities will occur during construction and intermittently but repeatedly during operations for maintenance activities.

- Reversibility: medium to long-term – depending on the associated land use and the growth time required for species in each affected area (*e.g.*, forb versus tree), it may take more than 10 years to return to existing conditions depending on the types of communities affected. The incremental effects of the proposed pump stations (*e.g.*, Black Pines) and power lines (*i.e.*, Black Pines, Kingsvale) on native vegetation and rare ecological communities are expected to be prolonged beyond the first year of the operations phase (*e.g.*, disturbances resulting from pump station expansions or power lines) or may extend for the life of the Project (*i.e.*, long-term).

- Magnitude: medium – the Project's contribution to cumulative changes in the disturbance or alteration of native vegetation and rare ecological communities are anticipated to be largely mitigated during construction and post-construction environmental monitoring. The Project is located adjacent to existing disturbances where practical and the construction of the Project will result in the clearing of approximately 2,058 ha of native vegetation, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.

- Probability: high – the proposed pipeline corridor encounters known locations of rare ecological communities, grasslands and native vegetation. No rare ecological communities were identified during the 2013 field surveys at pump stations or power lines, though these proposed activities encounter native vegetation. In addition, grasslands in the BG BGC Zone are not affected by any proposed pump stations or terminals associated with the Project. Reasonably foreseeable developments are located on native vegetation lands with the potential to support rare ecological communities, so the probability is high for the Project and reasonably foreseeable developments to act cumulatively to affect vegetation communities of concern.

- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

8.8.3.2 Vegetation Indicator – Plant and Lichen Species of Concern

The following provides the evaluation of significance of potential residual effects on the plant and lichen species of concern indicator.

Project Contribution to Incremental Increase in Alteration or Disturbance of Rare Plant and Rare Lichen Populations, if Mitigation Does Not Completely Protect the Site

Most of the rare plant and rare lichen species with potential to occur in the Vegetation RSA are found on lands supporting native vegetation (see the Vegetation Technical Report of Volume 5C). Alteration or disturbance of native vegetation reduces the potential habitat for rare plant and lichen species of concern, therefore, effects to native vegetation also affect rare plant and lichen species of concern.

The desktop review conducted prior to the vegetation surveys identified several previously identified populations of rare plants within the Vegetation RSA. Areas of native vegetation with high potential to support rare plants or lichens are known to occur in the Vegetation RSA and a low number of records of previously identified rare plants or lichens in some areas of the RSA may be a result of low survey effort in the area rather than an actual lack of rare plant or lichen populations (ACIMS 2013, BC CDC 2012).

Rare plant surveys were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental ground based rare plant surveys are planned to be conducted prior to construction in some areas with high potential habitat for rare plant or lichen species that were not surveyed in 2013, new lands as a result of reroutes, as well as in some areas where access was not available and sites where rare plant or lichen species need to be confirmed (see Section 9.0). In the event that additional rare plant or lichen populations are identified for the Project during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Pipeline EPP of Volume 6B).

In addition to those populations of rare plants and rare lichens previously identified as occurring in the Vegetation RSA, vegetation surveys conducted for the Project documented 151 occurrences of ACIMS and BC CDC-listed rare plant and lichen species, including 10 liverwort populations (5 unique species), 2 moss species, 133 vascular plant populations (39 unique species) and 6 rare lichen populations (6 unique species) (see the Vegetation Technical Report of Volume 5C). Due to potential connectivity among populations associated with an Element Occurrence (see Section 7.2.9), alteration of known or previously unidentified populations of rare plants or lichens may affect the viability of other populations in the Vegetation RSA.

Increased distance of light penetration due to clearing associated with for the Project and reasonably foreseeable developments will result in an indirect alteration of native vegetation (*i.e.*, the native plant species making up the habitat for rare plant and lichen populations). If part of a treed community is cleared, the light penetrating to the understory will change the species composition along the edges of the community where clearing occurred. However, this effect will not substantially contribute to the cumulative effects on rare plant or lichen populations beyond the direct effects on these populations caused by the clearing of native vegetation. Additionally, during the course of reclamation for the Project and reasonably foreseeable developments, as revegetation progresses, light penetration will generally decrease over time.

Indirect alteration of rare plant or lichen populations adjacent to the Project and reasonably foreseeable developments may occur due to soil erosion and disruption of surface flow patterns. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with mulch, straw, crimping), the indirect alteration of native vegetation (*i.e.*, the native species making up the habitat for rare plant and lichen populations) as a result of erosion will not measurably contribute to overall effects on rare plant or lichen populations.

During all phases of the Project and reasonably foreseeable developments, vehicle traffic may increase dust deposition onto native vegetation adjacent to the development area which could include rare lichen populations. During reclamation and operations, dust due to development traffic could also result in minor cumulative effects to rare lichens located adjacent to the right-of-way.

With proper implementation of the industry-accepted standard mitigation practices, disruption of surface flow patterns and light levels following construction or maintenance activities is expected to be minor for the Project and reasonably foreseeable developments. However, construction activities may contribute to some localized alteration of light levels and natural surface drainage patterns until settlement is complete and seeded vegetation has matured.

Some lichens are found only in very specific habitats, living within a very narrow range of humidity, light and moisture regimes. For example, soil crust lichens may be sensitive to changes in moisture regimes, drainage patterns or erosion. Another example is arboreal lichens which may be sensitive to humidity and air flow patterns, which are affected by clearing in forested areas. If a lichen species only grows on trees, then any effect of the Project or reasonably foreseeable developments on trees or forested areas will in turn affect these lichen species.

Combined ground disturbance from the Project and reasonably foreseeable developments (as identified in Table 8.8-1) will act cumulatively with existing activities to affect rare plant and lichen populations in the Vegetation RSA.

Lands within the Vegetation RSA include approximately 127,407 ha (63%) of native vegetation, while the remaining areas have previously been converted to non-native cover types that provide little to no habitat value for rare plants and rare lichens. Loss or alteration of native vegetation attributed to existing activities associated with land use change (*i.e.*, agricultural activities, rural and urban residential development) precludes the ability to determine the extent to which previously existing or remnant populations of rare plants and rare lichens in the Vegetation RSA have been altered. However, the potential for rare plant and rare lichen populations is highest on lands supporting native vegetation and, therefore, construction activities for the Project and reasonably foreseeable developments may act cumulatively to alter remaining or previously unaffected rare plant and lichen populations in the Vegetation RSA. Details of reasonably foreseeable developments that may act cumulatively with construction of the proposed pipeline and facilities are provided in Section 8.1.4 and Tables 8A.1-1 through 8A.1-6 of Appendix 8.1.

The presence and abundance of rare plant and lichen populations along the proposed pipeline corridor were assessed during early and late-season rare plant surveys in 2013 (see the Vegetation Technical Report of Volume 5C). Implementation of site and species-specific mitigation measures outlined in Section 7.2.9 and the Pipeline EPP of Volume 6B is expected to reduce the magnitude and shorten the period of reversibility for residual effects to known rare plant populations. Mitigation measures that were implemented during construction of other major pipeline projects including the TMX Anchor Loop Project are similar to those that have been recommended for construction of this Project. Additionally, disturbed areas supporting native vegetation or wetlands will be left to naturally regenerate or will be seeded with an appropriate native seed mixture. Due to the size and scope of reasonably foreseeable developments in the Vegetation RSA, it is anticipated that implemented site and species-specific mitigation measures for potentially affected rare plant and rare lichen populations will be similar to those recommended for the Project. Consequently, the number of rare plant and rare lichen populations affected by the Project and reasonably foreseeable developments acting cumulatively may not be much greater than those predicted to be altered by the Project alone. Specifically, the Project is predicted to contribute to 78% of the projected total new disturbance to native vegetation (which provides habitat for rare plant and lichen species). For any rare plant or rare lichen populations identified for the Project during future rare plant surveys (see Section 9.0), appropriate site-specific protection measures outlined in the Plant Species and Ecological Communities of Concern Discovery Contingency Plan (Pipeline EPP of Volume 6B) will be implemented. The appropriate mitigation will be selected so that the rare plant and lichen populations, particularly S1 species if identified, are not placed at risk. To this end, Trans Mountain will report any rare plants or rare lichens identified to the provincial conservation data centre (*i.e.*, BC CDC or ACIMS). No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B are deemed warranted.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, cumulative effects resulting from indirect effects to vegetation are expected to persist until the pre-existing vegetation composition and structure is restored. The overall cumulative effects on plant and lichen species of concern within the Vegetation RSA are considered to be of medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

The Project's contribution to cumulative effects on rare plant and rare lichen populations is considered to be reversible in the medium to long-term, depending on the species affected and of medium magnitude (Table 8.8-4, point 2[a]). A summary of the rationale for all the significance criteria for the Project's

contribution to combined cumulative effects on the plant and lichen species of concern indicator is provided below.

- Spatial Boundary: Vegetation RSA – Project effects on rare plant and rare lichen populations could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to rare plant and lichen populations in the RSA.

- Duration: short-term – the Project's contribution to cumulative alteration of rare plant or lichen populations would occur during the construction phase or be completed within any one year during the operations phase.

- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the disturbance or alteration of rare plant or lichen populations will occur during construction and intermittently but repeatedly during operations for maintenance activities.

- Reversibility: medium to long-term – depending on the lichen or plant species (*e.g.*, forb vs. tree), and associated land use. It may take more than one year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored, and it will take several years for vegetation to grow back to former heights, which will prevent increased light from reaching surrounding rare plant and rare lichen populations. Based on post-construction environmental monitoring results from the TMX Anchor Loop Project, effects on rare plants and lichens were generally resolved in three to five years (*i.e.*, it was obvious in three to five years of post-construction environmental monitoring whether the population would recover or die) (TERA 2011c). However, effects from facilities and pump stations may result in a somewhat extended period of reversibility.

- Magnitude: medium – the Project's contribution to cumulative effects on rare plant or lichen species of concern is of medium magnitude since established regulatory standards typically require additional mitigation like those proposed for the Project to avoid unacceptable effects and reduce potential cumulative effects.

- Probability: high – the proposed pipeline corridor crosses 151 known occurrences of rare plant and lichen populations, and some of the reasonably foreseeable developments are predicted to be in areas of native vegetation with potential to support rare plant and rare lichen populations.

- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of post-construction environmental monitoring of past pipeline projects under similar conditions.

8.8.3.3 Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern

The following provides the evaluation of significance of potential residual effects on the presence of infestations of provincial weed species and other invasive non-native species identified as a concern indicator.

Project Contribution to Weed Introduction or Spread

Weeds typically establish in areas that have been previously disturbed. Existing activities resulting in ground disturbance that contributes to introduction and spread of weeds include agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. Since construction activities for the Project and reasonably foreseeable developments will require ground disturbance they could act cumulatively to cause weed introduction and spread within the Vegetation RSA. For example, the Parkland Airport (Phase 1) is predicted to be constructed on agricultural lands adjacent to the Project near Edmonton, Alberta and may contribute to weed introduction and spread within the Vegetation RSA.

Given the mitigation measures that will be implemented to control weed introduction and spread during both construction and operation of the Project, it is expected that the Project would contribute less to the

introduction and spread of weeds when compared to existing activities (*e.g.*, agriculture, highway developments) within the Vegetation RSA.

Vegetation surveys conducted in 2013 included incidental weed observations in areas of native vegetation selected for survey (see the Vegetation Technical Report of Volume 5C). The proposed weed-related mitigation outlined in Section 7.2.9 and in the Pipeline EPP of Volume 6B will reduce the potential for cumulative effects. Weed presence and abundance on the Footprint will be assessed during a pre-construction weed survey in 2015. Other developers within the Vegetation RSA are expected to implement similar industry standard mitigation to control weeds (*e.g.*, AENV 2003, BC OGC 2010, Government of Alberta 2011, 2013b). Further to this, it is anticipated that best management practices will be implemented by many farmers, ranchers, forestry companies and municipal areas to reduce introduction of weeds associated with anthropogenic activities within the Vegetation RSA. No additional weed mitigation beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B is deemed to be warranted. The overall cumulative effect on weeds and other invasive non-native species of concern within the Vegetation RSA is considered to be of low to medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

The Project's contribution to cumulative effects on weed introduction and spread within the Vegetation RSA is reversible in the short to medium-term depending on the species and the size of the infestation and of low to medium magnitude (Table 8.8-4, point 3[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on weeds and other invasive non-native species of concern is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on weed introduction and spread could interact with reasonably foreseeable developments within the Vegetation RSA to cause an incremental increase in weed distribution and abundance in the RSA.

- Duration: short-term – the Project's contribution to cumulative spread or introduction of weed species would occur during the construction phase or be completed within any one year during the operations phase.

- Frequency: isolated to periodic – the Project's contribution to cumulative weed introduction and spread will occur during construction and intermittently but repeatedly during operations for maintenance activities.

- Reversibility: short to medium-term – depending on the species, associated land use and the density/distribution of the occurrence.

- Magnitude: low to medium – the Project's contribution to combined weed introduction or spread is of low to medium magnitude since established regulatory standards typically require additional mitigation like those proposed for the Project to avoid unacceptable effects.

- Probability: high – weeds and invasive, non-native species are known to occur along the proposed pipeline corridor and likely to occur throughout the Vegetation RSA.

- Confidence: high – based on past pipeline projects and the professional experience of the assessment team.

8.8.3.4 Project Contribution to Combined Cumulative Effects on Vegetation

A number of potential effects (*i.e.*, Project contribution to combined incremental increase in alteration or disturbance of native vegetation, grasslands and rare ecological communities, incremental increase in alteration or disturbance of rare plant and rare lichen populations and weed introduction and spread) contribute to cumulative effects on vegetation in the Vegetation RSA, as described above for vegetation communities and populations of rare species.

The implementation of mitigation measures recommended in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) will reduce the severity of cumulative effects arising from the Project. It is

anticipated that many operators of other reasonably foreseeable developments would implement similar mitigation according to industry standards and provincial regulatory guidelines.

The Project's contribution to cumulative effects on the vegetation indicators is of low to medium magnitude, reversible in the short to long-term and of high probability (Table 8.8-4, point 4[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on the vegetation indicators is provided below.

- Spatial Boundary: Vegetation RSA – the Project's contribution to combined cumulative effects on vegetation may interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative effect on vegetation resources in the RSA.

- Duration: short-term – the Project's contribution to combined cumulative effects on vegetation would occur during the construction phase or be completed within any one year during the operation phase.

- Frequency: isolated to periodic – the Project's contribution to combined cumulative effects on vegetation will occur during construction and intermittently but repeatedly during operations for maintenance activities.

- Reversibility: short to long-term – depending on the species, the pre-existing vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the type of activity (*i.e.*, temporary facility, power line, pump station).

- Magnitude: low to medium – the Project's contribution to combined cumulative effects on vegetation is considered to be within environmental standards given the implementation of industry standard guidelines and federal and provincial recommended mitigation.

- Probability: high – it is likely that these cumulative combined effects will occur.

- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

8.8.4 Summary

As identified in Table 8.8-4, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on vegetation within the Vegetation RSA will be not significant.

8.9 Wildlife and Wildlife Habitat

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on wildlife and wildlife habitat indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, mammal, bird, and amphibian and reptile indicators).

Relevant regulatory guidelines, ATK, TEK, ecological context and residual Project effects were considered in the characterization of potential cumulative effects for wildlife and wildlife habitat indicators. TEK participants identified the potential long-term and cumulative effects of pipeline construction on wildlife as a concern. Additional information on wildlife TEK collected during field studies for the Project is provided in the Wildlife Technical Report of Volume 5C.

8.9.1 Reasonably Foreseeable Developments

Inclusion lists of the reasonably foreseeable developments located within the Wildlife RSA, Caribou RSA and Grizzly Bear RSA are provided in Appendix 8.1 (Tables 8A.1-1 to 8A.1-4), and Figures 8.1-1a to 8.1-1c. Developments with spatial information (Tables 8A.1-1 to 8A.1-4) were considered quantitatively in the evaluation of cumulative effects on the wildlife indicators.

As indicated in Section 8.1, additional reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations where development details (*e.g.*, approval status, location) were either lacking or the development is planned within previously disturbed areas of municipal boundaries, such as the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Appendix 8.1 (Tables 8A.1-5 and 8A.1-6). These developments were considered qualitatively, where relevant, in the assessment of cumulative effects on wildlife and wildlife habitat.

The current level of disturbance due to existing activities within the Wildlife RSA, as well as the predicted disturbance attributed to the Project and reasonably foreseeable developments is summarized in Tables 8.9-1 (Alberta) and 8.9-2 (BC). The Project Footprint used in the quantitative analysis is defined in Section 7.2.10.2. A hierarchy table was applied to quantitative analyses to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority); thereby avoiding double-counting of overlapping disturbances.

TABLE 8.9-1

EXISTING AND NEW AREAL DISTURBANCE IN THE WILDLIFE REGIONAL STUDY AREA IN ALBERTA

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Other Activities	Total	
Cities/Towns/Communities	96,328.1	--	--	--	96,328.1
Airports/Airfields	217.6	--	37.4	37.4	255.0
Primary Roads	13,315.1	--	--	--	13,315.1
Quarries/Mines/Aggregates	12,144.7	--	949.0	949.0	13,093.7
Commercial/Industrial Features	6,842.9	1.0	839.0	840.0	7,682.9
Secondary Roads	7,957.3	--	--	--	7,957.3
Railways	1,147.9	--	--	--	1,147.9
Oil and Gas Well Sites	4,874.6	--	52.8	52.8	4,927.4
Tertiary/Access Roads	2,754.4	--	--	--	2,754.4
Buildings	28,922.5	--	--	--	28,922.5
Recreation	526.2	--	--	--	526.2
Crop/Pasture Land	259,679.1	--	--	--	259,679.1
Cutlines, Seismic Lines	8,810.7	--	--	--	8,810.7
Transmission/Power Lines	2,274.3	--	113.9	113.9	2,388.2
Buried Utility Lines	418.5	--	--	--	418.5
Oil and Gas Pipelines	5,949.3	455.0	350.0	805.0	6,754.3
Hydroelectric Infrastructure	--	--	--	--	--
Cities/Towns/Communities	96,328.1	--	--	--	96,328.1
Trails	--	--	--	--	--
Cutblocks[1]	65,386.1	--	22,608.8	22,608.8	87,994.9
Fire (< 40 years)	6,949.7	--	--	--	6,949.7
Total Areal Disturbance (ha)	524,499.0	456.0	24,950.9	25,406.9	548,905.9
Percent of Wildlife RSA Disturbed	50.30	0.04	2.39	2.44	52.74

Note: 1 Spatial data for future cutblocks was not available at the time of assessment. The area of future forest harvest in the Wildlife RSA was estimated based on available annual harvest information (*e.g.*, annual allowable cut) and projected to the end of 2017 (anticipated in-service date of the Project).

TABLE 8.9-2

EXISTING AND NEW AREAL DISTURBANCE IN THE WILDLIFE REGIONAL STUDY AREA IN BC

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Other Activities	Total	
LMDA/Cities/Towns/Communities	229,171.4	--	--	--	229,171.4
Airports/Airfields	43.1	--	--	--	43.1
Primary Roads	9,310.3	--	0.9	0.9	9,311.2
Quarries/Mines/Aggregates	5,454.2	--	6,078.2	6,078.2	11,532.4
Commercial/Industrial Features	1,085.9	3.6	26.9	30.5	1,116.4
Secondary Roads	10,271.4	--	--	--	10,271.4
Railways	1,897.8	--	--	--	1,897.8
Oil and Gas Well Sites	---	--	--	--	--
Tertiary/Access Roads	13,867.8	--	2.9	2.9	13,870.7
Buildings	916.8	--	--	--	916.8
Recreation	815.5	--	--	--	815.5
Crop/Pasture Land	27,999.5	--	--	--	27,999.5
Cutlines, Seismic Lines	165.7	--	--	--	165.7
Transmission/Power Lines	4,529.7	161.5	422.5	584.0	5,113.7
Buried Utility Lines	296.1	--	--	--	296.1
Oil and Gas Pipelines	1,238.4	1,437.2	47.7	1,484.9	2,723.3
Hydroelectric Infrastructure	--	--	40.6	40.6	40.6
Trails	0.1	--	--	--	0.1
Cutblocks[1]	307,122.3	--	75,113.6	75,113.6	382,235.9
Fire (< 40 years)	26,767.3	--	--	--	26,767.3
Total Areal Disturbance (ha)	640,953.3	1,602.3	81,733.3	83,335.6	724,288.9
Percent of Wildlife RSA Disturbed	31.66	0.08	4.04	4.12	35.77

Note: 1 Spatial data for future cutblocks was not available at the time of assessment. The area of future forest harvest in the Wildlife RSA was estimated based on available annual harvest information (*e.g.*, annual allowable cut) and projected to the end of 2017 (anticipated in-service date of the Project).

The Project is likely to interact with the existing and reasonably foreseeable developments to contribute to cumulative effects on wildlife and wildlife habitat through all three identified effects pathways: changes in habitat (Section 8.9.2); changes in movement (Section 8.9.3); and increased mortality risk (Section 8.9.4).

8.9.2 Cumulative Changes in Habitat

Habitat loss or alteration resulting from natural disturbances, existing activities and reasonably foreseeable developments will act cumulatively with the Project to affect wildlife habitat. Existing activities and reasonably foreseeable developments also have or will alter wildlife habitat by changing or removing vegetation. In addition to anthropogenic disturbance, natural disturbance was considered in the evaluation of cumulative habitat change in the Wildlife RSA. Wildfires alter wildlife habitat by interrupting successional sequences and producing landscape-level mosaics in forest maturity that include regenerating, immature and late successional stands (*i.e.*, mature and old forest) (Johnson *et al.* 1995). Abundance and species composition of wildlife communities change post-wildfire in response to the succession of vegetation from early initiation stages, through establishment and intermediate stages into mature and old forests (Fisher and Wilkinson 2005, Hobson and Schieck 1999). Approximately 33,717 ha (1.1%) of the Wildlife RSA has been altered by forest fires that have burned in the last 40 years. Natural fire patterns have been substantially modified in the Wildlife RSA as a result of fire suppression and vegetation modification (*e.g.*, agriculture, developed lands). Most of the fires occurred in the Black Pines to Hope Segment (over 100 documented fires with an average size and standard deviation of 234.4 ha ± 1,088.2 ha). A notable number of fires also occurred in the Edmonton to Hinton and Hargreaves to Darfield segments (over 70 fires in each with an average size and standard deviation of 324.6 ha ± 1,145.0 ha and 119.4 ha ± 303.3 ha, respectively). Fire was less common in the Hinton to Hargreaves, Darfield to Black Pines, Hope to Sumas and Sumas to Burnaby segments (*i.e.*, less than 15 fires in each); this is to be expected given the relative abundance of agricultural and developed land, as well as the naturally lower fire interval of the wetter coastal region (compared to dry interior regions) in these segments.

In most cases, endemic biotic disturbance (*e.g.*, biotic and abiotic forest health factors) is a natural ecosystem process; however, human activity can interfere with these processes to potentially cause unnatural disturbance events and exacerbate the issue (Managed Forest Areas and Forest Health Technical Report of Volume 5C). The mountain pine beetle infestation has caused substantial natural disturbance in some areas of BC. The clearings and roads associated with salvage harvest of pine beetle infested stands have contributed further to cumulative effects on wildlife and wildlife habitat. The quantitative analysis of habitat change and disturbance in the Wildlife RSA incorporates changes associated with fire, mountain pine beetle, forest harvest and roads to the extent possible with the available regional habitat and disturbance data.

A critical threshold for habitat loss may be defined as an abrupt, non-linear change that occurs in some parameter (*e.g.*, behaviour, abundance, community composition) across a small range of habitat loss (Swift and Hannon 2010) (*e.g.*, the abundance of a species in a landscape declines more or less linearly as suitable habitat is lost, but may decline more rapidly once the amount of remaining habitat in the landscape falls below a certain proportion of the total landscape area). Critical threshold relationships between habitat loss and various ecological responses have been suggested in numerous simulation models and, to a lesser degree, empirical landscape-scale studies (Swift and Hannon 2010). Although highly variable, depending on species or landscape characteristics or other conditions, most of the observed critical thresholds for cumulative habitat loss occur between 10% and 50% of remaining habitat (*i.e.*, when 50% to 90% of suitable habitat has been lost) (Swift and Hannon 2010). The available scientific literature indicates that cumulative effects risk is highest when total habitat loss measured at the landscape (*i.e.*, regional) scale is high (> 70%), as discussed in more detail below.

Habitat loss or alteration by both the Project and existing activities and reasonably foreseeable developments may act cumulatively to cause habitat fragmentation. Habitat fragmentation results when complete or partial barriers to movement cause functional separation of habitats into smaller, isolated habitat patches (Andrén 1994, Jalkotzy *et al.* 1997). The three main components of habitat fragmentation are habitat loss, reduced habitat patch size and increased isolation of patches (Andrén 1994). Habitat fragmentation has the potential to alter species abundance and distribution over the landscape by affecting predation and brood parasitism, altering microclimate, decreasing food, and reducing ability of animals to move between habitat patches within a landscape (Swift and Hannon 2010). Species that have late age of first reproduction, low population densities, low reproductive rates, large home-ranges, low fecundity, and move over large distances to disperse, find food and mate, display low resilience to habitat fragmentation (Dunne and Quinn 2009).

Several studies suggest that cumulative effects risk and the influence of patch size and spatial arrangement is highest when habitat loss measured at the landscape (*i.e.*, regional) scale is high (> 70%). For example, a modelling-based study by Flather and Bevers (2002) concluded that the amount of habitat accounted for > 96% of total variation in wildlife abundance compared to < 1% for arrangement of habitat, over a broad range of habitat types and arrangements. They also concluded that when total habitat loss was less than 50-70%, the effects were simply habitat loss effects; with higher total loss, habitat arrangement effects became more important. These findings are consistent with conclusions from other meta-analyses and modeling studies (Andrén 1994, Fahrig 1997, Forman and Collinge 1997, Rich *et al.* 1994, Schmiegelow and Mönkkönen 2002, Swift and Hannon 2010). Andrén (1994) suggests that in landscapes with more than 30% of suitable habitat remaining (*i.e.*, less than 70% of suitable habitat is disturbed), the total area of suitable habitat is of greater importance than its spatial arrangement (*e.g.*, patch size and isolation). As habitat loss increases, the remaining habitat becomes increasingly fragmented or the habitat patches are increasingly isolated, which may compound the effects of habitat loss (Swift and Hannon 2010). The proportion of the Wildlife RSA in Alberta that is disturbed is predicted to increase from 50.3% under existing conditions to 52.7% with the Project and foreseeable future developments (Table 8.9-1). In the Wildlife RSA in BC, the proportionate disturbance increases from 31.7% under existing conditions, to 35.8% with the Project and foreseeable future developments (Table 8.9-2). In some areas of the Wildlife RSA such as the LMDA, the existing cumulative disturbance level is high, and fragmentation effects can be expected. However, based on the above research findings, this level of cumulative disturbance suggests that the cumulative effects risk is likely moderate at the scale of the Wildlife RSA, and substantial fragmentation (*i.e.*, habitat spatial arrangement) effects are not anticipated.

The predicted change in wildlife habitat types from existing conditions to future conditions (*i.e.*, cumulative scenario) is summarized in Tables 8.9-3 (Alberta) and 8.9-4 (BC). Ecosystem units for the RSA in Alberta were based on the Alberta Ground Cover Classification (AGCC) data (ASRD 2010). AGCC land cover classes were combined into ecologically relevant higher order groupings ("habitat types") to simplify the analysis and increase accuracy. Ecosystem units in BC were derived from the Broad Ecosystem Inventory (BEI) data (BC MOE 2003). The BEI provides mapping of broad ecosystem units (BEUs), which describe the vegetation communities that a given location can support based on geological or climatic conditions. BEUs have been used previously by government-supported projects in BC to evaluate wildlife habitat, and are included as a component of the provincial wildlife accounts (BC Ministry of Water, Lands and Air Protection [MWLAP] 2004), which facilitates determining the BEUs that are likely to represent suitable habitat for a given species. The predicted change in habitat from existing to cumulative future conditions was estimated by incorporating updated disturbance information for existing activities, the Project, and reasonably foreseeable developments into the available regional-scale habitat data (AGCC in Alberta, BEI in BC).

Tables 8.9-3 and 8.9-4 summarize the predicted changes in habitat from existing conditions to Project and cumulative conditions within the Wildlife RSA. For ease of description, anthropogenic disturbance is grouped into broad categories: agriculture, cutblock, vegetated linear anthropogenic (defined to include linear disturbances that are typically reclaimed to a vegetated state, such as pipeline, power line and utility rights-of-way, and seismic lines), and other anthropogenic disturbance (includes the remaining disturbance types such as urban, industrial, commercial and transportation developments). Detailed disturbance information is provided in Tables 8.9-1 and 8.9-2. Figures 8.9-1 and 8.9-2 illustrate the relative proportion of each habitat type within the Natural Subregions (Alberta) and Ecoprovinces (BC) in the Wildlife RSA, and the predicted change from existing conditions to Project and cumulative conditions. Disturbance in the Wildlife RSA in Alberta is primarily associated with agriculture. Cutblocks and other anthropogenic disturbance (mostly urban and transportation development) are the primary disturbance types in the Wildlife RSA in BC.

TABLE 8.9-3

PREDICTED HABITAT CHANGE IN THE WILDLIFE REGIONAL STUDY AREA IN ALBERTA

Habitat Type	Ecosystem Unit[1]	Existing Condition	Project Condition[2]		Cumulative Condition[3]	
		Area (ha)	Area (ha)	% Change[4]	Area (ha)	% Change[4]
Barren Lands	Barren	11,837.4	11,834.7	0.02 ↓	11,808.8	0.24 ↓
Grassland	Grassland	21,668.0	21,646.5	0.10 ↓	21,600.7	0.31 ↓
Shrubland	Shrubland	9,563.6	9,554.5	0.10 ↓	9,551.1	0.13 ↓
Forested	Pine	107,509.9	107,406.0	0.10 ↓	107,091.7	0.39 ↓
	Coniferous	145,927.3	145,875.7	0.04 ↓	145,481.8	0.31 ↓
	Deciduous	88,059.5	87,981.0	0.09 ↓	87,867.2	0.22 ↓
	Mixed	31,054.0	31,042.9	0.04 ↓	31,025.9	0.09 ↓
Wet Areas	Open Water	43,167.3	43,162.1	0.01 ↓	43,141.0	0.06 ↓
	Graminoid Wetland	223.4	223.4	0	223.3	0.02 ↓
	Shrubby Wetland	8,159.1	8,157.3	0.02 ↓	8,151.4	0.09 ↓
	Bog	8,709.7	8,708.2	0.02 ↓	8,702.6	0.08 ↓
	Unclassified Wetland	51,877.0	51,809.5	0.13 ↓	51,704.8	0.33 ↓
Anthropogenic	Agriculture	271,049.2	271,013.9	0.01 ↓	270,725.9	0.12 ↓
	Cutblock	68,323.2	68,259.3	0.09 ↓	67,684.1	0.94 ↓
	Vegetated Linear Anthropogenic	15,509.9	15,964.8	2.93 ↑	16,376.3	5.59 ↑
	Other Anthropogenic	158,464.7	158,464.0	< 0.01 ↓	159,967.0	0.95 ↑
No Data	Unclassified	1,601.5	1,601.2	0.02 ↓	1,601.0	0.03 ↓

Notes:
1 Ecosystem units are derived from Land Cover Classes, using AGCC data (ASRD 2010). Disturbance units are incorporated using disturbance data compiled for the Project.
2 Project Condition includes existing activities (with available spatial data) + Project.
3 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).
4 Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

TABLE 8.9-4

PREDICTED CHANGE IN HABITAT IN THE WILDLIFE REGIONAL STUDY AREA IN BC

Habitat Type	Ecosystem Unit[1]	Existing Condition	Project Condition[2]		Cumulative Condition[3]	
		Area (ha)	Area (ha)	% Change[4]	Area (ha)	% Change[4]
Alpine and Subalpine	Alpine Meadow	6,570.8	6,570.8	0	6,570.8	0
	Alpine Tundra	16,860.1	16,860.1	0	16,860.1	0
	Alpine Unvegetated	64,941.5	64,941.5	0	64,941.5	0
	Engelmann Spruce – Subalpine Fir Parkland	33,932.8	33,932.8	0	33,908.6	0.07 ↓
	Mountain Hemlock Parkland	627.0	627.0	0	627.0	0
	Subalpine Meadow	6,141.9	6,141.9	0	6,125.7	0.26 ↓
	Subalpine Fir – Mountain Hemlock Wet Parkland	1,313.9	1,313.9	0	1,313.9	0
Natural Non-Forested	Rock	4,951.2	4,951.2	0	4,950.7	0.01 ↓
	Glacier	13,381.4	13,381.4	0	13,381.4	0
Shrub and Herb Ecosystems	Avalanche Track	24,035.0	24,016.7	0.08 ↓	24,015.3	0.08 ↓
	Bunchgrass Grassland	91,727.4	91,632.3	0.10 ↓	90,751.5	1.06 ↓
	Big Sagebrush Shrub/Grassland	14,506.0	14,465.2	0.28 ↓	14,333.1	1.19 ↓
Coastal Forest Ecosystems	Coastal Douglas-Fir	27,414.0	27,397.1	0.06 ↓	27,356.4	0.21 ↓
	Coastal Western Hemlock – Western Redcedar	7,023.2	7,023.2	0	7,009.0	0.20 ↓
	Coastal Western Hemlock – Douglas-Fir	50,833.9	50,741.3	0.18 ↓	50,660.3	0.34 ↓
	Amabilis Fir – Western Hemlock	72,740.6	72,705.7	0.05 ↓	72,664.9	0.10 ↓
	Mountain Hemlock – Amabilis Fir	59,297.1	59,285.9	0.02 ↓	59,277.5	0.03 ↓
Southern Interior Forest Ecosystems	Interior Douglas-Fir Forest	23,899.4	23,841.1	0.24 ↓	23,834.8	0.27 ↓
	Douglas-Fir – Lodgepole Pine	153,879.5	153,556.4	0.21 ↓	153,404.3	0.31 ↓
	Douglas-Fir – Ponderosa Pine	61,749.0	6,1631.0	0.19 ↓	61,430.5	0.52 ↓
	Engelmann Spruce – Subalpine Fir Dry Forest	270,959.2	270,942.5	0.01 ↓	268,387.6	0.95 ↓
	Interior Western Hemlock – Douglas-Fir	81,380.0	81,230.3	0.18 ↓	81,151.2	0.28 ↓
	Interior Western Hemlock – White Spruce	26,431.8	26,422.9	0.03 ↓	26,422.9	0.03 ↓
	Ponderosa Pine	26,608.6	26,558.8	0.19 ↓	26,470.7	0.52 ↓
	Western Redcedar – Paper Birch	9,310.7	9,310.7	0	9,310.7	0
	Western Redcedar – Douglas Fir	24,484.9	24,448.6	0.15 ↓	24,448.6	0.15 ↓
	Spruce - Douglas-Fir	4,871.9	4,853.4	0.38 ↓	4,853.4	0.38 ↓
Central and Northern Forest Ecosystems	Lodgepole Pine	6,213.7	6,198.8	0.24 ↓	6,198.8	0.24 ↓
	Subalpine Fir – Mountain Hemlock Wet Forest	19,890.1	19,890.1	0	19,890.1	0
	Spruce – Douglas Fir	4,871.9	4,853.4	0.38 ↓	4,853.4	0.38 ↓
	White Spruce –- Subalpine Fir	53,304.5	53,286.3	0.03 ↓	53,282.0	0.04 ↓
	Subboreal White Spruce – Lodgepole Pine	45,270.9	45,209.8	0.14 ↓	45,192.7	0.17 ↓
Riparian	Black Cottonwood Riparian	62.8	62.8	0	62.8	0
	Engelmann Spruce Riparian	458.5	458.5	0	458.5	0
	Sitka Spruce – Black Cottonwood Riparian	3,082.4	3,037.2	1.47 ↓	3,036.0	1.50 ↓
	Western Redcedar – Black Cottonwood Riparian	5,431.1	5,377.0	1.00 ↓	5,377.0	1.00 ↓
	White Spruce – Black Cottonwood Riparian	8,381.7	8,300.2	0.97 ↓	8,300.2	0.97 ↓
Wetland/Watercourse	Flooded Channel	13.2	13.2	0	13.2	0
	Lake	28,569.8	28,569.0	0	28,547.5	0.08 ↓
	Marsh	8,596.6	8,593.0	0.04 ↓	8,580.1	0.19 ↓
	Marine	1,874.4	1,874.4	0	1,874.4	0
	Reservoir	31.5	31.5	0	31.5	0
	River	15,934.5	15,924.9	0.06 ↓	15,922.1	0.08 ↓
	Slow Perennial Stream	701.0	700.7	0.03 ↓	700.7	0.03 ↓
	Sphagnum Bog	429.3	429.3	0	429.3	0
	Swamp	4,801.9	4,798.2	0.08 ↓	4,796.2	0.12 ↓
	Unclassified Wetland	44.9	44.9	0	44.9	< 0.01 ↓
Anthropogenic	Cultivated Field	37,886.4	37,864.5	0.06 ↓	37,859.8	0.07 ↓
	Cutblock	307,102.1	306,888.7	0.07 ↓	304,775.0	0.76 ↓
	Vegetated Linear Anthropogenic	5,900.4	7,498.6	27.09 ↑	7,967.6	35.03 ↑
	Other Anthropogenic	266,397.5	266,412.3	0.01 ↑	272,445.7	2.27 ↑

Notes:
1 Ecosystem units are derived from BEUs, using BEI data (BC MOE 2003). Disturbance units are incorporated using disturbance data compiled for the Project.

2 Project Condition includes existing activities (with available spatial data) + Project.

3 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).

4 Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

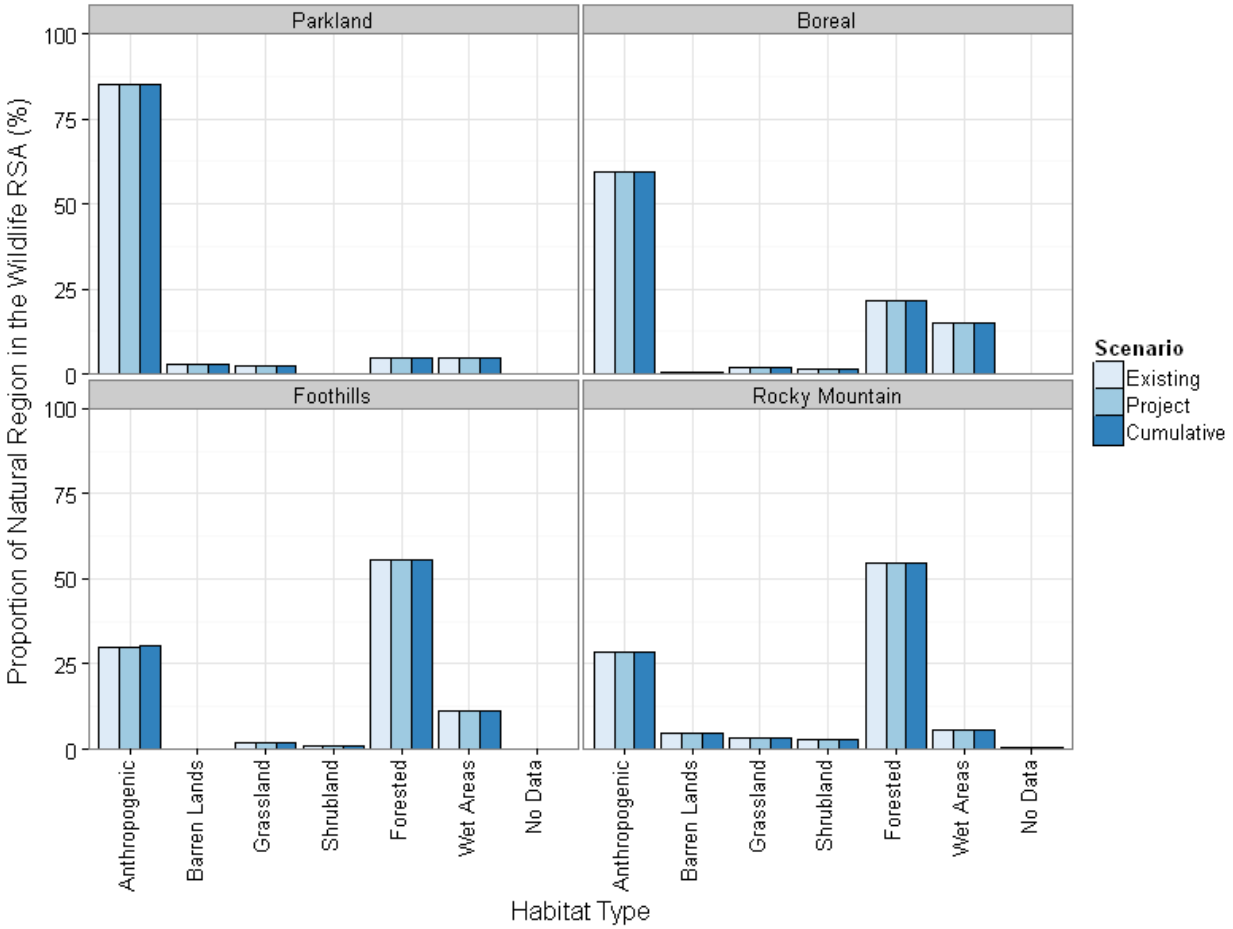


Figure 8.9-1 Predicted Change in Habitat Types in the Wildlife RSA in Alberta
Change in habitat types is presented as the proportion of the Natural Region within the Wildlife RSA represented by each habitat type at existing, Project and cumulative conditions. The ecosystem units that comprise the habitat types are presented in Table 8.9-3.

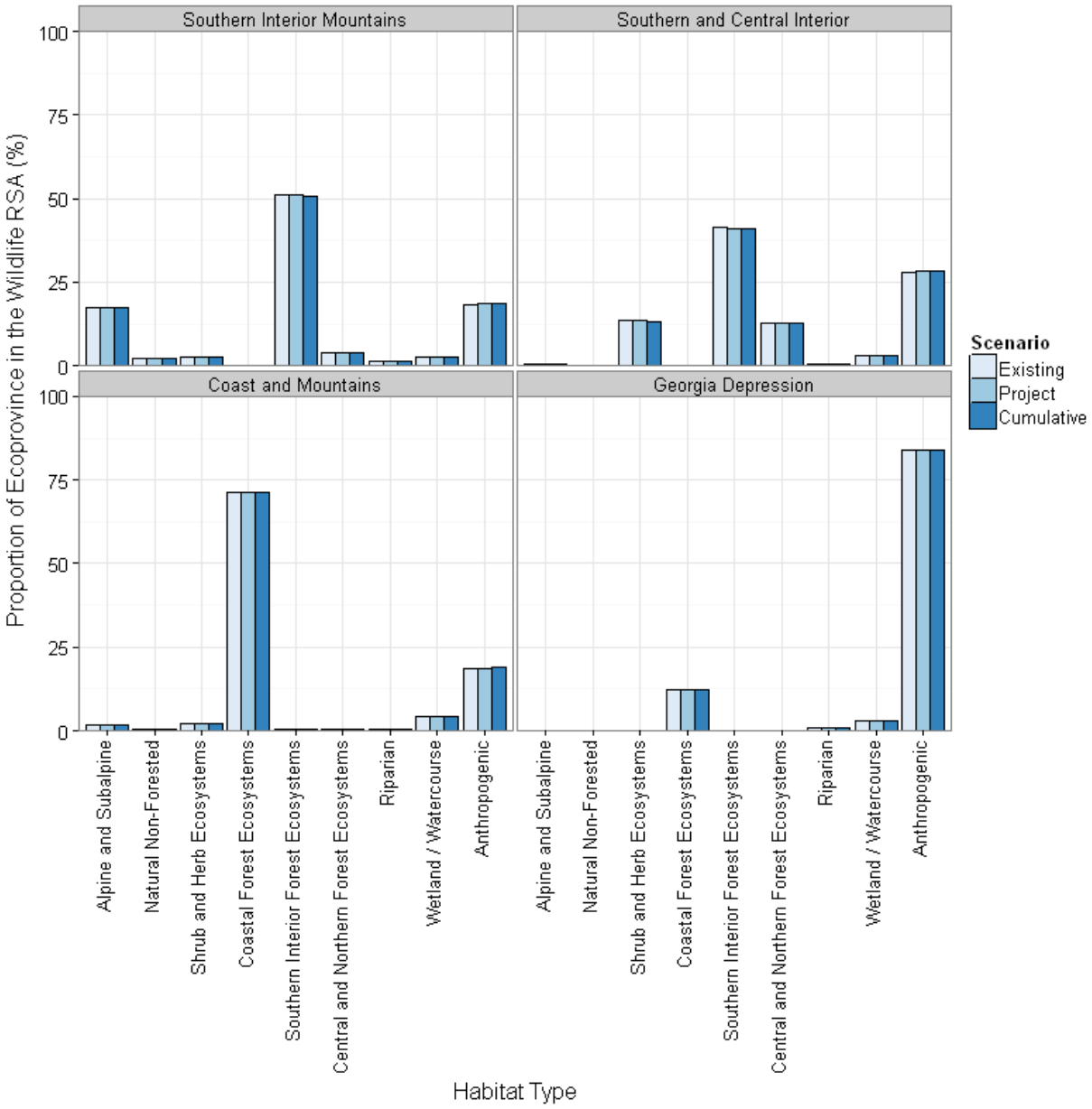


Figure 8.9-2 Predicted Change in Habitat Types in the Wildlife RSA in BC
Change in habitat types is presented as the proportion of the Ecoprovince within the Wildlife RSA represented by each habitat type at existing, Project and cumulative conditions. The ecosystem units that comprise the habitat types are presented in Table 8.9-4.

8.9.3 Cumulative Changes in Wildlife Movement

The Project may contribute to cumulative effects in combination with existing activities and reasonably foreseeable developments to increase filters or barriers (partial or complete barriers respectively) to movement for some wildlife species. Wildlife movement patterns vary between species, with species-specific attributes such as size and life stage, and other factors such as time of day and season. Many species alter their movements to avoid areas with high levels of human activity and development. However, some species may be less affected by, or are attracted to, anthropogenic disturbance and habitually use established trails for movement, regardless of proximity to human activity and development. In some cases, linear developments have been shown to block, delay or deflect ungulate movements, potentially restricting or reducing access to some parts of their range (Harper *et al.* 2001). Studies on small mammal movements in forested habitat have concluded that pipeline rights-of-way may act as barriers or filters to movement of flying squirrels, red squirrels and marten (Marklevitz 2003). Changes in movement patterns can also occur since some wildlife species may be attracted to linear corridors as travel routes. For example, wolverines have been found to diverge from their line of travel under forest cover when linear corridors with compacted snow were encountered, in order to follow the linear corridors, which provided easier travel routes (Wright and Ernst 2004). Changes in movement patterns may also occur as some species are attracted to early seral vegetation in regenerating areas. Species that prefer edges and habitat generalists are most likely to use disturbed areas (Jalkotzy *et al.* 1997). Sensory disturbance of wildlife resulting from Project construction activities may also act cumulatively with existing sources of auditory and visual disturbances, such as industrial development and traffic, to cause wildlife to alter their movement patterns (*i.e.*, reduced use or avoidance).

8.9.4 Cumulative Risk of Wildlife Mortality

Wildlife mortality risk may increase due to the cumulative effects of the Project, existing activities (*e.g.*, recreational and subsistence hunting and trapping, traffic) and reasonably foreseeable developments. Increased mortality risk may result from habitat disturbance (*e.g.*, clearing and soil handling has potential to disturb active nests, dens, hibernacula, overwintering sites), sensory disturbance, vehicle/wildlife collisions, and increased predation, hunting or trapping as a result of increased access or habitat alteration. Trapping, hunting and poaching are often associated with roads or other linear corridors that create access (Collister *et al.* 2003, Wiacek *et al.* 2002). Linear corridors can also increase the risk of mortality for some species by attracting prey species to early seral vegetation establishing on the disturbance, where the improved access and increased sight-lines may lead to increased predator efficiency. Linear corridors are attractive to predators as easy travel routes (James 1999, Stuart-Smith *et al.* 1997, Thurber *et al.* 1994) and may affect predator-prey dynamics (Bergerud *et al.* 1984, Edmonds and Bloomfield 1984, Rohner and Kuzyk 2000).

8.9.5 Potential Cumulative Effects on Wildlife and Wildlife Habitat Indicators

The potential and likely residual effects associated with the construction and operation of the Project on wildlife indicators were identified in Section 7.2.10.7 and are listed in Table 8.9-5, along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.9-5

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON WILDLIFE AND WILDLIFE HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on grizzly bear resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Grizzly Bear RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on grizzly bear.	• Existing activities/disturbance including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, hunting/trapping. • Reasonably foreseeable developments within the Grizzly Bear RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
2. Combined Project effects on woodland caribou resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Caribou RSA	Hargreaves to Darfield Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on woodland caribou.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
3. Combined Project effects on moose resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on moose.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, hunting. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined Project effects on forest furbearers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on forest furbearers.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, trapping. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
5. Combined Project effects on coastal riparian small mammals resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on coastal riparian small mammals.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
6. Combined Project effects on bats resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on bats.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
7. Combined Project effects on grassland/ shrub-steppe birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on grassland/shrub-steppe birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
8. Combined Project effects on mature/old forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on mature/old forest birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
9. Combined Project effects on early seral forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on early seral forest birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
10. Combined Project effects on riparian and wetland birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on riparian and wetland birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
11. Combined Project effects on wood warblers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on wood warblers.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-5 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
12. Combined Project effects on short-eared owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on short-eared owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
13. Combined Project effects on rusty blackbird resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on rusty blackbird.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
14. Combined Project effects on flammulated owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on flammulated owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
15. Combined Project effects on Lewis's woodpecker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on Lewis's woodpecker.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
16. Combined Project effects on Williamson's sapsucker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on Williamson's sapsucker.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
17. Combined Project effects on western screech-owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line) Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on western screech-owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
18. Combined Project effects on great blue heron resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on great blue heron.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
19. Combined Project effects on spotted owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on spotted owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
20. Combined Project effects on bald eagle resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on bald eagle.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
21. Combined Project effects on common nighthawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on common nighthawk.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
22. Combined Project effects on northern goshawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on northern goshawk.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
23. Combined Project effects on olive-sided flycatcher resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on olive-sided flycatcher.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
24. Combined Project effects on pond-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on pond-dwelling amphibians.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
25. Combined Project effects on stream-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Tanks (Sumas)	Construction to Operations	Project contribution to cumulative effects on stream-dwelling amphibians.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
26. Combined Project effects on arid habitat snakes resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on arid habitat snakes.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

8.9.6 Significance Evaluation of Potential Cumulative Effects on Mammals

The Project is likely to interact with existing and reasonably foreseeable disturbances to have an incremental cumulative effect on habitat, movement and mortality risk of mammals within the Grizzly Bear, Caribou and Wildlife RSAs. Table 8.9-6 provides a summary of the significance evaluation of the Project's contribution to cumulative effects on mammal indicators. The assessment rationale is provided below.

TABLE 8.9-6

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MAMMAL INDICATORS

Potential Cumulative Effects	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
			Duration	Frequency	Reversibility				
1. Wildlife Indicator – Grizzly Bear									
1(a) Project contribution to cumulative effects on grizzly bear.	Negative	Grizzly RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2. Wildlife Indicator – Woodland Caribou									
2(a) Project contribution to cumulative effects on woodland caribou.	Negative	Caribou RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
3. Wildlife Indicator – Moose									
3(a) Project contribution to cumulative effects on moose.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
4. Wildlife Indicator – Forest Furbearers									
4(a) Project contribution to cumulative effects on forest furbearers.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5. Wildlife Indicator – Coastal Riparian Small Mammals									
5(a) Project contribution to cumulative effects on coastal riparian small mammals.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
6. Wildlife Indicator – Bats									
6(a) Project contribution to cumulative effects on bats.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Low	Not significant

Note: 1 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.6.1 Cumulative Change in Habitat for Mammal Indicators

The Project will contribute to combined loss or alteration of mammal habitat resulting from natural disturbance, existing activities and foreseeable future disturbances. Table 8.9-7 and Figure 8.9-3 summarize the predicted changes in availability of potential habitat for mammal indicators as a result of combined disturbance from the Project and reasonably foreseeable developments within the Wildlife RSA.

TABLE 8.9-7

PREDICTED CHANGE IN POTENTIAL HABITAT FOR MAMMAL INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator[1]	Habitat Potential[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Moose	Potential	1,679,902.4	1,680,159.1	256.7 ↑	0.02 ↑	1,674,156.6	5745.8 ↓	0.34 ↓
Marten (forest furbearers indicator)	Potential	1,262,477.8	1,261,204.0	1,273.8 ↓	0.10 ↓	1,257,508.3	4969.5 ↓	0.39 ↓
Fisher (forest furbearers indicator)	Potential	873,839.9	873,067.5	772.4 ↓	0.09 ↓	869,593.1	4246.8 ↓	0.49 ↓
Mountain Beaver (coastal riparian small mammals indicator)	Potential	212,887.1	212,651.1	236.1 ↓	0.11 ↓	212,501.7	385.4 ↓	0.18 ↓
Pacific Water Shrew[6] (coastal riparian small mammals indicator)	Potential	159,202.0	159,057.6	144.3 ↓	0.09 ↓	158,880.2	321.7 ↓	0.20 ↓

TABLE 8.9-7 Cont'd

Wildlife Indicator[1]	Habitat Potential[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Bats	Potential	1,462,419.1	1,460,964.0	1,455.1 ↓	0.10 ↓	1,456,795.6	5,623.5 ↓	0.38 ↓

Notes:
1 Quantitative analyses for grizzly bear and caribou habitat change were completed with different methods. Results are provided in Tables 8.9-8 and 8.9-9.
2 Refer to the Wildlife Modelling and Species Accounts Technical Report of Volume 5C for definition of habitat potential.
3 Project Conditions includes existing activities (with available spatial data + Project.
4 Cumulative Conditions includes existing activities + Project + reasonably foreseeable disturbances (with available spatial data).
5 Incremental and percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.
6 Pacific water shrew is modeled using a habitat capability model provided by provincial regulatory agency. Because the model is a capability model (not suitability), only disturbances that were expected to affect habitat capability were included. These disturbances are ones where permanent changes take place, or where normal succession will not be permitted to proceed for an extended period (*e.g.*, pipeline, transmission line, and commercial/industrial footprints). The results indicate the current or future capacity of the habitat to support water shrews. Refer to the Wildlife Modelling and Species Accounts Technical Report of Volume 5C for additional information.

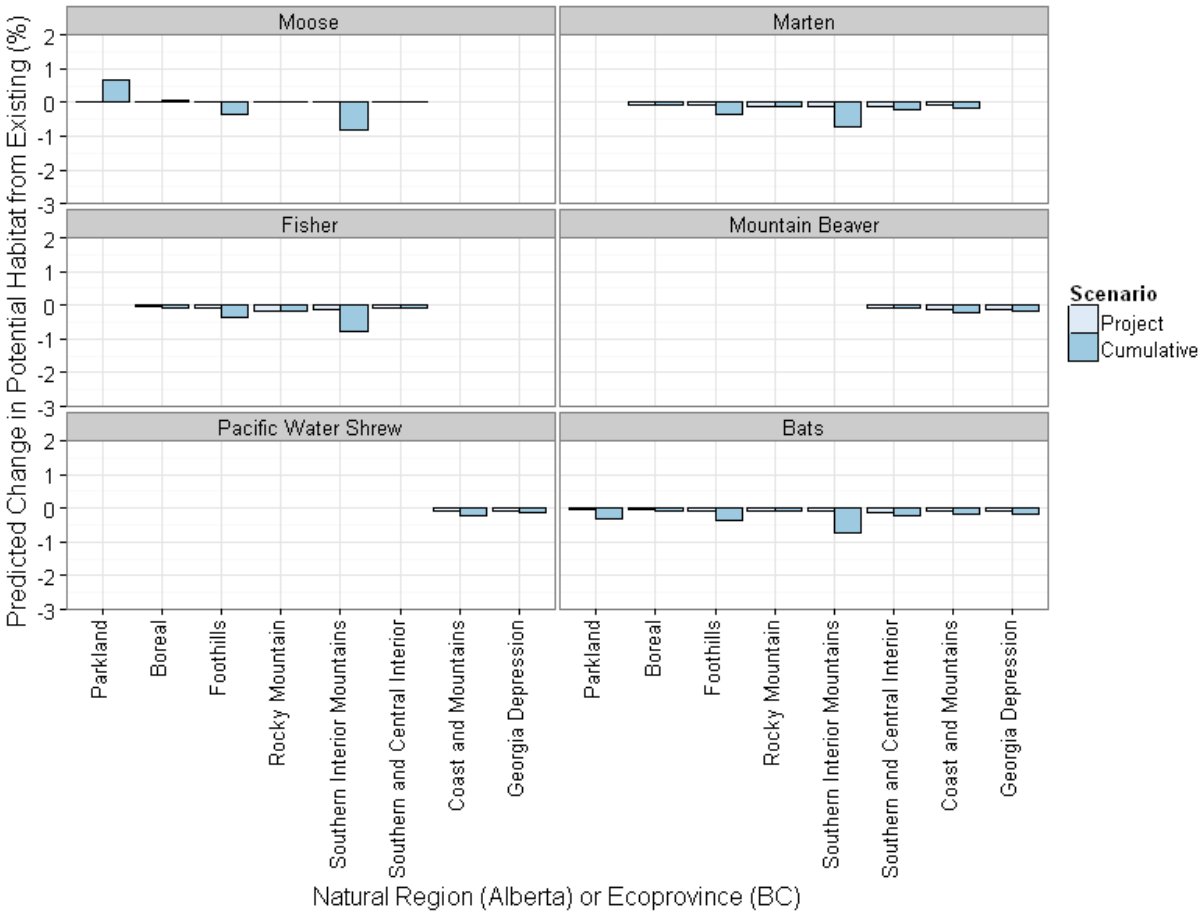


Figure 8.9-3 Predicted Change in Potential Habitat for Mammal Indicators
The predicted change in potential habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA.

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10.6. By implementing the proposed mitigation, the Project's contribution to cumulative effects on mammal habitat will be reduced. It is expected that most other operators in the Grizzly Bear, Caribou and Wildlife RSAs will implement similar best practices and standard mitigation to reduce the contribution of existing and reasonably foreseeable developments to cumulative effects. For the mammal indicators, the predicted change in potential habitat at the regional scale as a result of the Project indicates a very low contribution to cumulative effects. Therefore, mitigation in addition to the measures already proposed in Section 7.0 is not warranted. The commitments outlined in Section 7.2.10.6 to implement additional mitigation beyond the standard measures to address the Project's residual effect on woodland caribou habitat, and to work with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for coastal riparian small mammals (*i.e.*, Pacific water shrew, Townsend's mole), are expected to adequately address the Project's contribution to cumulative effects on these sensitive habitats for mammal indicators.

Additional quantitative analyses were completed to inform the assessment of the Project's contribution to cumulative effects on grizzly bear and caribou. These are discussed in the following subsections.

Grizzly Bear

Grizzly bear core (or "core security") habitats are locations with high habitat value and low mortality risk, and are an important component of grizzly bear management (Gibeau *et al.* 2001, Mace and Waller 1998). Core areas can vary in size; 10 km^2 (1,000 ha) is a generally accepted benchmark for defining suitable core roadless areas for grizzly bears (Hamilton pers. comm.). An analysis of grizzly bear core areas was completed using the 'roadless' reciprocal of the moving window motorized access density analysis described below under the mortality risk evaluation for grizzly bear. Grizzly bear core areas were defined as areas ≥ 10 km^2 with a motorized access density of 0 km/km^2, and excluding large lakes, exposed rock and ice (*e.g.*, glaciers).

Results of the grizzly bear core area analysis indicate that the Project will intersect 12 of the core security habitat patches for grizzly bear available under existing conditions in the Grizzly Bear RSA. The Project does not change the number of core patches from existing conditions (Table 8.9-8). The number of core patches is predicted to increase in the North Cascades Grizzly Bear Population Unit (GBPU) (Table 8.9-8) as a result of reasonably foreseeable developments, which is a function of large patches being fragmented into multiple smaller patches that are still of suitable size (*i.e.*, > 10 km/km^2). The number of core security patches in the Robson GBPU decreases from existing conditions as a result of reasonably foreseeable developments (Table 8.9-8), indicating some patches are fragmented into areas too small to be considered core habitat (*i.e.*, < 10 km/km^2). The Project does not have an incremental contribution to cumulative disturbance in grizzly bear core habitat in the Grande Cache, Yellowhead and Columbia-Shuswap GBPUs (*i.e.*, there is no reduction in the total area of core habitat from existing to Project conditions [Figure 8.9-4]). The Project's contribution to cumulative effects on grizzly bear core habitat in the Wells Gray, Robson and North Cascades GBPUs is negligible (Figure 8.9-4).

Management targets for grizzly bear include maintaining a maximum number (*i.e.*, as many as possible) of linked core security habitat patches larger than 10 km^2 within the landscape (Hamilton pers. comm.). The Project is not expected to affect the potential for this target to be achieved. The proposed mitigation in Section 7.0 to reduce the Project's residual effect on grizzly bear habitat is expected to adequately address the Project's contribution to cumulative effects on grizzly bear. No additional mitigation is deemed warranted specifically for cumulative effects on grizzly bear habitat.

TABLE 8.9-8

PREDICTED CHANGE IN GRIZZLY BEAR CORE HABITAT PATCHES

GBPU	Existing Conditions		Project Conditions[2]			Cumulative Conditions[3]		
	Number of Patches	Mean Patch Size (km²) ± SD	Number of Patches	Number of Patches Intersected[1]	Mean Patch Size (km²) ± SD	Number of Patches	Number of Patches Intersected[1]	Mean Patch Size (km²) ± SD
Grande Cache	79	154.618 ± 962.015	79	0	154.618 ± 962.015	79	17	154.573 ± 962.018
Yellowhead	47	167.875 ± 684.172	47	0	167.875 ± 684.172	47	6	167.874 ± 648.172
Columbia-Shuswap	32	184.525 ± 577.870	32	0	184.525 ± 577.870	32	0	184.525 ± 577.870
Wells Gray	27	321.154 ± 1,490.591	27	4	321.1005 ± 1,490.380	27	4	320.910 ± 1,489.392
Robson	33	571.291 ± 1,509.199	33	1	571.257 ± 1,509.033	30	4	570.402 ± 1,507.374
North Cascades	40	112.096 ± 174.287	40	7	112.064 ± 174.298	41	19	108.7136 ± 172.366

Notes:
1 Indicates the number of core patches available under existing conditions that are intersected by the Project and reasonably foreseeable developments. Patches that overlap more than one GBPU are quantified in their entirety for each relevant GBPU.

2 Project conditions include existing activities (with available spatial data + Project).

3 Cumulative conditions include existing activities + Project + reasonably foreseeable developments (with available spatial data).

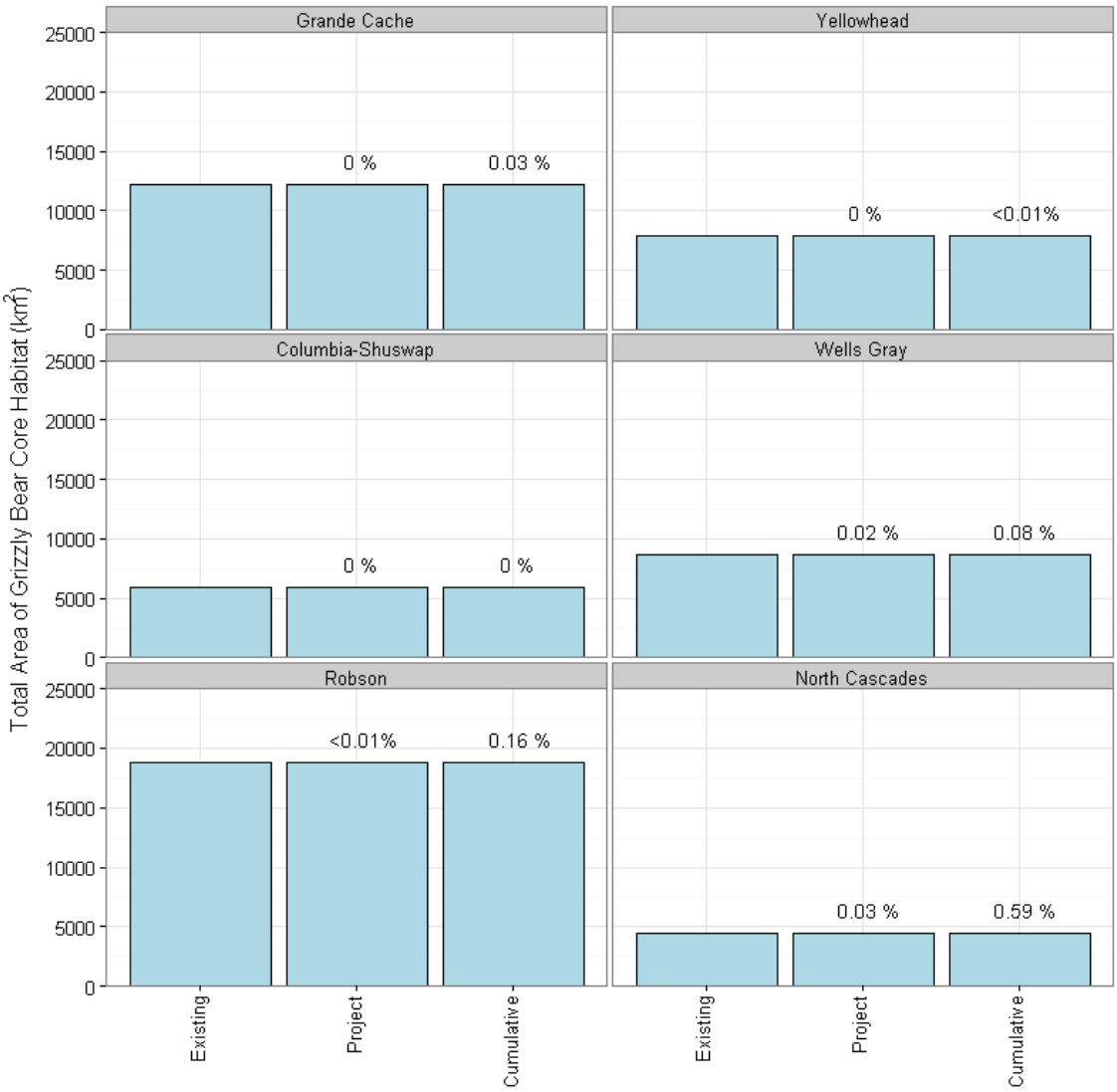


Figure 8.9-4 Predicted Change in Total Area of Grizzly Bear Core Habitat
The total area (km²) of core habitat is the sum of the area of all core habitat patches within each GBPU. The percent change from existing conditions to Project and cumulative conditions is provided numerically above each relevant bar.

Caribou

The Caribou RSA is approximately 1,098,884 ha in size and includes the Wells Gray and Groundhog caribou ranges and associated UWR and WHA (illustrated in the Wildlife Technical Report of Volume 5C). Direct habitat disturbance within the Caribou RSA was quantified based on available existing disturbance data (anthropogenic and fire < 40 years). Functional habitat disturbance incorporates the direct disturbance and the potential zone of influence (reduced habitat effectiveness) within 500 m of anthropogenic disturbance.

Using the method developed for the federal *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus* caribou)*, Boreal population, in Canada* (Environment Canada 2012), undisturbed caribou habitat is defined as the habitat remaining within the range that has not been burned in the last 40 years and is greater than 500 m from land use features such as clearings and corridors. This method was developed to delineate critical habitat for boreal woodland caribou across Canada (Environment Canada 2008, 2011, 2012). In the absence of current models, measures or thresholds specific to mountain caribou, this approach was adopted for this cumulative effects assessment because it is considered to reflect the widest range of woodland caribou life history conditions. Limitations associated with differences in

mountain and boreal caribou life history and spatial segregation of seasonal ranges (especially high value winter ranges) for mountain but not boreal caribou, are acknowledged. The Environment Canada (2012) method for assessing boreal caribou range condition is currently considered the best available quantitative approach for assessing potential cumulative effects on caribou habitat, and allows the expected incremental contribution of existing disturbance, the Project and reasonably foreseeable developments to cumulative effects on caribou habitat to be differentiated.

There is a moderate level (approximately 31.6%) of existing functional habitat disturbance within the Caribou RSA. Cutblocks are the only reasonably foreseeable development identified within the Caribou RSA. Spatial data were not available for future cutblocks at the time of the assessment; therefore, the quantitative assessment of functional disturbance includes only the interaction of the Project with existing activities in the Caribou RSA (Table 8.9-9). Future forest harvest is considered qualitatively in the significance assessment of cumulative effects on caribou habitat. The Project is predicted to contribute to the cumulative functional disturbance in the Caribou RSA by a negligible amount (< 0.01% [Table 8.9-9]).

Environmental Protection and Management Regulation under the BC *Oil and Gas Activities Act* states that operating areas should not be located in a designated UWR unless the operating area will not have a material adverse effect on the ability of the wildlife habitat within the UWR to provide for the survival, within the UWR, of the wildlife species for which the UWR was established. Within the intersected UWR, the proposed pipeline corridor parallels the existing TMPL right-of-way, Highway 5, and an existing railway. Results of the quantitative analysis of caribou habitat change in the Caribou RSA indicate there is no increase in functional habitat disturbance in the caribou UWR as a result of the Project. Despite the relatively low value of the habitat within the proposed pipeline corridor for caribou (due to its low elevation location and existing disturbances), the Project is expected to improve habitat conditions for moose forage and for wolves (prey availability, ease of travel). Wolves have been documented travelling during winter along the existing TMPL in the Caribou RSA (Sturgenor pers. comm.). Wolves are suggested as a primary factor in the decline of mountain caribou in the Caribou RSA. Changes in moose-wolf-caribou interactions are likely the primary mechanism by which the Project will potentially contribute to cumulative effects on caribou. As noted above, mitigation beyond standard measures is warranted to address the Project's residual and incremental contribution to cumulative effects on woodland caribou (*e.g.*, planting conifer seedlings in strategic locations within the Project Footprint, and potentially the existing TMPL). Trans Mountain will work with provincial regulatory authorities, tenure holders and other stakeholders to identify opportunities to address potential residual Project effects on caribou habitat. Implementation of appropriate mitigation is expected to address the Project's residual effect and contribution to cumulative effects (Table 8.9-6 point 2[a]).

TABLE 8.9-9

PREDICTED CHANGE IN HABITAT IN THE CARIBOU REGIONAL STUDY AREA

Caribou Habitat Boundary	Area (ha)	Habitat Disturbance[1]	Existing Conditions (ha)	Project Conditions[2]		
				Project (ha)	Incremental Change (ha)[3]	% Change[3]
Caribou RSA	1,098,884.4	Direct Anthropogenic Disturbance	84,322.1	84,406.8	84.6↑	0.10↑
		Fire < 40 years	15,776.0	15,776.0	0	0
		Functional Disturbance	347,011.8	347,014.2	2.3	< 0.01↑
		Undisturbed	751,872.6	751,870.2	2.3↓	< 0.01↓
UWR	283,467.7	Direct Anthropogenic Disturbance	4,0245.8	40,253.4	7.6↑	0.02↑
		Fire < 40 years	2,769.3	2,769.3	0	0
		Functional Disturbance	147,269.9	147,269.9	0	0
UWR	283,467.7	Undisturbed	136,197.8	136,197.8	0	0

Notes: 1 Direct anthropogenic disturbance: area of anthropogenic disturbance (direct footprint).

Functional disturbance: area of anthropogenic disturbance buffered by 500 m, and fire < 40 years.

Undisturbed: area of caribou range outside of functional disturbance.

2 Cumulative conditions are not presented since there are no reasonably foreseeable developments with available spatial data in the Caribou RSA.

3 Incremental and percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

8.9.6.2 Cumulative Change in Movement of Mammal Indicators

The Project is expected to contribute to cumulative effects on movement of mammal indicators, in combination with existing and reasonably foreseeable future disturbances. Sections 7.2.10.5 and 7.2.10.9 provide discussion of the potential effects mechanisms of the Project on mammal movement. Existing activities and reasonably foreseeable developments and activities are expected to affect mammal movement, in particular high-traffic roads, urban (commercial, residential) and industrial development, and resource extraction (*e.g.*, recent forestry cutblocks, mines). Where the proposed pipeline corridor parallels existing linear features, the incremental increase in the width of the corridor is likely to affect movement of some mammal indicators. Noise and activity during construction and operations will interact with existing activities and reasonably foreseeable developments to affect mammal movement patterns (*e.g.*, barriers, filters, sensory displacement).

To meet management objectives for grizzly bear, one target outcome is to maintain the maximum number of linked core security patches (Hamilton pers. comm.). During the operations phase of the Project, early seral natural vegetation will regenerate over the Project Footprint, access control measures will be implemented to discourage motorized access, and human presence for operational activities (*e.g.*, for monitoring/maintenance activities) is expected to be infrequent. As a result, it is considered unlikely that the proposed pipeline right-of-way will create a barrier to grizzly bear movement that would isolate habitats. Therefore, it is assumed that the grizzly bear habitat fragmented by the Project footprint will remain functionally linked.

Mitigation measures to address the expected Project effects on wildlife movement are provided in Section 7.2.10.6. It is expected that most other operators in the Grizzly Bear, Caribou and Wildlife RSAs will implement similar best practices and standard mitigation. No mitigation measures beyond the Project-specific mitigation are deemed warranted to address the incremental cumulative effect on mammal movement.

8.9.6.3 Cumulative Risk of Mortality for Mammal Indicators

The Project is expected to contribute to incremental mammal mortality risk in combination with existing and reasonably foreseeable disturbances. Improved access for predators and humans, clearing, blasting, traffic and human-wildlife conflicts are likely mechanisms of Project incremental cumulative effects on mammal mortality risk that will interact with existing and reasonably foreseeable disturbances and activities. Application of the proposed mitigation to avoid wildlife mortality associated with traffic, machinery and human-wildlife conflict is expected to reduce the Project's incremental contribution to cumulative mortality risk to negligible levels.

Sections 7.2.10.9 and 8.9.4 discuss the cause-effect relationship between access and wildlife mortality risk from hunting, trapping and predation. Given the linear nature of the primary components of the Project, effects on mammal mortality risk during operations are expected to result largely from access. Linear feature density is a metric that can be used to provide insight into the potential cumulative effects of development on habitat effectiveness and mortality risk (Salmo *et al.* 2003). Linear feature density is a measure of the concentration of linear features (*e.g.*, roads, transmission lines, railways and pipelines) on the landscape. Since road density thresholds are available for grizzly bear, a quantitative analysis was completed to inform the assessment of cumulative effects on grizzly bear mortality risk.

The BC Identified Wildlife Species Account for grizzly bear recommends an open road density of less than 0.6 km/km² to meet access management objectives in grizzly bear areas (BC MWLAP 2004). The Alberta Grizzly Bear Recovery Plan identifies objectives that would limit the rate of human-caused mortality per Bear Management Area (or GBPU) by maintaining open road densities at or below 0.6 km/km² in Grizzly Bear Priority Areas, and at or below 1.2 km/km² in all remaining grizzly bear range (ASRD 2008).

Open road density thresholds are inconsistently applied to various combinations of linear feature data sets in different management regions. For example, some jurisdictions use open road density to mean only primary and secondary roads, while other jurisdictions include all anthropogenic linear features for which spatial data are available. The validity of including seismic lines as access is uncertain, since there is a large amount of variation in the ability of these features to facilitate motorized access during the growing season, and the available spatial data does not differentiate between seismic lines of varying

width, continuity and vegetation regeneration. For the purposes of this assessment, the analysis of access density used a combination of linear feature data to represent motorized access, as identified in Table 8.9-10.

TABLE 8.9-10

ACCESS DENSITY PARAMETERS

Parameter	Details
Performance Measure	Motorized Access Density (km/km²)
Definition	Access routes (without closures/restrictions) that receive conventional and/or off-road vehicle (*e.g.*, ATV) use
Threshold	0.6 km/km²
Spatial Data Features	• Primary Roads • Secondary Roads • Tertiary Roads • Transmission Lines • Power Lines • Pipelines

A moving window (sometimes called 'roving window') approach is often used in grizzly bear studies for calculating access density (Allen *et al.* 2011). The moving window approach calculates the density of linear features in the neighbourhood ('window') of each output raster cell ('pixel') in the middle of the window (ESRI 2012). Access density was computed using a moving window analysis in ArcGIS with a 500 m circular window radius (*i.e.*, a 1 km window) and 30 m^2 pixels. Results were provided by GBPU, and categorized into strata based on known access density thresholds for grizzly bear (Hamilton pers. comm.):

- 0 km/km²;
- > 0 to 0.6 km/km²;
- > 0.6 to 1.2 km/km²;
- > 1.2 to 2.4 km/km²; and
- > 2.4 km/km².

The proposed pipeline and power lines were included in the analysis of the Project's contribution to motorized access density. The locations of access roads needed to construct and operate the Project are unknown at the time of assessment. It is understood that the majority of access will utilize existing access roads. Access is considered qualitatively in addition to the quantitative analysis in the characterization of effects and determination of significance.

Results of the moving window analysis (Table 8.9-11) indicate that the existing average motorized access density in the Columbia-Shuswap, Wells Gray, Robson and North Cascades GBPUs currently exceeds the threshold of 0.6 km/km², suggesting a high risk of grizzly bear mortality and displacement under current conditions in these GBPUs. The predicted cumulative contribution of the Project and reasonably foreseeable developments to motorized access density will not cause the average density to exceed 0.6 km/km² at the regional (*i.e.*, GBPU) scale for those GBPUs currently below this threshold under existing conditions (*i.e.*, Grande Cache and Yellowhead GBPUs). Figure 8.9-5 shows the predicted change in motorized access density, as a proportion of each GBPU, from existing to Project and cumulative conditions. The combined change in the proportion of each GBPU in each access density category as a result of the Project and reasonably foreseeable developments is minimal for all GPBUs (*i.e.*, < 0.4% change from existing conditions). In some instances, the Project has the apparent effect of reducing the access density (*e.g.*, Wells Gray and Robson GBPUs [Table 8.9-11]), since the proposed pipeline corridor is located between existing linear features and will effectively join currently separated corridors into a single wide corridor, thereby reducing the corridor density.

The results indicate that the average motorized access density at the GBPU scale does not change substantially as a result of the Project (Table 8.9-11). However, the proposed route and foreseeable future disturbances are predicted to have a localized effect on the motorized access density within each GBPU intersected by the Project, which will cause localized increases from baseline conditions below 0.6 km/km² to levels that exceed the threshold. Figures 8.9-6 to 8.9-11 illustrate the minor extent of the localized contribution to combined disturbance from the Project and reasonably foreseeable developments to the motorized access density in each GBPU intersected by the Project, whereby the density is predicted to exceed the 0.6 km/km² threshold for grizzly bear.

TABLE 8.9-11

PREDICTED CHANGE IN MOTORIZED ACCESS DENSITY FROM EXISTING CONDITIONS IN THE GRIZZLY BEAR REGIONAL STUDY AREA

	Existing Conditions	Project Conditions[1]		Cumulative Conditions[2]	
GBPU	Average Density ± Standard Deviation (km/km²)	Average Density ± Standard Deviation (km/km²)[3]	% Change in Average Density from Existing Conditions[3]	Average Density ± Standard Deviation (km/km²)	% Change in Average Density from Existing Conditions[3]
Grande Cache	0.34 ± 0.76	0.34 ± 0.76	< 0.01 ↑	0.34 ± 0.76	< 0.01 ↑
Yellowhead	0.27 ± 0.70	0.27 ± 0.70	< 0.01 ↑	0.27 ± 0.70	< 0.01 ↑
Columbia-Shuswap	1.07 ± 1.30	1.07 ± 1.30	< 0.01 ↑	1.07 ± 1.30	< 0.01 ↑
Wells Gray	0.66 ± 1.15	0.66 ± 1.15	< 0.01 ↓	0.66 ± 1.15	< 0.01 ↓
Robson	0.75 ±1.28	0.75 ± 1.28	< 0.01 ↓	0.75 ± 1.29	< 0.01 ↑
North Cascades	1.05 ± 1.38	1.05 ± 1.38	< 0.01 ↑	1.06 ± 1.40	0.01↑

Notes: 1 Project Conditions includes existing activities (with available spatial data) + Project disturbances.

2 Cumulative Conditions includes existing activities + Project + reasonably foreseeable developments (with available spatial data).

3 ↓ represents a decrease and ↑ represents an increase.

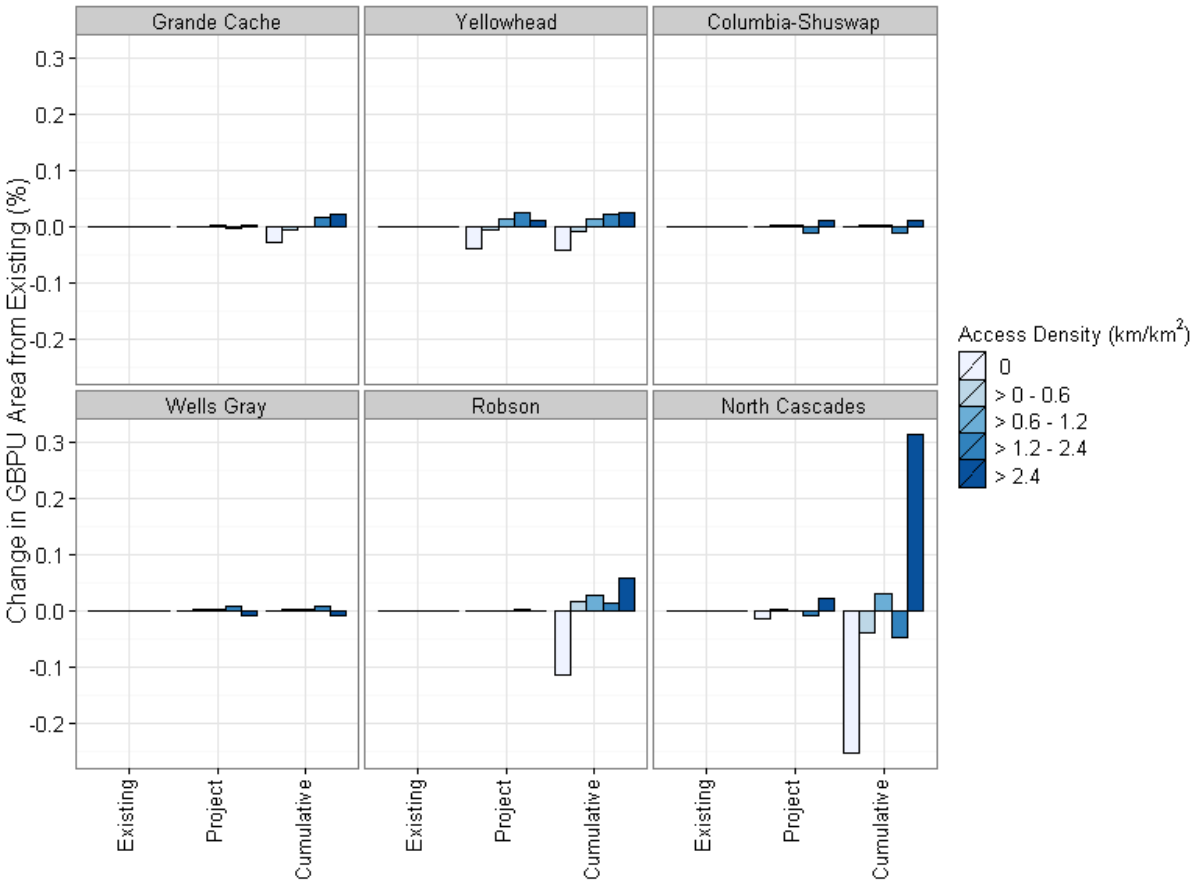
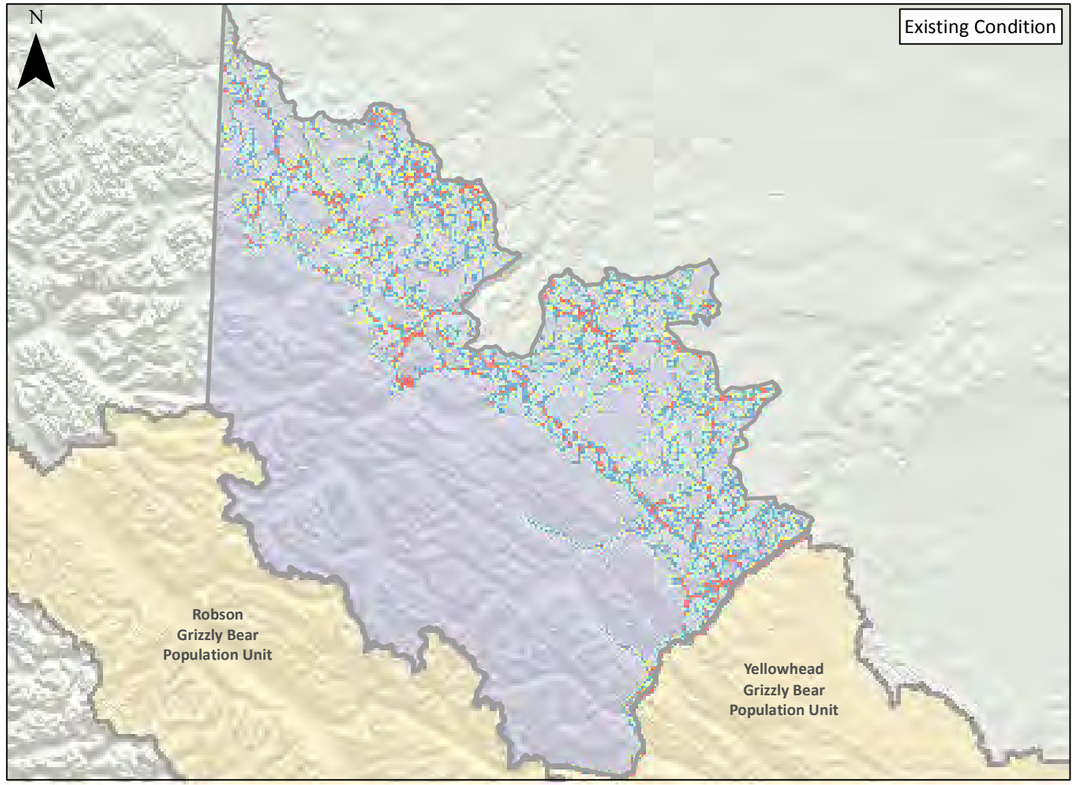
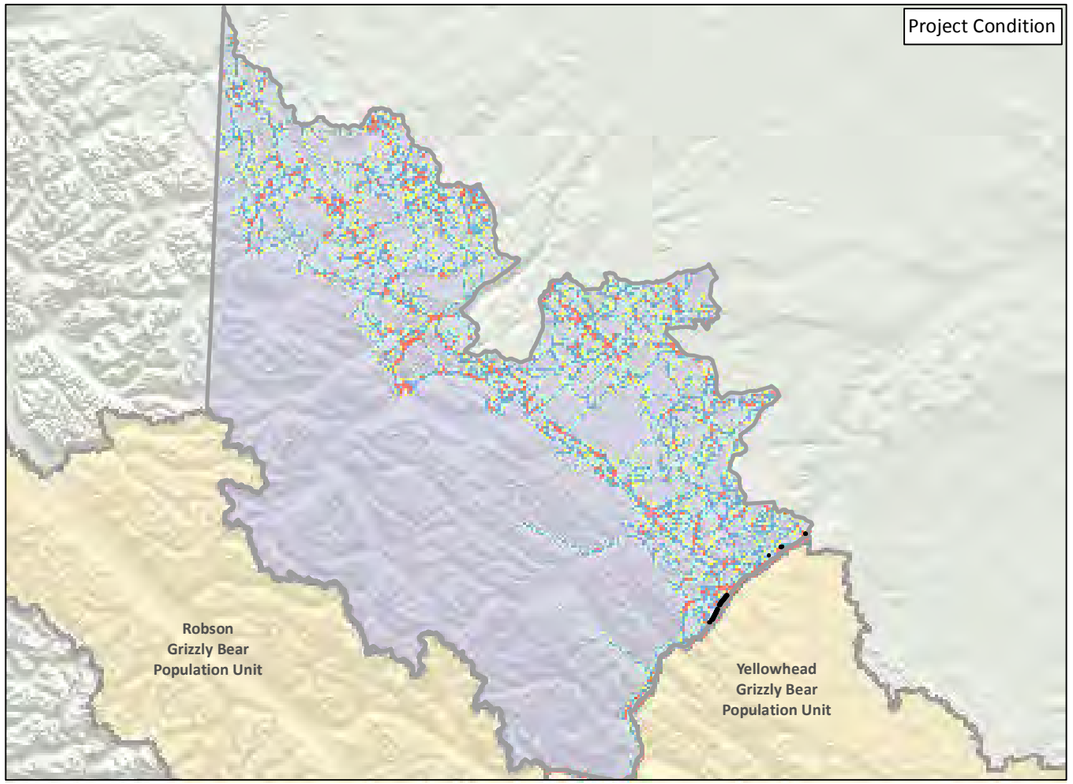
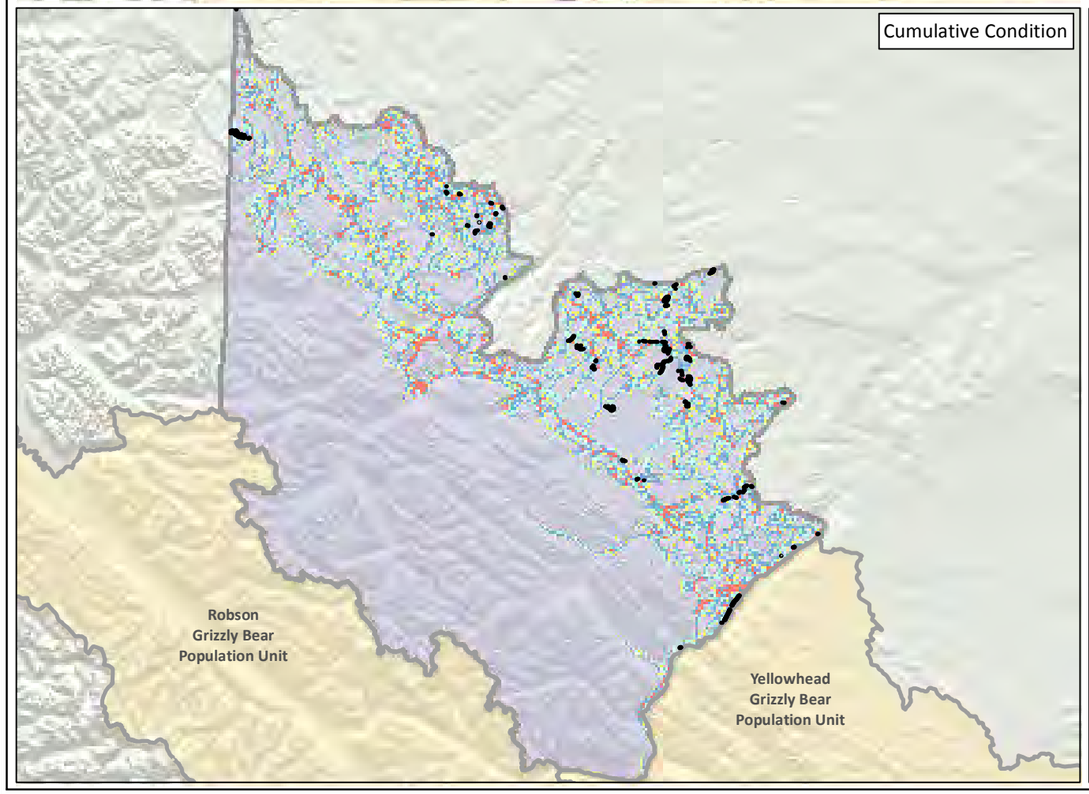
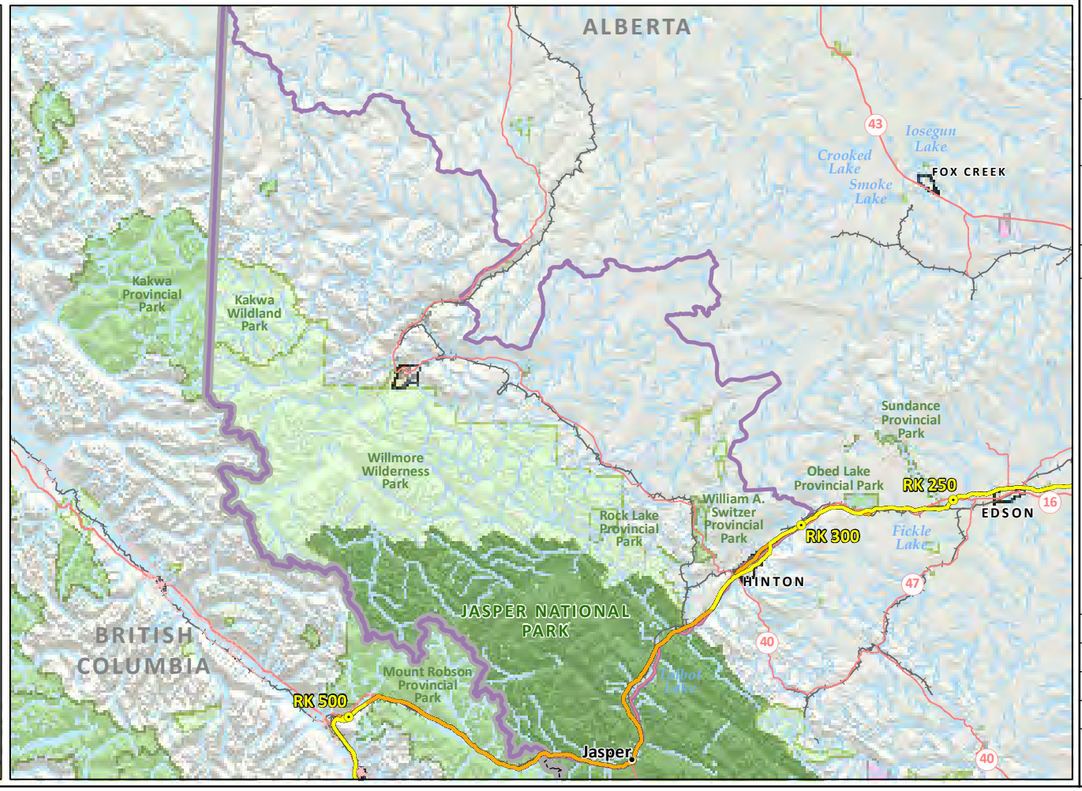


Figure 8.9-5 Predicted Change in Motorized Access Density by GBPU
Changes in motorized access density are presented as the percent change from existing conditions with respect to the proportion of the GBPU represented by each access density strata.









TRANSMOUNTAIN

FIGURE 8.9-6

MOTORIZED ACCESS DENSITY
GRANDE CACHE GBPU
ALBERTA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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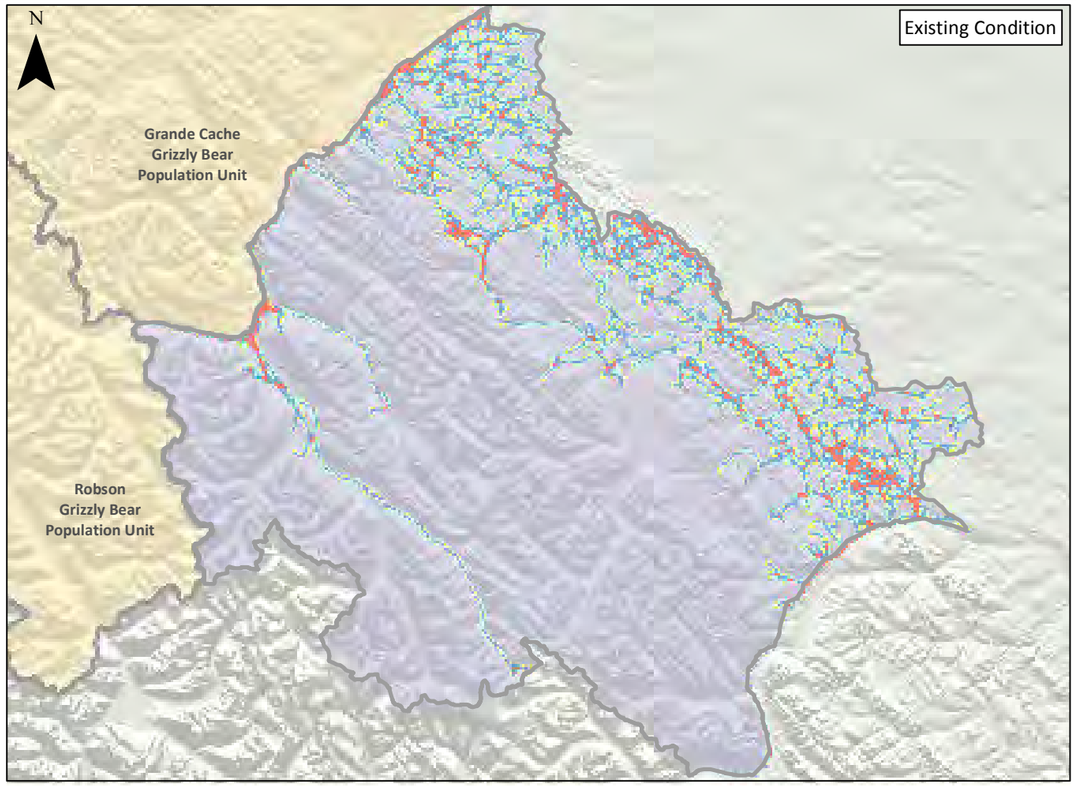
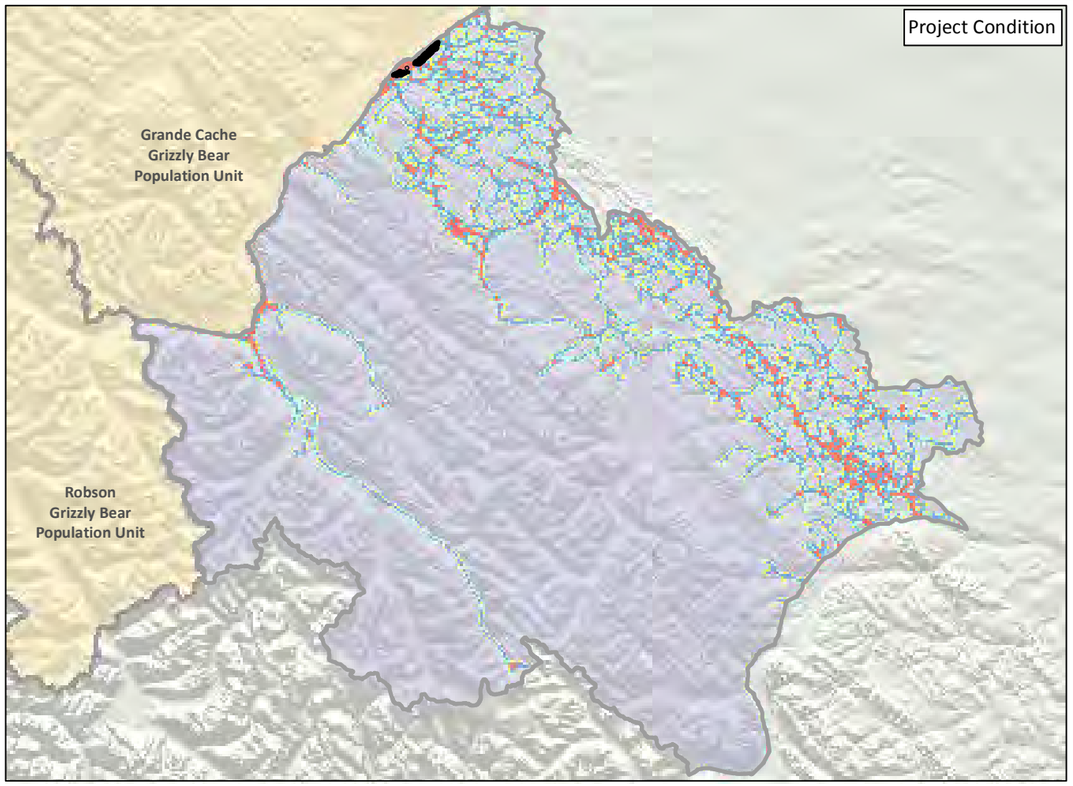
MAP NUMBER 201311_MAP_TERA_WL_00484_REV0_01		PAGE SHEET 1 OF 6
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:1,750,000	PAGE SIZE 11x17	DISCIPLINE WL
DRAWN CAS	CHECKED AJS	DESIGN TGG

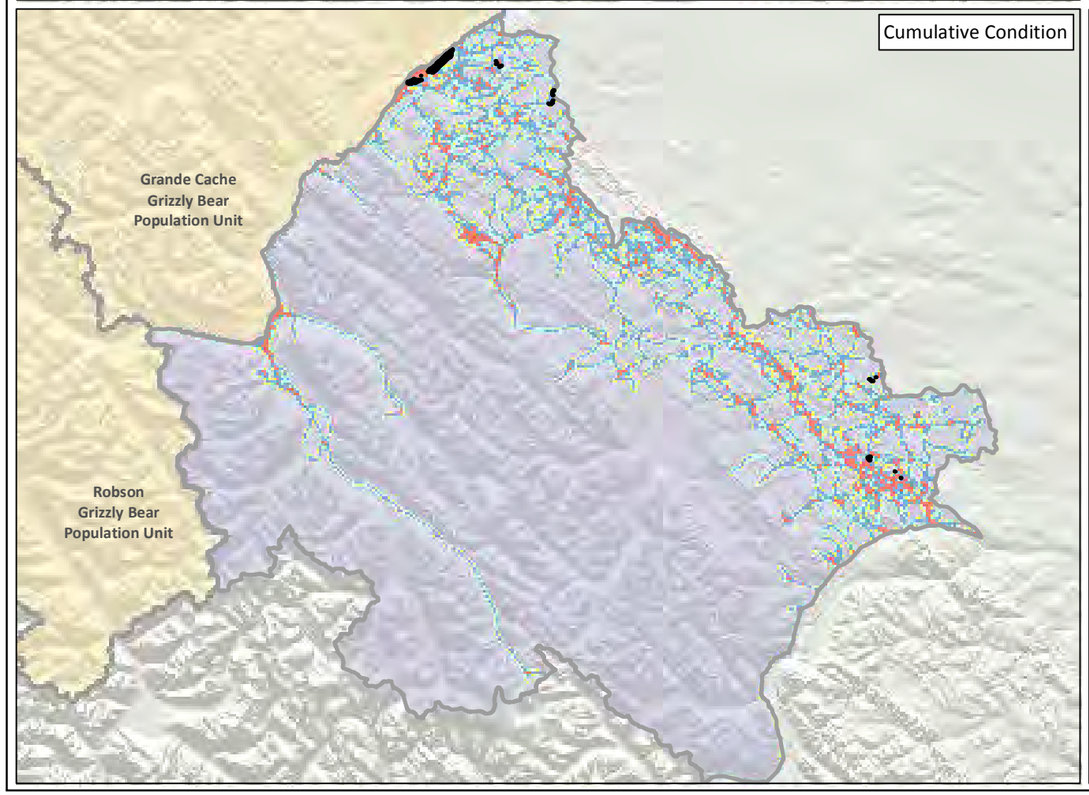
0 10 20 30 40 50 60 km

ALL LOCATION APPROXIMATE

201311_MAP_TERA_WL_00484_Rev0_01.mxd







TRANSMOUNTAIN

FIGURE 8.9-7

MOTORIZED ACCESS DENSITY
YELLOWHEAD GBPU
ALBERTA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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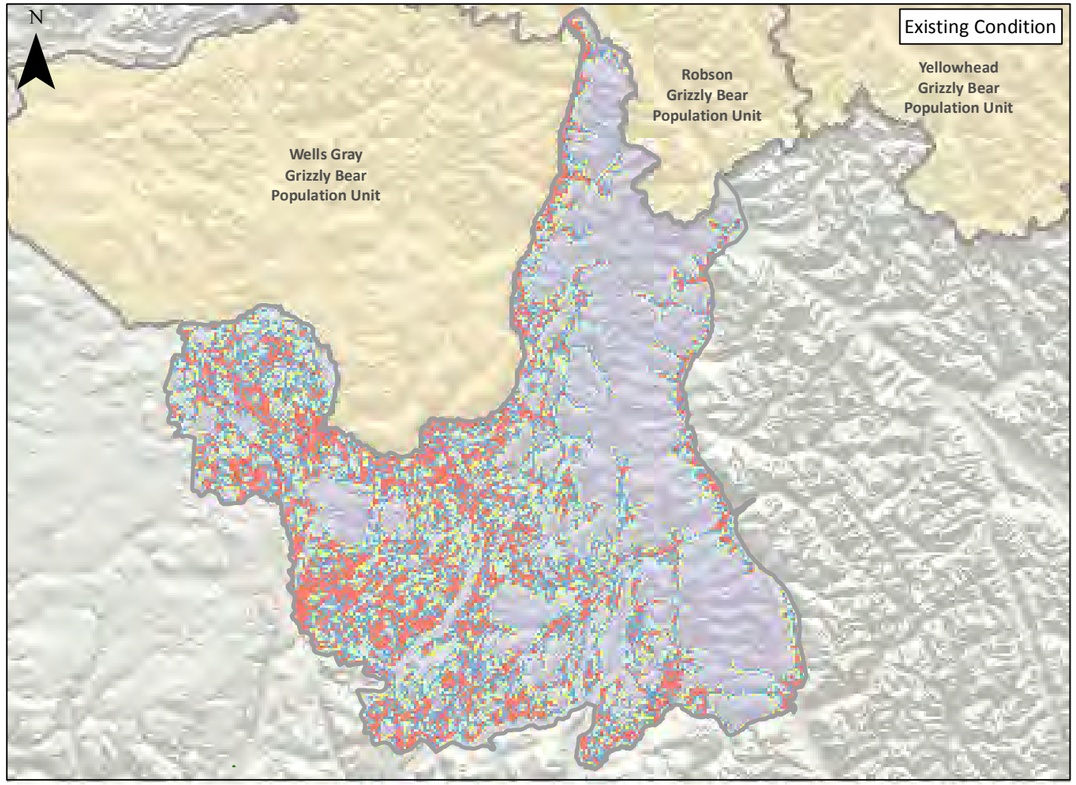
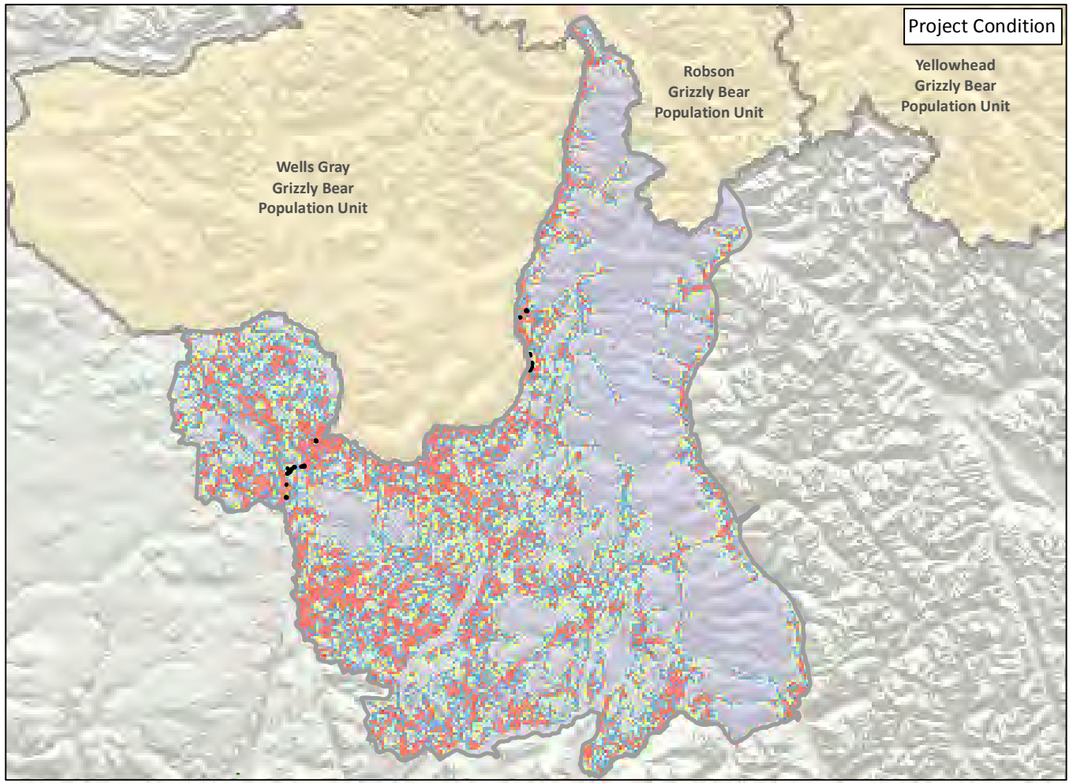
SCALE: 1:1,300,000	PAGE SIZE: 11x17	DISCIPLINE: WL
DRAWN: CAS	CHECKED: AJS	DESIGN: TGG

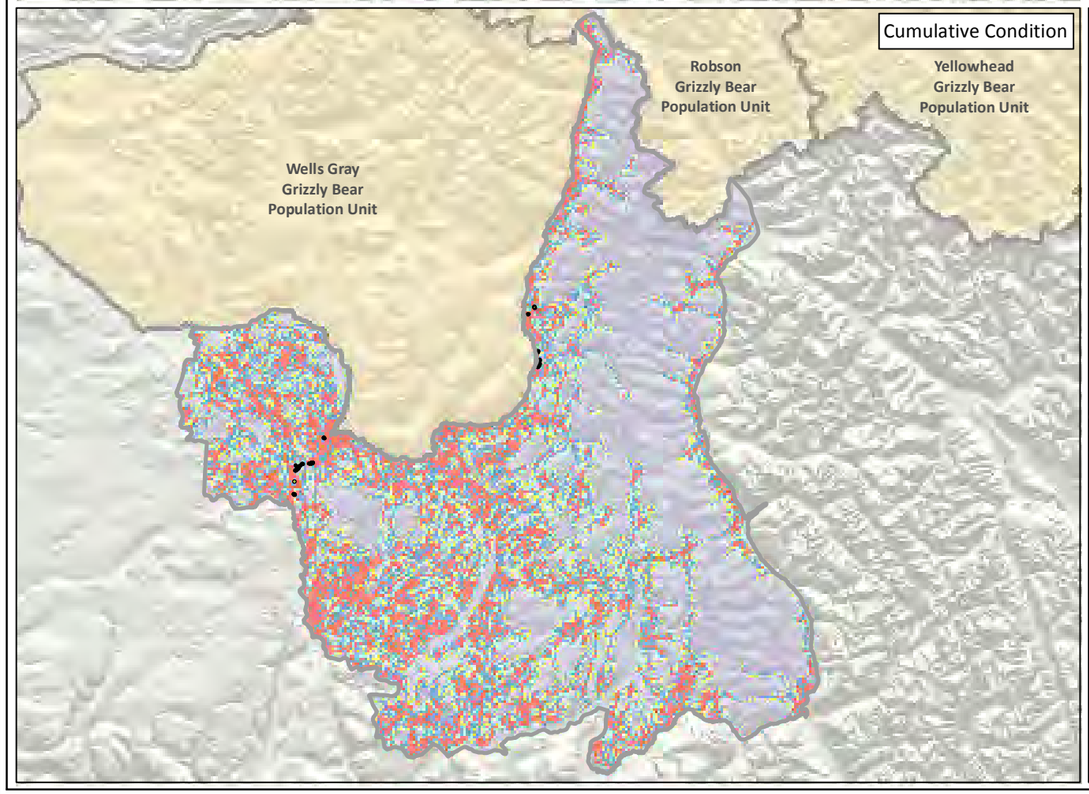
0 10 20 30 40 50 km

ALL LOCATION APPROXIMATE

201311_MAP_TERA_WL_00484_Rev0_02.mxd







TRANS MOUNTAIN

FIGURE 8.9-8

MOTORIZED ACCESS DENSITY
COLUMBIA-SHUSWAP GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,600,000	PAGE SIZE: 11x17	DISCIPLINE: WL
DRAWN: CAS	CHECKED: AJS	DESIGN: TGG

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ALL LOCATION APPROXIMATE

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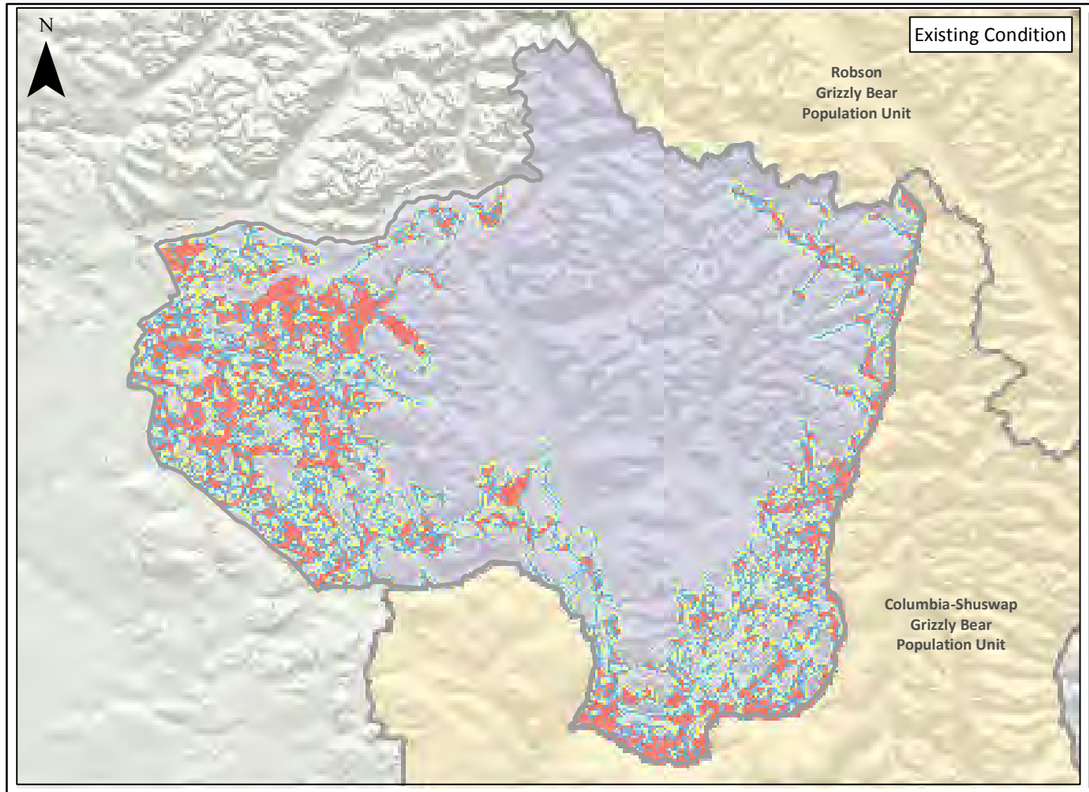

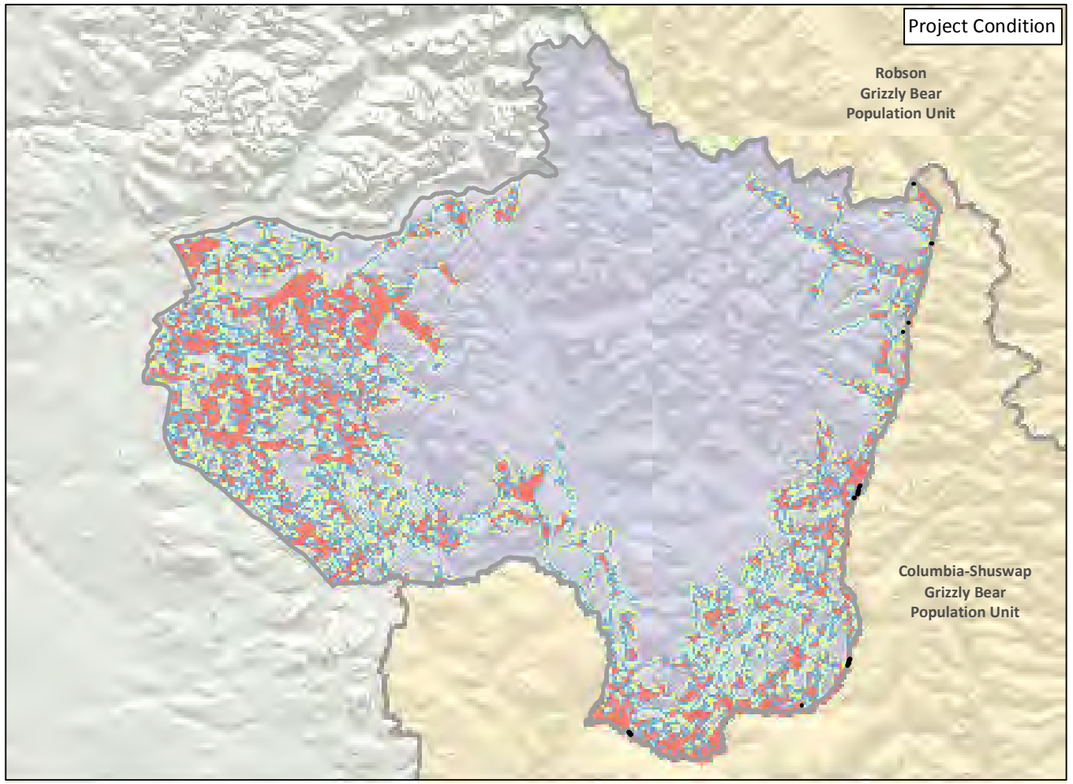

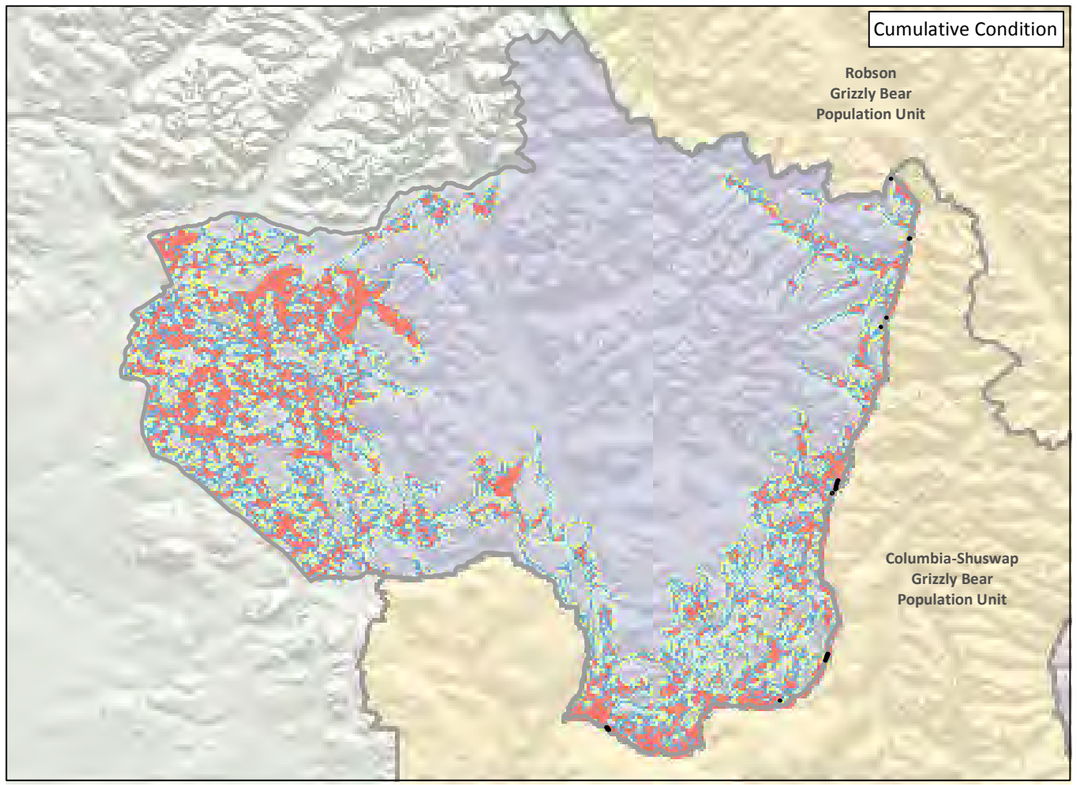

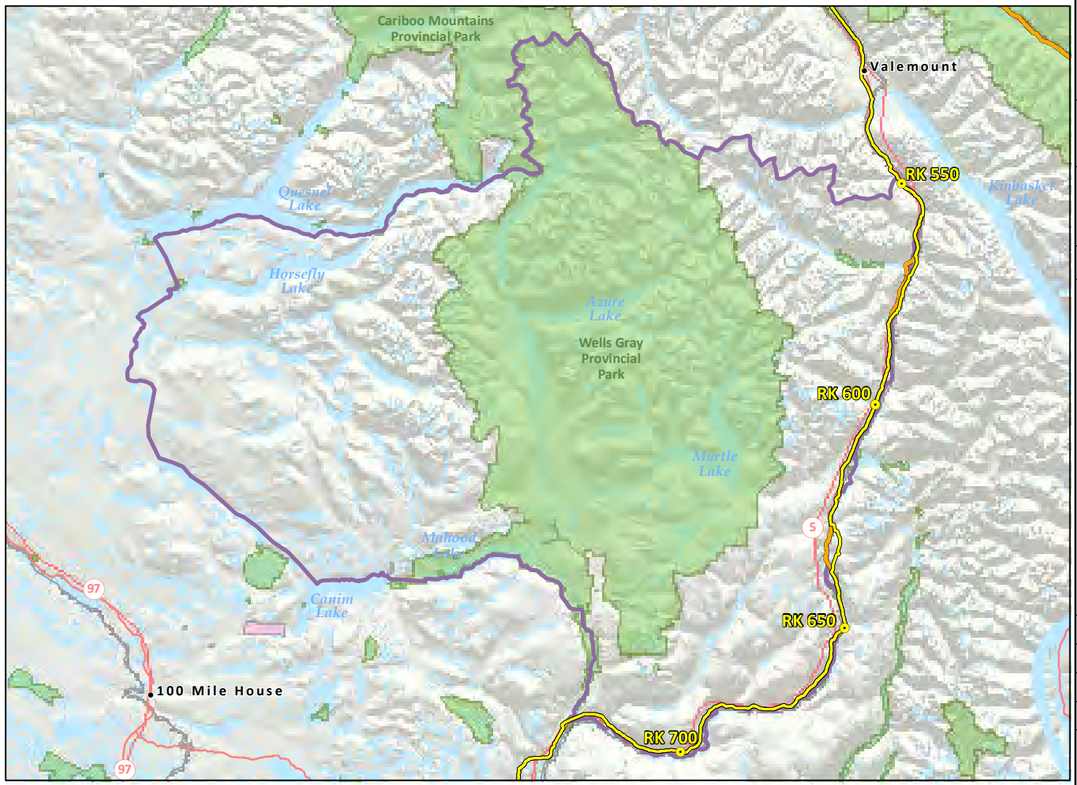

TRANS MOUNTAIN

FIGURE 8.9-9

MOTORIZED ACCESS DENSITY
WELLS GRAY GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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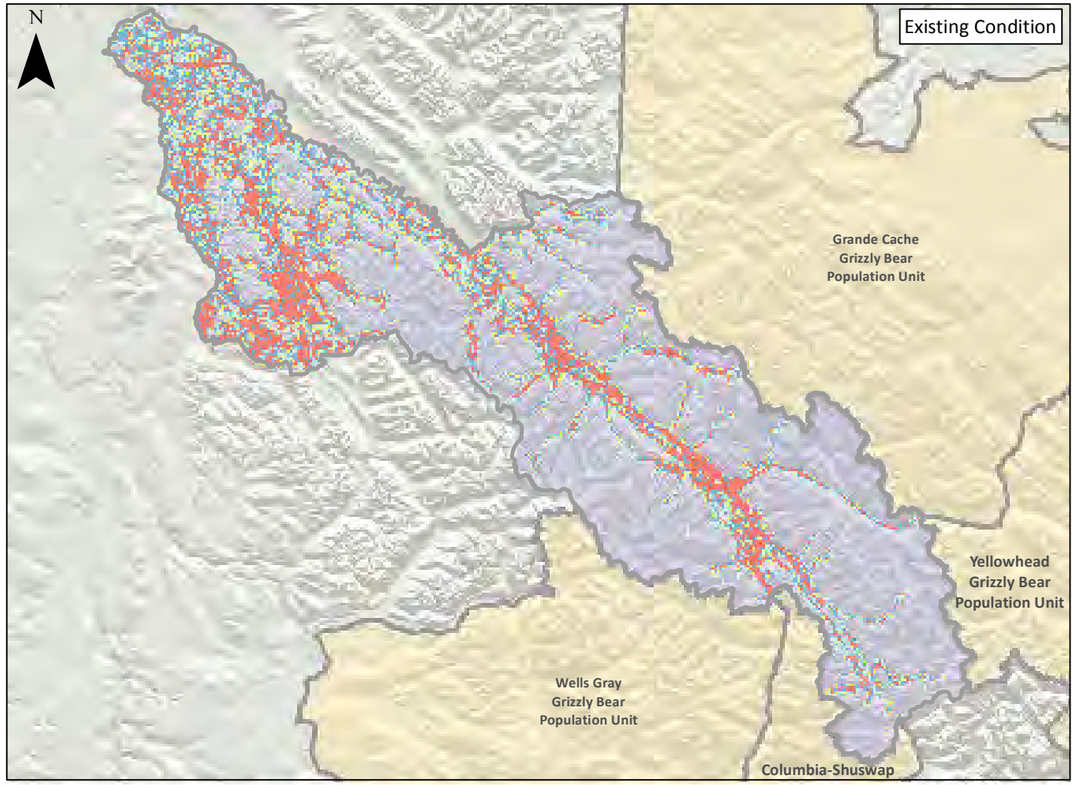
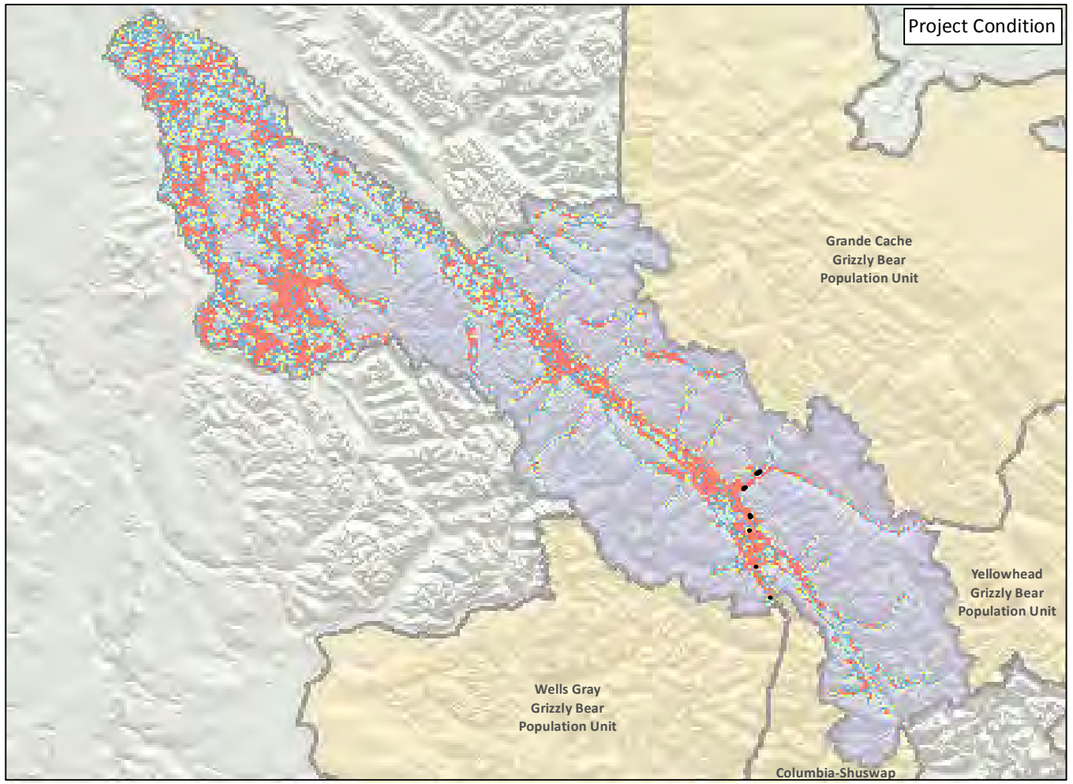
MAP NUMBER 201311_MAP_TERA_WL_00484_REV0_04		PAGE SHEET 4 OF 6
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:1,200,000	PAGE SIZE 11x17	DISCIPLINE WL
DRAWN CAS	CHECKED AJS	DESIGN TGG

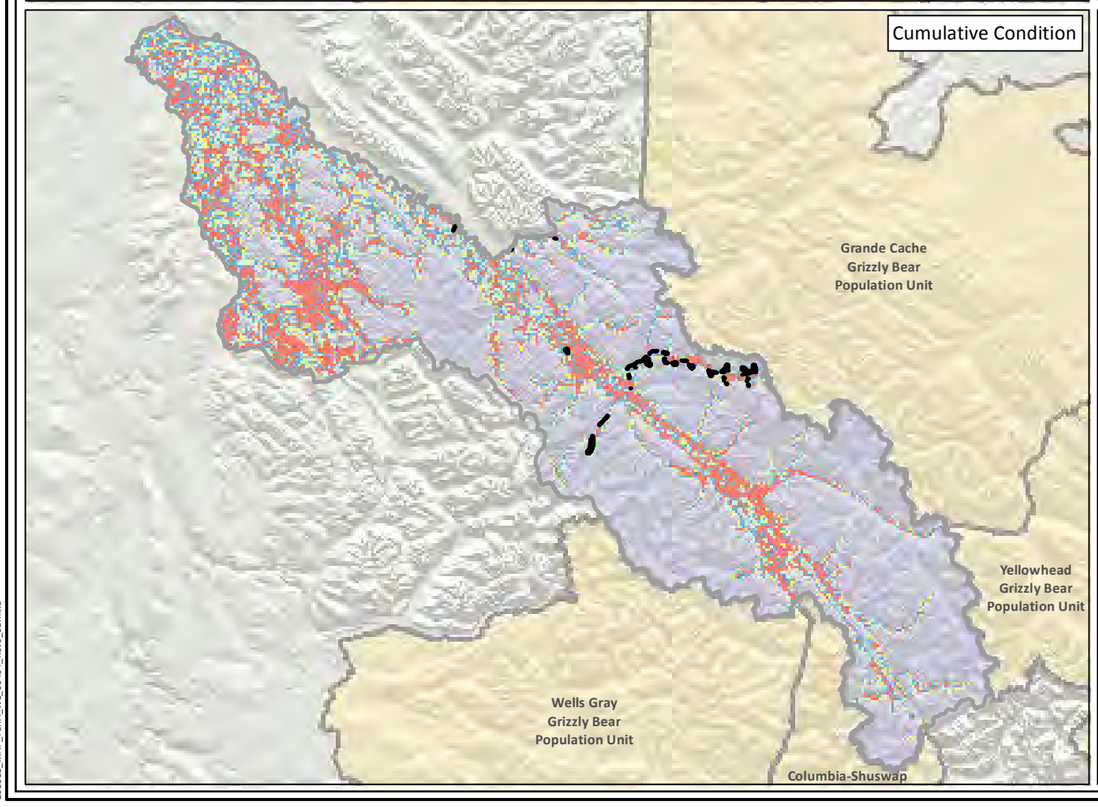
0 10 20 30 40 50 km

ALL LOCATION APPROXIMATE

201311_MAP_TERA_WL_00484_Rev0_04.mxd







TRANSMOUNTAIN

FIGURE 8.9-10

MOTORIZED ACCESS DENSITY
ROBSON GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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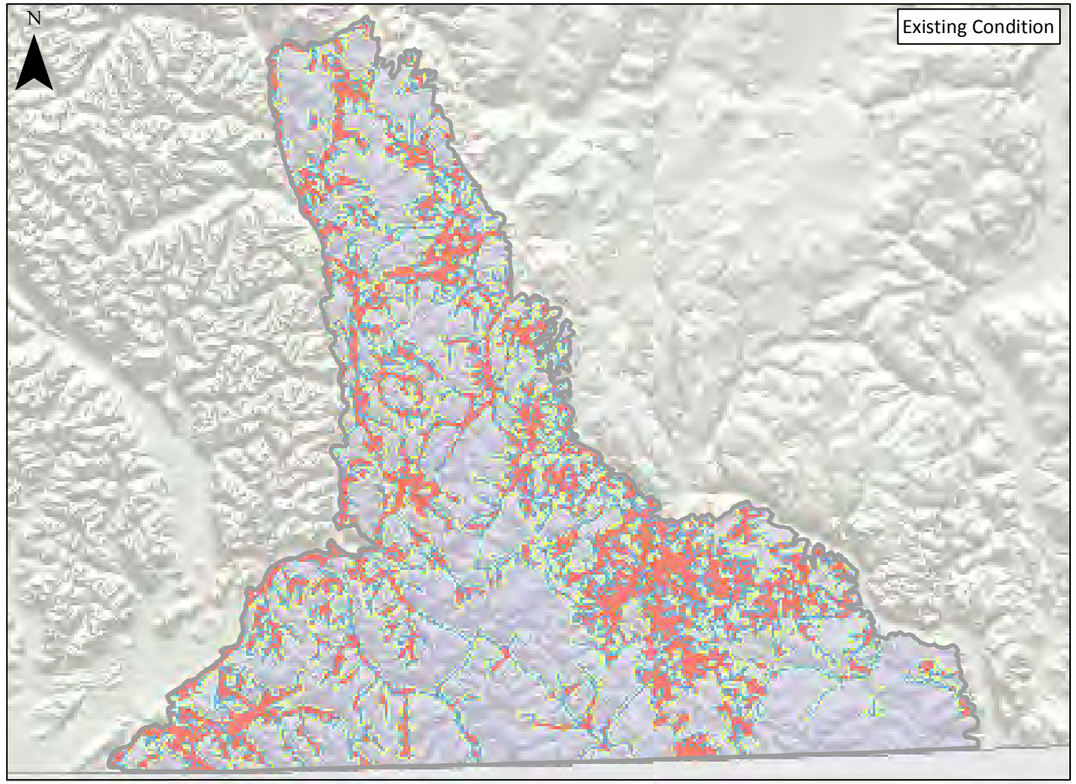
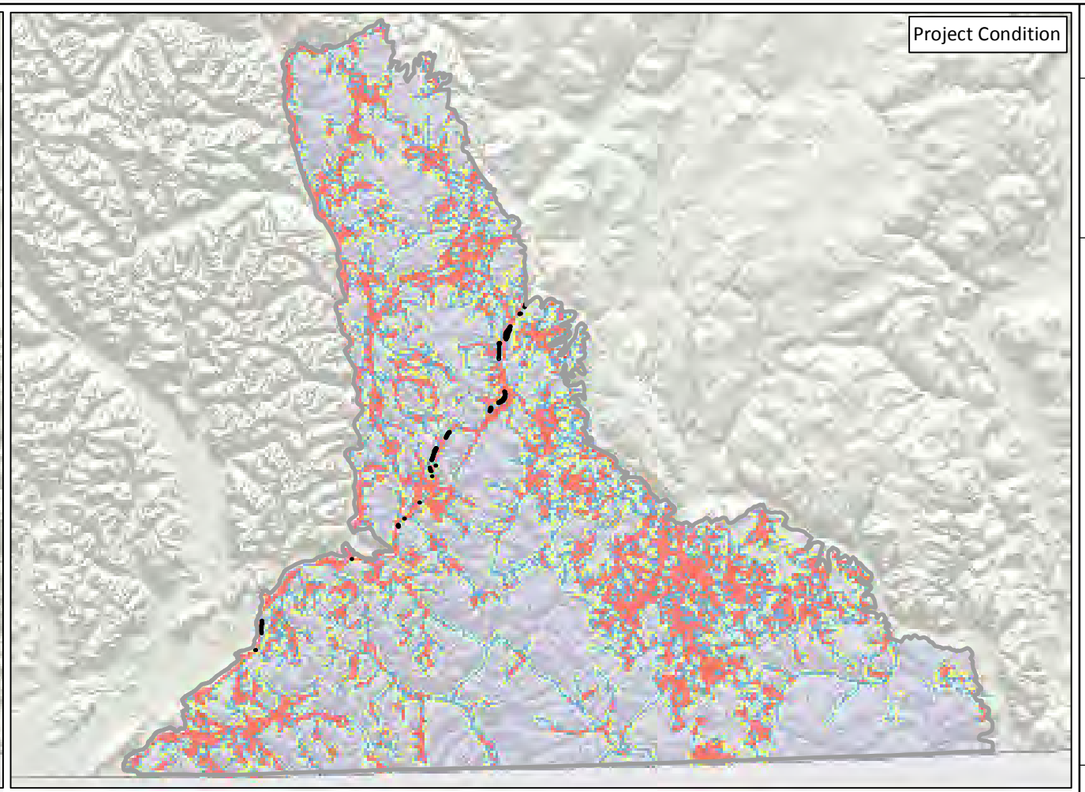
DRAWN: CAS	CHECKED: AJS	DESIGN: TGG

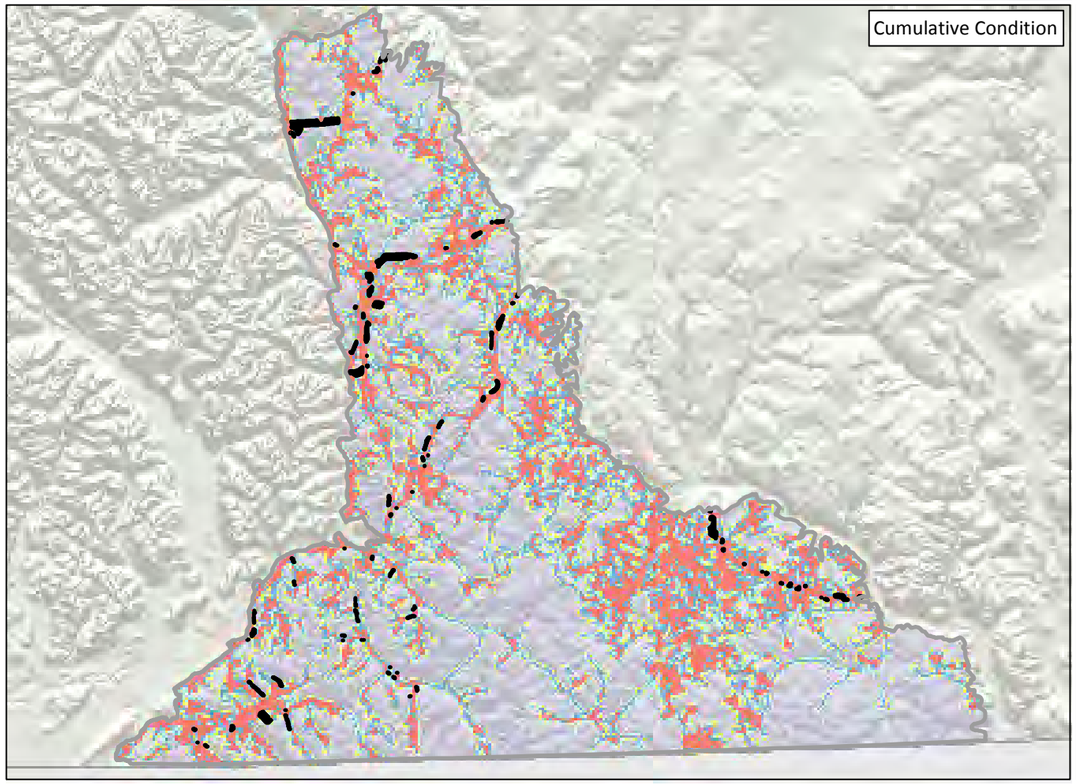
km 0 10 20 30 40 50 60 70 80

ALL LOCATION APPROXIMATE

201311_MAP_TERA_WL_00484_Rev0_05.mxd







TRANSMOUNTAIN

FIGURE 8.9-11

MOTORIZED ACCESS DENSITY
NORTH CASCADES GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 10N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:1,150,000	PAGE SIZE 11x17	DISCIPLINE WL
DRAWN CAS	CHECKED AJS	DESIGN TGG

0 10 20 30 40 50 km

ALL LOCATION APPROXIMATE

201311_MAP_TERA_WL_00484_Rev0_06.mxd

The mitigation proposed in Section 7.2.10.6 to address the Project's residual effects on mammal indicators is expected to adequately address the Project's contribution to cumulative effects on mammal mortality risk with one exception. The Project will contribute to grizzly bear mortality risk in the North Cascades GBPU, causing an incremental effect on mortality risk for a threatened population. To address the Project's contribution to this cumulative effect, additional mitigation beyond that identified in Section 7.2.10.6 is warranted. This mitigation may include additional access control and habitat restoration both on the Project Footprint and the existing TMPL within the North Cascades GBPU (*e.g.*, barriers to block access, signs, planting woody vegetation) and allowing select segments of the Footprint to regenerate to natural vegetation across the width of the right-of-way. Trans Mountain will work with the appropriate regulatory authorities to develop a mitigation strategy to address the Project's incremental cumulative effect on grizzly bear in the North Cascades GBPU.

8.9.6.4 Summary of Significance Rationale for Incremental Cumulative Effects on Mammal Indicators

A summary of the significance criteria ratings for the mammal indicators is provided in Table 8.9-6. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility and probability are similar for all of the mammal indicators.

- Spatial boundary: RSA – cumulative effects on wildlife are best evaluated at the regional (landscape) scale. The Project's contribution to combined habitat loss and alteration, movement effects, and mortality risk may interact with existing and reasonably foreseeable development within the RSA relevant to the indicator (*i.e.*, Wildlife, Caribou or Grizzly Bear RSA) to cause cumulative effects on mammal indicators.
- Duration: short-term – Project construction (*e.g.*, clearing, creation of new access) and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) are short-term events that will interact with existing activities and reasonably foreseeable developments to have an incremental contribution to cumulative effects.
- Frequency: periodic – Project construction (*e.g.*, clearing, creation of new access) and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) will occur intermittently over the assessment period to interact with existing activities and reasonably foreseeable developments, causing an incremental contribution to cumulative effects.
- Reversibility: long-term – incremental cumulative effects of the Project will extend over the long-term, until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.
- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect the indicator.

The criteria ratings and rationale for magnitude and confidence vary, and are provided below for each mammal indicator.

<u>Grizzly Bear</u>

- Magnitude: medium – grizzly bear is a species of conservation concern provincially and federally, largely due to extensive range and population reductions influenced by habitat development and fragmentation, and human-related conflicts and mortality. The Project will have a negligible contribution to cumulative effects on grizzly bear core habitat and mortality risk at the regional scale. Nonetheless, the Project and reasonably foreseeable disturbances will contribute to local increases in motorized access density in each GBPU crossed by the proposed pipeline corridor, causing a change in motorized access density from existing conditions below 0.6 km/km² to levels that exceed the threshold. The Project will contribute to grizzly bear mortality risk in the North Cascades GBPU, causing an incremental effect on mortality risk for a threatened population. To address this incremental cumulative effect, additional mitigation beyond that identified in Section 7.2.10 is warranted, which may include the measures noted above. Trans Mountain will work with the appropriate regulatory authorities to develop a mitigation strategy to address the Project's contribution to cumulative effects on grizzly bear in the North Cascades GBPU. With implementation of appropriate mitigation, the magnitude of the Project's contribution to cumulative effects on grizzly bear is concluded to be medium.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Woodland Caribou

- Magnitude: medium – the Wells Gray and Groundhog caribou herds are Threatened under Schedule 1 of *SARA*. The Project is predicted to contribute to the cumulative disturbance of functional habitat in the Caribou RSA by a negligible amount (< 0.01%) and will not change the existing area of functional habitat disturbance in the UWR (Table 8.9-9). Although the Project is expected to have a negligible effect on caribou habitat value, caribou are sensitive to human disturbance, and research has demonstrated adverse interactions between linear disturbance, primary prey and predator response, and caribou mortality. Given the sensitivity of woodland caribou, regulatory guidelines and management objectives, mitigation beyond standard measures is warranted to address the Project's residual and incremental contribution to cumulative effects on woodland caribou. Measures may include additional access control and habitat restoration both on the Project Footprint and the existing TMPL right-of-way. Trans Mountain will develop an appropriate mitigation plan in consultation with regulatory authorities to address the Project's residual and cumulative effects on caribou. Implementation of the measures in the plan, in addition to the proposed mitigation provided in Section 7.2.10, is expected to reduce the magnitude of the Project's contribution to cumulative effects on caribou to medium.

- Confidence: moderate – the assessment is based on a reasonable understanding of cause-effect relationship; limitations are associated with the absence of models, measures or thresholds specific to mountain ecotype woodland caribou.

Moose

- Magnitude: low – moose are highly valued as a game species and for traditional and cultural purposes, but do not have conservation status designations of concern, either provincially or federally. Moose populations are considered more sensitive to overharvest and other sources of mortality than to habitat loss and fragmentation. Hunting is often the primary limiting factor of moose populations in areas accessible to humans. Predation by wolves is an important factor for moose mortality, and may be associated with declines in moose populations recently observed in the North Thompson region. BC MFLNRO actively monitors and manages moose populations. The Project's contribution to cumulative effects on moose is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Forest Furbearers

- Magnitude: low – the forest furbearer indicator group includes species of conservation concern (*e.g.*, fisher, wolverine). These species are managed as furbearers (*i.e.*, for harvest) in BC and Alberta. Habitat loss (forest clearing from human development) and trapping are primary threats to furbearer populations. The Project's contribution to cumulative effects on forest furbearers is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Coastal Riparian Small Mammals

- Magnitude: medium – the Project crosses proposed critical habitat for Pacific water shrew and early candidate critical habitat for Townsend's mole (Environment Canada 2013). The sensitive status of various coastal riparian small mammal species is attributable largely to the existing high level of cumulative habitat disturbance in the LMDA. The Project is predicted to have a small contribution to cumulative effects on coastal riparian small mammals at the regional scale. In addition to the Project-specific mitigation, Trans Mountain will work with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for coastal riparian small mammals (*i.e.*, Pacific water shrew, Townsend's mole). Additional mitigation may include habitat restoration measures within disturbed riparian areas. With implementation of appropriate mitigation, the magnitude of the Project's contribution to cumulative effects on coastal riparian small mammals is concluded to be medium.

- Confidence: low – the assessment is based on an incomplete understanding of cause-effect relationships (*i.e.,* limited research and literature is available for these species), and limitations and uncertainty associated with the available data used to assess the Project's incremental cumulative effect.

Bats

- Magnitude: low - Several bat species with conservation status of concern occur in the LSA. Known threats to bat populations are limited (*e.g.*, wind energy development, white-nose syndrome). The potential effects of the Project (*e.g.*, change in habitat and mortality risk) may contribute to other existing and potential future threats to have a cumulative effect on bats. The Project's contribution to cumulative effects on bats is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: low - The assessment is based on an incomplete understanding of cause-effect relationships (*i.e.*, limited research and literature is available for these species), and limitations and uncertainty associated with the available data used to assess the Project's incremental cumulative effect.

8.9.7 Significance Evaluation of Potential Cumulative Effects on Birds

The Project is likely to interact with existing and reasonably foreseeable disturbances to contribute to cumulative effects on habitat, movement and mortality risk of birds within the Wildlife RSA (Table 8.9-5). Table 8.9-12 provides a summary of the significance evaluation of the Project's contribution to cumulative effects on bird indicators. The assessment rationale is provided below.

TABLE 8.9-12

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON BIRD INDICATORS

	Cumulative Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Grassland/Shrub-steppe Birds									
1(a)	Project contribution to cumulative effects on grassland/shrub-steppe birds.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2.	Wildlife Indicator – Mature/Old Forest Birds									
2(a)	Project contribution to cumulative effects on mature/old forest birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
3.	Wildlife Indicator – Early Seral Forest Birds									
3(a)	Project contribution to cumulative effects on early seral forest birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

TABLE 8.9-12 Cont'd

Cumulative Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
4. Wildlife Indicator – Riparian and Wetland Birds									
4(a) Project contribution to cumulative effects on riparian and wetland birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5. Wildlife Indicator – Wood Warblers									
5(a) Project contribution to cumulative effects on wood warblers.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
6. Wildlife Indicator – Short-eared Owl									
6(a) Project contribution to cumulative effects on short-eared owl.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
7. Wildlife Indicator – Rusty Blackbird									
7(a) Project contribution to cumulative effects on rusty blackbird.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
8. Wildlife Indicator – Flammulated Owl									
8(a) Project contribution to cumulative effects on flammulated owl.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
9. Wildlife Indicator – Lewis's Woodpecker									
9(a) Project contribution to cumulative effects on Lewis's woodpecker.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
10. Wildlife Indicator – Williamson's Sapsucker									
10(a) Project contribution to cumulative effects on Williamson's sapsucker.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
11. Wildlife Indicator – Western Screech-owl									
11(a) Project contribution to cumulative effects on western screech-owl.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
12. Wildlife Indicator – Great Blue Heron									
12(a) Project contribution to cumulative effects on great blue heron.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
13. Wildlife Indicator – Spotted Owl									
13(a) Project contribution to cumulative effects on spotted owl.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
14. Wildlife Indicator – Bald Eagle									
14(a) Project contribution to cumulative effects on bald eagle.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
15. Wildlife Indicator – Common Nighthawk									
15(a) Project contribution to cumulative effects on common nighthawk.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
16. Wildlife Indicator – Northern Goshawk									
16(a) Project contribution to cumulative effects on northern goshawk.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
17. Wildlife Indicator – Olive-sided Flycatcher									
17(a) Project contribution to cumulative effects on olive-sided flycatcher.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Wildlife RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.7.1 Cumulative Change in Habitat for Bird Indicators

The Project will contribute to loss or alteration of habitat for the bird indicators in combination with natural disturbance, existing activities and reasonably foreseeable developments. Table 8.9-13 and Figures 8.9-12 and 8.9-13 summarize the predicted changes in potential and effective habitat for bird indicators as a result of cumulative disturbance within the Wildlife RSA.

TABLE 8.9-13

PREDICTED CHANGE IN POTENTIAL AND EFFECTIVE HABITAT FOR BIRD INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator[1]	Potential/Effective Habitat[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Grassland/Shrub-Steppe Birds	Potential	276,320.4	276,901.4	580.9 ↑	0.21 ↑	276,053.7	266.7 ↓	0.10 ↓
Mature/Old Forest Birds	Potential	1,464,837.6	1,463,377.3	1,460.3 ↓	0.10 ↓	1,459,218.0	5619.6 ↓	0.38 ↓
Early Seral Forest Birds	Potential	1,835,460.9	1,833,727.1	1,733.8 ↓	0.10 ↓	1,826,880.8	8580.1 ↓	0.47 ↓
Riparian and Wetland Birds	Effective	456,355.8	456,111.4	244.4 ↓	0.05 ↓	454,814.7	1,541.1 ↓	0.34 ↓
Cavity Nesting Wetland Birds (Riparian and Wetland Bird Indicator)	Effective	430,111.9	429,804.6	307.3 ↓	0.07 ↓	427,880.6	2,231.3 ↓	0.52 ↓
Wood Warblers	Potential	232,838.2	232,714.1	124.1 ↓	0.05 ↓	232,212.4	625.8 ↓	-0.27 ↓
Short-Eared owl	Potential	115,9742.1	1,160,251.4	509.2 ↑	0.04 ↑	1,161,317.9	1575.8 ↑	0.14 ↑
Rusty Blackbird	Potential	104,182.5	1,040,21.0	161.5 ↓	0.16 ↓	103,904.9	277.6 ↓	0.27 ↓
Flammulated Owl	Potential	95,008.2	94,836.4	171.8 ↓	0.18 ↓	94,541.5	466.6 ↓	0.49 ↓
Lewis's Woodpecker	Potential	203,110.7	202,800.6	310.1 ↓	0.15 ↓	201,489.0	1621.6 ↓	0.80 ↓
Williamson's Sapsucker	Effective	3,345.4	3,341.0	4.5 ↓	0.13 ↓	3,337.8	7.6 ↓	0.23 ↓
Western Screech-Owl (Coastal)	Potential	1,277.3	1,277.3	<0.1 ↓	<0.01 ↓	1,276.6	0.7 ↓	0.05 ↓
Western Screech-Owl (Interior)	Potential	8,090.4	8,042.9	47.5 ↓	-0.59 ↓	8,041.9	48.5 ↓	0.60 ↓
Spotted Owl	Effective	60,871.2	60,867.7	3.5 ↓	0.01 ↓	60,614.1	257.1 ↓	0.42 ↓
Common Nighthawk	Potential	1,144,941.8	1,146,126.4	1,184.6 ↑	0.10 ↑	1,142,202.8	2739.0 ↓	0.24 ↓
Northern Goshawk	Effective	24,630.5	24,624.8	5.7 ↓	0.02 ↓	24,569.5	60.9	0.25 ↓
Olive-Sided Flycatcher	Potential	2,274,754.0	2,274,890.2	136.2 ↑	0.01 ↑	2,268,441.8	6,312.2 ↓	0.28 ↓

Notes:
1 Potential contribution of the Project to cumulative effects on great blue heron and bald eagle is expected to be site-specific and mitigable with the proposed mitigation measures in Section 7.2.10. These indicators were not suited to quantification of potential habitat using available data.

2 Refer to the Wildlife Modeling and Species Accounts Technical Report of Volume 5C for definition of habitat potential. Where suitability models were applied for RSA-scale analysis, the change in effective habitat is indicated rather than potential habitat.

3 Project Condition includes existing activities (with available spatial data) + Project.

4 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).

5 Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

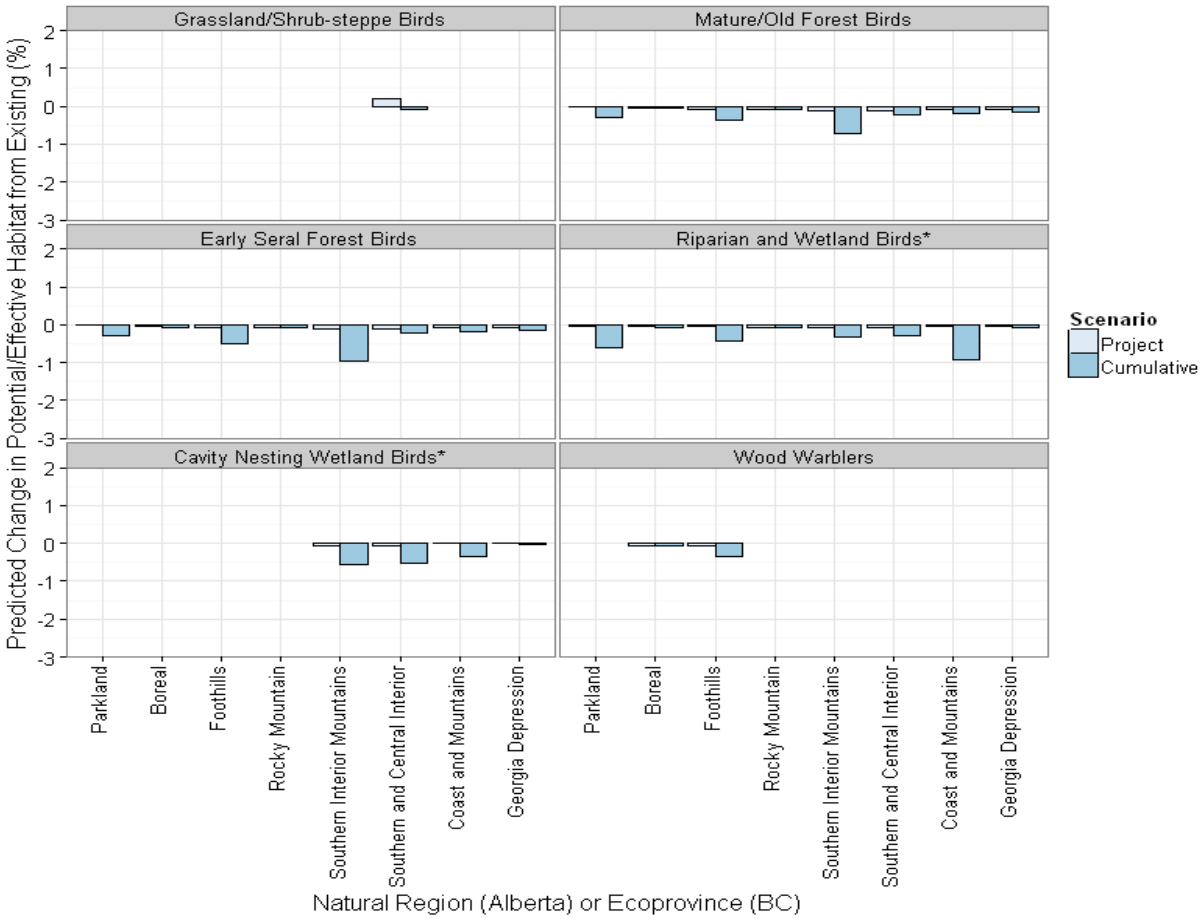

Figure 8.9-12 Predicted Change in Potential/Effective Habitat for Bird Community Indicators
The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*); change in potential habitat is presented for the other community indicators. Cavity nesting wetland birds were modeled separately as part of the riparian and wetland birds community indicator.

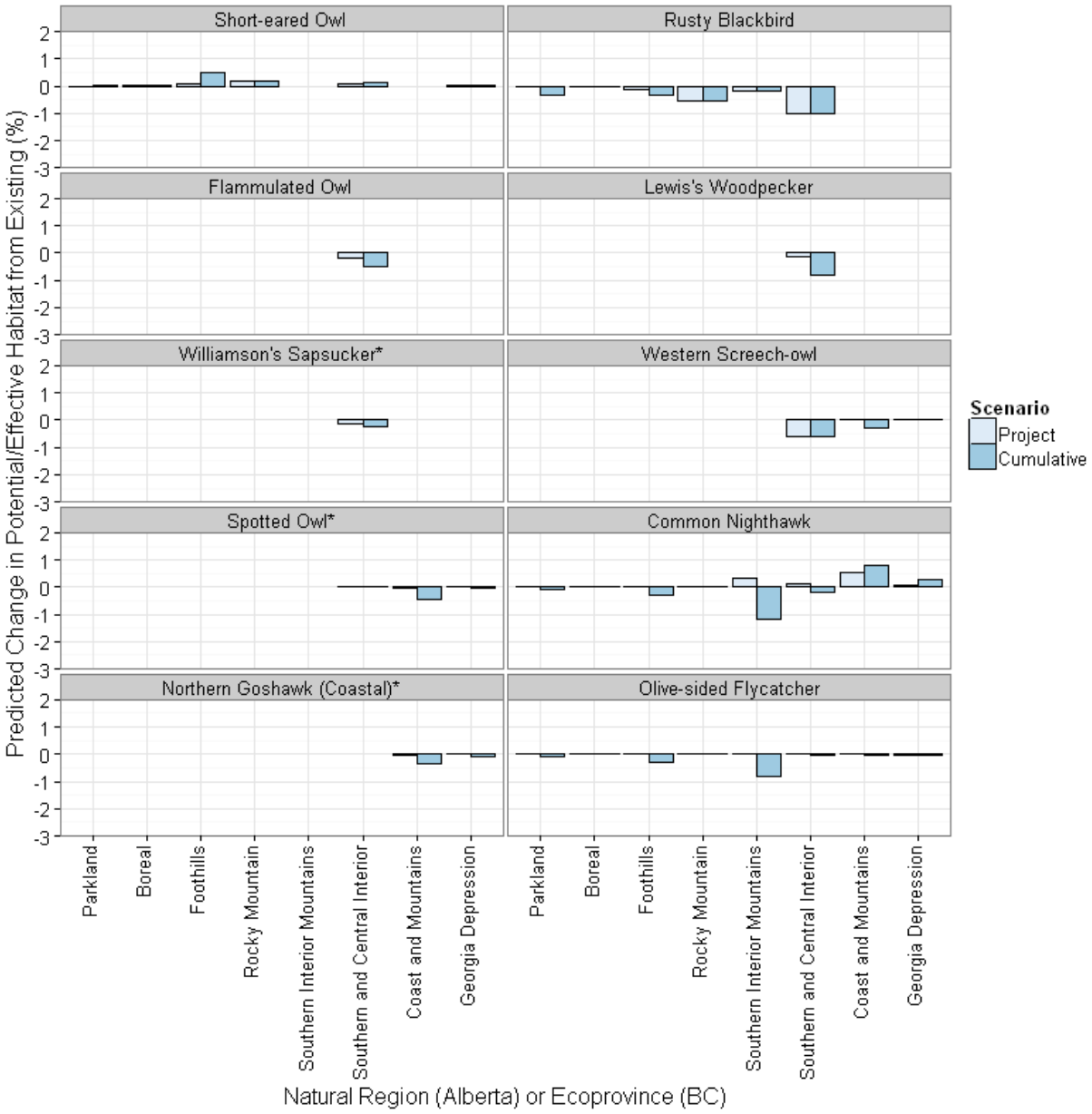

Figure 8.9-13 Predicted Change in Potential/Effective Habitat for Bird Indicators
The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*); change in potential habitat is presented for the other bird indicators. Both the interior and coastal western screech-owl are provided in the results at the species level, but can be distinguished by the Ecoprovince (*i.e.*, interior subspecies occurs within the Southern and Central Interior Ecoprovince; coastal subspecies occurs within the Coast and Mountains, and Georgia Depression Ecoprovince).

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10. By implementing the proposed mitigation, including working with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for Lewis's woodpecker and Williamson's sapsucker, the Project's contribution to cumulative effects on bird habitat will be reduced. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing and reasonably foreseeable developments to cumulative effects.

Given the species' sensitivity, regulatory guidelines (*e.g.*, no-net-loss policy for spotted owl habitat in the Sowaqua Spotted Owl Wildlife Habitat Area 2-498), management objectives, and existing levels of cumulative effects on spotted owl, additional mitigation beyond the standard measures is warranted to address the Project's residual and incremental cumulative effect within the WHA for spotted owl traversed by the proposed pipeline corridor. This additional mitigation commitment is included in the residual Project effects assessment (Section 7.2.10). A mitigation plan will be developed for the Project, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat. Mitigation measures are anticipated to include efforts to minimize clearing, restore areas within the WHA that are not needed for long-term operations, and offsets. Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing.

8.9.7.2 Cumulative Change in Movement and Mortality Risk for Bird Indicators

Construction and operations of the Project has potential to contribute to cumulative effects on bird movement and mortality risk. The Project's incremental effects are likely to interact with the identified existing activities and reasonably foreseeable developments in the Wildlife RSA (Table 8.9-5) to cause cumulative changes to bird movement, in particular where the proposed pipeline corridor parallels existing linear disturbance and will increase the corridor width. As discussed in Section 7.2.10.10, parallel forest openings can cause a cumulative barrier effect at the landscape scale for some bird species (Bélisle and St. Clair 2001).

Vegetation clearing for the Project will create new access and edges, which may combine with existing disturbance to have cumulative effects on bird mortality risk. Cumulative changes in access at the regional scale can affect hunting pressure for game birds such as grouse. Although numerous studies in forested landscapes have found no evidence of increased nest predation due to either forestry (Bayne and Hobson 1997, Cotterill and Hannon 1999, Ibarzabal and Desrochers 2001, Schmiegelow and Mönkkönen 2002) or roads (Ortega and Capen 1999), some species (*e.g.*, marbled murrelet) have substantially higher probability of nest disturbance in proximity to edges compared to forest interior (Section 7.2.10.10). Regional differences in predator communities can also influence the potential effects of fragmentation on nest predation (Chalfoun *et al.* 2002).

With implementation of the mitigation proposed in Section 7.2.10, the Project's contribution to cumulative effects on movement and mortality risk for the bird indicators is expected to be small at the regional scale. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects on bird mortality risk. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.7.3 Summary of Significance Rationale for Incremental Cumulative Effects on Bird Indicators

A summary of the significance criteria ratings for the Project's contribution to cumulative effects on bird indicators is provided in Table 8.9-12. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility and probability are similar for all of the bird indicators.

- Spatial boundary: Wildlife RSA – cumulative effects on birds are best evaluated at the regional (landscape) scale.

- Duration: short-term – Project construction and operational activities are short-term events that will interact with existing activities and reasonably foreseeable developments to contribute to cumulative effects.

- Frequency: periodic – Project construction and operational activities that could interact with existing activities and reasonably foreseeable developments will occur intermittently over the assessment period.

- Reversibility: long-term – the Project's contribution to cumulative effects will extend over the long-term until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.

- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect bird indicators.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Wildlife RSA reduce the confidence level to moderate.

The criteria ratings and rationale for magnitude vary, and are provided below for each bird indicator.

Grassland/Shrub-Steppe Birds

- Magnitude: medium – the Project is likely to interact with existing and reasonably foreseeable developments in the grasslands region of interior BC. In particular, the Project will interact with the proposed Ajax open pit mine project and other existing (*e.g.*, City of Kamloops, agriculture) and reasonably foreseeable developments and activities in the grassland and shrub-steppe habitats within the Wildlife RSA traversing the interior of BC. Locally within this area, the overall cumulative effects from past and foreseeable future disturbance on the grassland/shrub-steppe bird community and other grassland dependent wildlife species is potentially high. However, the Project's contribution to cumulative effects on grassland/shrub-steppe birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of medium magnitude.

Mature/Old Seral Forest Birds

- Magnitude: low – the Project's contribution to cumulative effects on mature/old seral forest birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Early Seral Forest Birds

- Magnitude: low - the Project's contribution to cumulative effects on early seral forest birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Riparian and Wetland Birds

- Magnitude: low – the Project's contribution to cumulative effects on riparian and wetland birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Wood Warblers

- Magnitude: low – the Project's contribution to cumulative effects on wood warblers is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Short-eared Owl

- Magnitude: negligible – the primary threat to the short-eared owl is loss of nesting habitat due to rapid urbanization, industrialization, intensive agriculture and human disturbance. Fragmentation of habitats may cause fluctuations in the population of their rodent prey base (COSEWIC 2008, Demarchi and Bently 2005). Short-eared owl may use disturbed sites, although anthropogenic habitats may have lower value than natural openings. Sensory disturbance and mortality risk during construction will potentially interact with other existing activities and reasonably foreseeable developments to cumulatively affect short-eared owl. The magnitude of the Project's contribution to cumulative effects on short-eared owl is concluded to be negligible at the regional scale.

Rusty Blackbird

- Magnitude: low – the Project's contribution to cumulative effects on rusty blackbird is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Flammulated Owl

- Magnitude: low – the Project's contribution to cumulative effects on flammulated owl is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Lewis's Woodpecker

- Magnitude: medium – Lewis's woodpecker is a species of conservation concern at both the provincial (BC) and federal levels. Small population size and low density makes the species vulnerable to disturbance and habitat loss, particularly the loss of nesting trees and snags. The Project crosses candidate critical habitat for Lewis's woodpecker. The Project's contribution to cumulative effects on Lewis's woodpecker is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential incremental effects on the candidate critical habitat), is concluded to be of medium magnitude.

Williamson's Sapsucker

- Magnitude: medium – Williamson's sapsucker is a species of conservation concern at both the provincial (BC) and federal levels. Small population size and low density makes the species vulnerable to disturbance and habitat loss, particularly the loss of nesting trees and snags. The Project crosses proposed critical habitat for Williamson's sapsucker. The Project's contribution to cumulative effects on Williamson's sapsucker is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential incremental effects on the proposed critical habitat), is concluded to be of medium magnitude.

Western Screech-Owl

- Magnitude: low – the Project's contribution to cumulative effects on western screech-owl is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk is concluded to be of low magnitude.

Great Blue Heron

- Magnitude: negligible – with application of the proposed mitigation to address residual effects on great blue heron habitat, movement and mortality risk, the Project's contribution to cumulative effects on great blue heron is concluded to be negligible at the regional scale.

Spotted Owl

- Magnitude: medium – the Project is likely to interact with existing activities and reasonably foreseeable developments in the Wildlife RSA to affect spotted owl. In particular, the proposed Hope to Burnaby Segment of the Project is likely to interact with the high levels of existing urban and agricultural development, as well as the proposed Interior–Lower Mainland Transmission Project between Merritt and Coquitlam, which intersects identified spotted owl habitats (BC Hydro 2013c). Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing. A mitigation plan will be developed in consultation with BC MFLNRO, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat, as noted above. With application of appropriate mitigation, the Project's contribution to cumulative effects on spotted owl is concluded to be of medium magnitude.

Bald Eagle

- Magnitude: negligible – with application of the proposed mitigation to address residual effects on bald eagle habitat, movement and mortality risk, the Project's contribution to cumulative effects on bald eagle is concluded to be negligible at the regional scale.

Common Nighthawk

- Magnitude: low – declines in common nighthawk populations are attributed to various anthropogenic and natural causes, in particular changes in insect abundance, fire control and reductions in availability of suitable anthropogenic nesting habitat (*e.g.*, gravel rooftops). Construction and operations of the Project is unlikely to interact with these threats to have a detectable contribution to cumulative effects on common nighthawk. Common nighthawks are generally tolerant of habitat change and may use disturbed sites, although anthropogenic habitats may have lower value for nighthawk than natural openings. Sensory disturbance and mortality risk during construction will potentially interact with other existing activities and reasonably foreseeable developments to cumulatively affect common nighthawk. The magnitude of the Project's contribution to cumulative effects on common nighthawk is concluded to be low at the regional scale.

Northern Goshawk

- Magnitude: low – loss of mature forest (nesting and foraging habitat) may be the most important factor threatening goshawks in BC. Construction and operations of the Project will interact with existing and reasonably foreseeable disturbances to have cumulative effects on northern goshawk. The Project's contribution to cumulative effects on northern goshawk is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Olive-Sided Flycatcher

- Magnitude: low – the Project's contribution to cumulative effects on olive-sided flycatcher is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

8.9.8 Significance Evaluation of Potential Cumulative Effects on Amphibian and Reptile Indicators

The Project is likely to interact with existing and reasonably foreseeable disturbances to contribute to cumulative effects on habitat, movement and mortality risk of amphibians and reptiles within the Wildlife RSA. Table 8.9-14 provides a summary of the significance evaluation of the Project's incremental cumulative effects on amphibian and reptile indicators. The assessment rationale is provided below.

TABLE 8.9-14

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON AMPHIBIAN AND REPTILE INDICATORS

Cumulative Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Pond-dwelling Amphibians									
1(a)	Project contribution to cumulative effects on pond-dwelling amphibians.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
2.	Wildlife Indicator – Stream-dwelling Amphibians									
2(a)	Project contribution to cumulative effects on stream-dwelling amphibians.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
3.	Wildlife Indicator – Arid Habitat Snakes									
3(a)	Project contribution to cumulative effects on arid habitat snakes.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Wildlife RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.8.1 Cumulative Change in Habitat for Amphibian and Reptile Indicators

The Project will contribute to combined loss or alteration of amphibian and reptile habitat resulting from natural disturbance, existing activities and reasonably foreseeable developments. Table 8.9-15 and Figure 8.9-14 summarize the predicted combined changes in effective and potential habitat for amphibian and reptile indicators as a result of the Project and reasonably foreseeable developments to cumulative disturbance within the Wildlife RSA.

TABLE 8.9-15

PREDICTED CHANGE IN POTENTIAL HABITAT FOR AMPHIBIAN AND REPTILE INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator	Potential/ Effective Habitat[1]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Condition[2]			Cumulative Conditions[3]		
		Existing Conditions	Project Conditions	Incremental Change[4]	% Change[4]	Cumulative Conditions	Incremental Change[4]	% Change[4]
Pond-Dwelling Amphibians	Effective	269,976.0	269,855.1	121.0 ↓	0.04 ↓	269,485.4	490.6 ↓	0.18 ↓
Coastal Tailed Frog (Stream-Dwelling Amphibians Indicator)	Effective	145,828.6	145,707.4	121.2 ↓	0.08 ↓	145,598.8	229.9 ↓	0.16 ↓
Western Rattlesnake (Arid Habitat Snakes Indicator)	Potential	80,709.7	80,741.9	32.1 ↑	0.04 ↑	79,510.2	1,199.5 ↓	1.49 ↓

Notes:
1 Refer to the Wildlife Modeling and Species Accounts Technical Report of Volume 5C for definition of habitat potential. Where suitability models were applied for RSA-scale analysis, the change in effective habitat is indicated rather than potential habitat.
2 Project Condition includes existing activities (with available spatial data) + Project.
3 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).
4 ↓ represents a decrease and ↑ represents an increase.

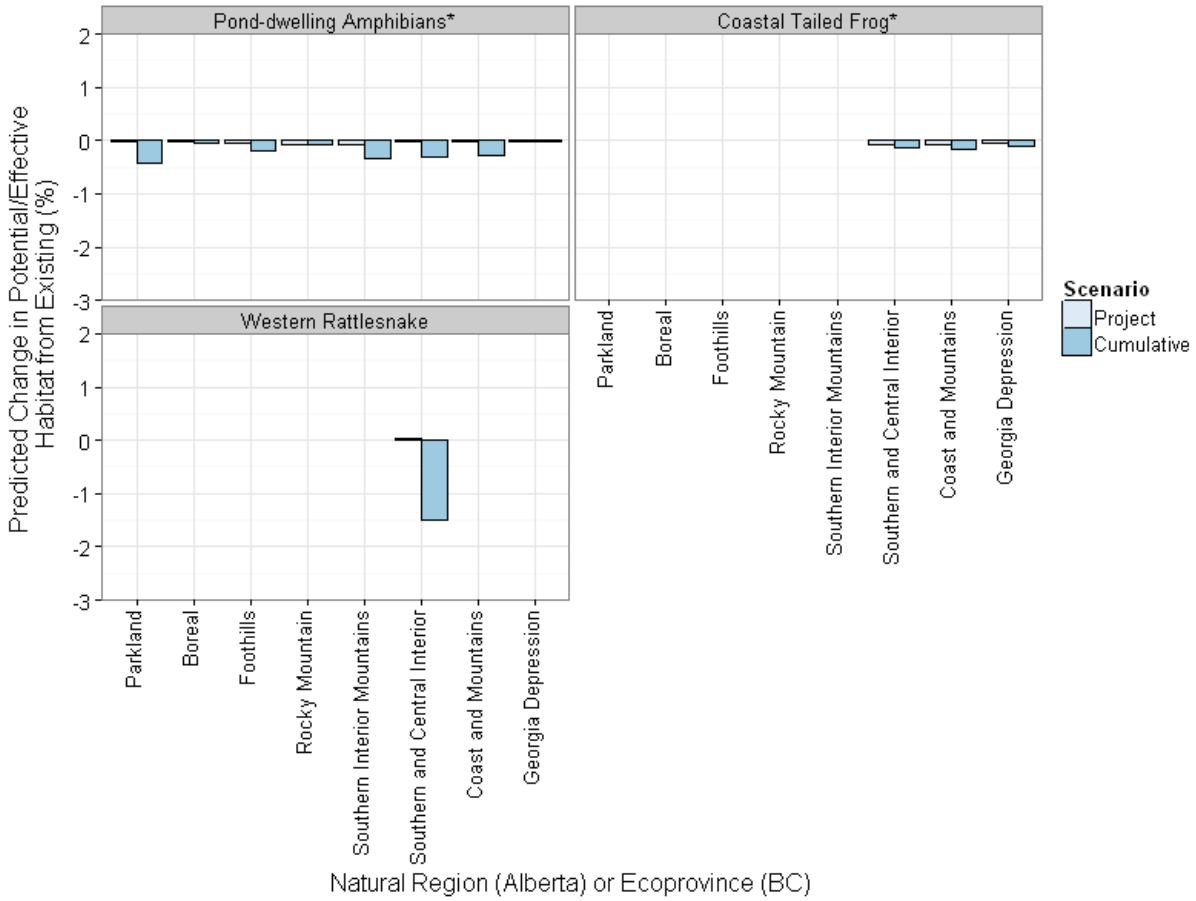

Figure 8.9-14 Predicted Change in Potential/Effective Habitat for Amphibian and Reptile Indicators
The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*) for pond-dwelling amphibians and coastal frog; change in potential habitat is presented for western rattlesnake living habitat.

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10.6. By implementing the proposed mitigation, including working with regulatory authorities to address potential incremental effects on the early candidate critical habitat for Pacific giant salamander, the Project's contribution to cumulative effects on amphibian and reptile habitat will be reduced. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.8.2 Cumulative Change in Movement and Mortality Risk for Amphibian and Reptile Indicators

Construction and operations of the Project has potential to contribute to cumulative effects on amphibian and reptile movement and mortality risk. The Project's incremental effects are likely to interact with the identified existing activities and reasonably foreseeable developments in the Wildlife RSA (Table 8.9-5) to cause cumulative changes to movement and mortality risk for the amphibian and reptile indicators. With implementation of the mitigation proposed in Section 7.2.10, the Project's contribution to cumulative effects on amphibian and reptile movement and mortality risk is expected to be small at the regional scale. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.8.3 Summary of Significance Rationale for Incremental Cumulative Effects on Amphibian and Reptile Indicators

A summary of the significance criteria ratings for the amphibian and reptile indicators is provided in Table 8.9-14. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility, probability and confidence are similar for all of the amphibian and reptile indicators.

- Spatial boundary: Wildlife RSA – cumulative effects on amphibians and reptiles are best evaluated at the regional (landscape) scale.

- Duration: short-term – Project construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) are short-term events that will interact with existing activities and reasonably foreseeable developments to contribute to cumulative effects.

- Frequency: periodic – Project construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) that could interact with existing activities and reasonably foreseeable developments will occur intermittently but repeatedly over the assessment period.

- Reversibility: long-term – some habitats suitable for amphibians and reptiles may be restored following reclamation of the Project Footprint in the medium-term. However, the reversibility is constrained by the time necessary to restore habitats that will take longer to regenerate to suitable conditions (*e.g.*, forested areas, sagebrush shrub-steppe), and Project components that will not be restored until decommissioning (*e.g.*, facilities). The Project's contribution to cumulative effects will extend over the long-term, until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.

- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect amphibian and reptile indicators.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Wildlife RSA reduce the confidence level to moderate.

The criteria ratings and rationale for reversibility and magnitude vary, and are provided below for each amphibian and reptile indicator.

Pond-Dwelling Amphibians

- Magnitude: low – the pond-dwelling amphibians indicator includes several species with conservation status of concern. Pond-dwelling amphibians require wetland and upland habitats, and movement corridors between these areas. Amphibian populations are declining over much of North America, and primary threats include habitat loss and degradation, barriers to movement, and mortality risk (*e.g.*, from predation). Cumulative habitat loss, fragmentation by road networks and developments, and risks associated with roads during annual migrations are attributed to putting western toad at risk. The Project's contribution to cumulative effects on pond-dwelling amphibians is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Stream-Dwelling Amphibians

- Magnitude: medium – siltation of streams and alteration of hydrological regime can adversely affect stream-dwelling amphibians. The Project has potential to interact with existing and future activities, in particular forest harvest and associated roads, to have cumulative effects on stream-dwelling amphibians. Clear-cuts can cause siltation of streams and alter the hydrological regime, both of which may negatively affect breeding success of tailed frogs (Dupuis and Steventon 1999, Wahbe *et al.* 2004). There is some evidence that the density of tailed frog tadpoles is greater in streams running through clear-cuts relative to those that do not, and that this may be linked to increased primary productivity in clear-cuts (Wahbe *et al.* 2004). The cumulative interaction of the Project on coastal tailed frog with future disturbance is considered qualitatively in the effects characterization and determination of significance. A series of run-of-river hydro developments are

underway or proposed on streams in the Wildlife RSA. These developments divert water from the stream to produce hydro-electric power; however, run-of-the-river projects rely on stable, substantial stream flow (BC Ministry of Energy, Mines and Petroleum Resources 2011). For this reason, it is unlikely that these developments would interact with the Project to cumulatively affect quality habitat for stream-dwelling amphibians, which require step-pool stream morphology and lower, albeit year-round, water flow. The Project's contribution to cumulative effects on stream-dwelling amphibians is expected to be small at the regional scale, but will contribute to cumulative effects on sensitive species and habitats (*e.g.*, early candidate critical habitat for Pacific giant salamander). With application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential effects on candidate critical habitat), the Project's contribution to cumulative effects on stream-dwelling amphibians is concluded to be of medium magnitude.

Arid Habitat Snakes

- Magnitude: low – arid snake species are particularly vulnerable to disturbance and local extirpation. Habitat loss and direct mortality due to road construction, utility development, agricultural expansion and urban expansion are the main threats to these species (Southern Interior Reptile and Amphibian Recovery Team 2008a,b). The Project's contribution to cumulative effects on arid habitat snakes is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

8.9.9 Summary

As identified in Tables 8.9-6, 8.9-12 and 8.9-14, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on wildlife and wildlife habitat are concluded to be not significant.

8.10 Species at Risk

As discussed in Section 7.2.11, potential effects of the Project on species at risk are assessed through the use of indicators in Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat. Consequently, the cumulative effects assessment on combined effects of the Project on indicator species at risk is conducted in Section 8.6 Fish and Fish Habitat, Section 8.8 Vegetation and Section 8.9 Wildlife and Wildlife Habitat.

Similar to Section 7.0, although not all species at risk are discussed explicitly under each indicator, potential cumulative effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects and Project contribution to cumulative effects on species at risk was addressed and mitigations to reduce these effects will apply to all species at risk, not just the indicators. Sections 8.6 Fish and Fish Habitat, Section 8.8 Vegetation and Section 8.9 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse cumulative effects on species at risk have been identified as a result of the pipeline and facilities component of the Project.

8.11 Marine Sediment and Water Quality

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine sediment and water quality indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, marine sediment quality and marine water quality).

8.11.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments are identified within the Marine RSA (Table 8A.1-1 of Appendix 8.1) that are considered in the evaluation of cumulative effects on marine sediment and water quality indicators. All three developments (Neptune Bulk Terminal Ltd., Richardson International Ltd. and Seaspan ULC expansion projects) are located in the Inner Harbour, west of the

Second Narrows, and distant from the Marine Sediment and Water Quality LSA. These developments are also summarized in Table 8.11-1.

TABLE 8.11-1

ANTICIPATED REASONABLY FORESEEABLE DEVELOPMENTS IN THE MARINE RSA

Project	Proponent	Description	Status
Coal Handling Infrastructure Upgrade and Expansion Project	Neptune Bulk Terminals Ltd.	Upgrade and expansion of metallurgical coal handling systems - increased vessel traffic expected to be approximately one vessel per week.	Under construction – in-service by late 2014.
Grain Storage Capacity Project	Richardson International Ltd.	Installation of approximately 494 open-ended steel wall piles and 315 timber piles, and construction of two 40,000 metric tonne concrete storage annexes.	Under construction – in-service by early 2015.
Shipyard Modernization Project	Seaspan ULC	Construction of a 53.56 m long x 31.8 m wide concrete load-out pier and installation of approximately 102 steel piles.	Under construction – in-service by early 2015..

The potential effects of increased vessel traffic, both Project and non-Project related, on marine water quality would be relevant to the marine transportation assessment (Section 4.3.2 of Volume 8A), however, the types of interactions expected would be limited to increases in potential for accidental release of bilge water from vessels, which is addressed in terms of accidents and malfunctions (Section 4.3.13 of Volume 8A).

Existing diffuse sources of contaminants in the Marine RSA, such as vessel traffic, marinas, port facilities, and stormwater discharges from urban areas and the effects of the 2007 accidental oil release from a ruptured Trans Mountain pipeline into Burrard Inlet have been accounted for in the baseline conditions described in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C.

8.11.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with construction and operation of the Westridge Marine Terminal on marine sediment and water quality indicators were identified in Section 7.11.1.10 and are listed in Table 8.11-2 along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.11-2

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE SEDIMENT AND WATER QUALITY CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on marine sediment quality.	RSA	Westridge Marine Terminal	Construction to Operation	Project contribution to cumulative change in marine sediment quality.	• Vessel loading at Westridge Marine Terminal. • Existing activities: stormwater runoff into the Marine RSA and vessel traffic in the Marine RSA. • Reasonably foreseeable developments within the Marine RSA listed in Table 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including dredging for construction of the Westridge Marine Terminal.

TABLE 8.11-2 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
2. Combined Project effects on marine water quality.	RSA	Westridge Marine Terminal	Construction to Operation	Project contribution to cumulative change in marine water quality.	• Existing activities: discharge of treated stormwater from the existing Westridge Marine Terminal, vessel traffic in the Marine RSA, stormwater runoff in the Marine RSA. • Reasonably foreseeable developments within the Marine RSA listed in Table 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including discharges of treated stormwater from the expanded Westridge Marine Terminal.

Note: 1 RSA = Marine RSA.

8.11.3 Significance Evaluation of Potential Cumulative Effects

Table 8.11-3 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine sediment and water quality indicators. The rationale used to evaluate the significance of each cumulative effect is provided below. Characterization of the Project's contribution to cumulative effects relied on available research literature and the professional judgment of the assessment team.

TABLE 8.11-3

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE SEDIMENT AND WATER QUALITY

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Marine Sediment and Water Quality Indicator – Marine Sediment Quality									
1(a) Project contribution to cumulative change in marine sediment quality.	Negative	LSA	Short-term	Isolated	Short-term	Low	Low	High	Not significant
2. Marine Sediment and Water Quality Indicator – Marine Water Quality									
2(a) Project contribution to cumulative change in marine water quality.	Negative	LSA	Long-term	Periodic	Short-term	Low	Low	High	Not significant
3. Combined Effects on Marine Sediment and Water Quality									
3(a) Project contribution to cumulative increase in effects on marine sediment and water quality indicators (1[a] and 2[a]).	Negative	LSA	Long-term	Periodic	Short-term	Low	Low	High	Not significant

Notes: 1 LSA = Marine Sediment and Water Quality LSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.11.3.1 Marine Sediment and Water Quality Indicator – Marine Sediment Quality

Dredging of a limited area for the Westridge Marine Terminal may be required, and would occur within the Project Footprint. Dredging has the potential to disturb existing contaminants in sediment (*e.g.*, polycyclic aromatic hydrocarbons [PAHs], polychlorinated biphenyls [PCBs], metals), resulting in their suspension and resettling. Residual effects of dredging are considered to be low in magnitude and short-term in duration. The use of a clamshell dredge and, if practical, turbidity curtains around the dredge location will restrict sediment disturbance and resettling to the Marine Sediment and Water Quality LSA.

Construction and operation activities associated with the three reasonably foreseeable developments listed above and described in Table 8A.1-6 of Appendix 8.1 will not overlap in time or space with Project activities. Construction methods for these developments are not provided, and they may or may not involve sediment disturbance from dredging or other activities. However, these developments are scheduled for completion in 2014 or 2015, prior to the Project construction schedule, and are located well away (in the Inner Harbour, within the Marine RSA) from the Westridge Marine Terminal, such that any spatial or temporal overlap with Project construction activities is not anticipated. As a result, the probability of the Project contributing to cumulative effects on marine sediment quality is considered low and any cumulative effects that do arise are predicted to be low in magnitude (Table 8.11-3, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine sediment quality is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.

- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to cumulative effects on marine sediment quality are limited to the construction phase.

- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to cumulative effects on marine sediment quality are limited to the construction phase.

- Reversibility: short-term – sediment disturbed by in-water construction activities will resettle within hours to days following cessation of construction activities at the Westridge Marine Terminal.

- Magnitude: low – mitigation measures will be implemented to restrict dispersion of sediment during dredging; no change in sediment quality is predicted; existing sediment meets disposal at sea screening criteria for PAH and PCBs but not for metals (small exceedance of Environment Canada disposal at sea criteria for copper, lead, and cadmium, consistent with other parts of the Marine RSA).

- Probability: low – timing of reasonably foreseeable developments in the Marine RSA will not overlap with the construction schedule for the Westridge Marine Terminal.

- Confidence: high – there is a good understanding of the cause-effect relationships between in-water construction activities and the re-suspension of contaminants, the effectiveness of proposed mitigation measures, and the spatial extent of changes in marine sediment quality resulting from Project activities at the Westridge Marine Terminal.

8.11.3.2 Marine Sediment and Water Quality Indicator – Marine Water Quality

Construction of the expanded Westridge Marine Terminal has the potential to affect marine water quality through release of total suspended solids (TSS) during dredging. The use of a clamshell dredge and, if practical, turbidity curtains around the dredge location will restrict sediment disturbance and elevated TSS levels to the Marine Sediment and Water Quality LSA.

Operation of the expanded Westridge Marine Terminal has the potential to affect marine water and, indirectly, sediment, through release of surface water (stormwater) runoff from the site. Runoff may contain hydrocarbons, metals and suspended sediment. Of these, hydrocarbons are of particular concern at an oil shipping terminal. Increased concentrations of contaminants can lead to toxicity in marine biota. Given the many existing sources of stormwater contaminants in Burrard Inlet (Balanced Environmental Services Inc. 2010), it can be difficult to identify specific contaminant sources.

The reasonably foreseeable developments listed above and described in Table 8A.1-6 of Appendix 8.1 may release TSS during their construction phases; however, Project effects will be localized and there will be no temporal or spatial overlap of Project and non-Project related construction activities and effects. These projects may also release stormwater during their operation phases. However, discharges at industrial sites require permits and monitoring programs similar in extent to that required of the Westridge Marine Terminal and may require treatment (*e.g.*, settling of sediment, removal of oil). As a result, any effects on water quality from industrial stormwater discharges are expected to be localized and low in

magnitude. Given that the reasonably foreseeable developments are located away from the Marine Sediment and Water Quality LSA, there is unlikely to be any spatial overlap with Project effects. As a result, the probability of the Project contributing to cumulative effects on marine water quality is considered low and any cumulative effects that do arise are predicted to be low in magnitude (Table 8.11-3, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine water quality is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.

- Duration: long-term – stormwater discharges from the reasonably foreseeable developments may begin during the construction phase of the Westridge Marine Terminal and extend into the operations phase.

- Frequency: periodic – stormwater discharges will occur intermittently but repeatedly over the assessment period (during rainfall events).

- Reversibility: short-term – each event is reversible immediately after dredging ceases or stormwater is released; however, the overall effect of stormwater discharge will not cease until the end of operations at the Westridge Marine Terminal.

- Magnitude: low – site runoff from the Westridge Marine Terminal, existing industrial sites and reasonably foreseeable developments will be within permit requirements, which are set to protect marine aquatic biota.

- Probability: low – based on the lack of spatial overlap between the Project and reasonably foreseeable developments in the Marine RSA.

- Confidence: high – there is a good understanding of the cause-effect relationships between industrial operations and stormwater, effectiveness of stormwater treatment, and the spatial extent of changes in marine water quality resulting from Project activities at the Westridge Marine Terminal.

8.11.3.3 Combined Cumulative Effects on Marine Sediment and Water Quality

The potential cumulative effects (*i.e.*, change in marine sediment quality and change in marine water quality) may act in combination to affect marine sediment and water quality in the Marine RSA. However, given that there will be little if any spatial or temporal overlap between Project-specific effects on marine sediment and water quality and reasonably foreseeable developments in the Marine RSA, the probability of combined cumulative effects is considered low. Implementing mitigation measures described in Section 7.0 will reduce the spatial extent of Project-related changes in marine sediment and water quality, making combined cumulative effects even more unlikely. As a result, combined cumulative effects of the Project on marine sediment and water quality are predicted to be low in magnitude (Table 8.11-3, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine sediment and water quality indicators is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.

- Duration: long-term – the events causing combined cumulative effects on marine sediment and water quality will extend through the construction and operations phases of the Project.

- Frequency: periodic – the events causing combined cumulative effects on marine sediment and water quality will occur intermittently but repeatedly over the assessment period.

- Reversibility: short-term – Project contribution to combined cumulative effects on marine sediment and water quality will reverse after each stormwater event soon after the discharge stops and will cease when the facility is decommissioned.

- Magnitude: low – the Project's contribution to combined cumulative effects on marine sediment and water quality is considered to be within environmental standards given the implementation of industry standard guidelines and recommended mitigations.

- Probability: low – based on the lack of spatial and temporal overlap between the Project and reasonably foreseeable developments.

- Confidence: high – there is a good understanding of the cause-effect relationships between Project activities and marine sediment and water quality, and effectiveness of proposed mitigation measures, and the spatial extent of changes in marine sediment and water quality resulting from Project activities.

8.11.4 Summary

As identified in Table 8.11-3, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on marine sediment and water quality within the Marine RSA will be not significant.

8.12 Marine Fish and Fish Habitat

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine fish and fish habitat indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, intertidal habitat, subtidal habitat, Dungeness crab, inshore rockfish and Pacific salmon).

8.12.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments were identified within the Marine RSA: the Neptune Terminals Coal Handling Expansion Project; the Richardson International Grain Storage Capacity Expansion Project; and the Seaspan Modernization Project. These developments are listed in Table 8A.1-6 of Appendix 8.1 and are described in Section 8.1.4. Only the Seaspan Modernization Project will involve in-water works; therefore, it is the only reasonably foreseeable development that has the potential to contribute to cumulative effects on marine fish and fish habitat.

8.12.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with construction and operation of the Westridge Marine Terminal on marine fish and fish habitat were identified in Section 7.11.1.11 and are listed in Table 8.12-1 along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

Construction of the Westridge Marine Terminal will result in the loss of a small area of marine riparian habitat; however, this residual effect is not considered in the context of cumulative effects because none of the three reasonably foreseeable developments in the Marine RSA will affect marine riparian habitat. While construction of the Seaspan load-out pier will affect intertidal and subtidal habitats, the site is heavily industrialized and there is no marine riparian habitat present.

The assessment of potential Project effects on inshore rockfish and Pacific salmon resulting from construction of the Westridge Marine Terminal concluded that injury or mortality are unlikely (see Section 7.6.9.6). As a result, these effects are not considered in the context of cumulative effects. Operational activities at the Westridge Marine Terminal are not expected to affect marine fish and fish habitat; therefore, there is no potential for cumulative effects during the operations phase of the Project.

TABLE 8.12-1

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE FISH AND FISH HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Loss of intertidal habitat due to construction activities.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative loss of intertidal habitat.	• Historical changes to intertidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
2. Loss of subtidal habitat due to construction activities.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative loss of subtidal habitat.	• Historical changes to subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
3. Combined Project effects on Dungeness crab.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative increase in injury or mortality and cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
4. Decrease in productive capacity of suitable habitat for Pacific salmon.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
5. Decrease in productive capacity of suitable habitat for Pacific salmon.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.

Note: 1 RSA = Marine RSA.

8.12.3 Significance Evaluation of Potential Cumulative Effects

Table 8.12-2 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine fish and fish habitat indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below. Characterization of the Project's contribution to cumulative effects relied on studies of the historical changes to marine habitats in the Marine RSA, a qualitative assessment of the potential residual effects of the Seaspan Modernization Project on marine fish and fish habitat, and professional judgment of the assessment team.

TABLE 8.12-2

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE FISH AND FISH HABITAT

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Marine Fish and Fish Habitat Indicator – Intertidal Habitat									
1(a) Project contribution to cumulative loss of intertidal habitat.	Negative	RSA	Short-term	Isolated	Permanent	Low	High	High	Not significant

TABLE 8.12-2 Cont'd

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
2. Marine Fish and Fish Habitat Indicator – Subtidal Habitat									
2(a) Project contribution to cumulative loss of subtidal habitat.	Negative	RSA	Short-term	Isolated	Permanent	Low	High	High	Not significant
3. Marine Fish and Fish Habitat Indicator – Dungeness Crab									
3(a) Project contribution to cumulative decrease in productive capacity of suitable habitat for Dungeness crab.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
3(b) Project contribution to cumulative injury or mortality of Dungeness crab.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4. Marine Fish and Fish Habitat Indicator – Inshore Rockfish									
4(a) Project contribution to cumulative decrease in productive capacity of suitable habitat for inshore rockfish.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5. Marine Fish and Fish Habitat Indicator – Pacific Salmon									
5(a) Project contribution to cumulative decrease in productive capacity of suitable habitat for Pacific salmon.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
6. Combined Cumulative Effects on Marine Fish and Fish Habitat									
6(a) Project contribution to combined cumulative effects on the marine fish and fish habitat indicators (1[a]-5[a]).	Negative	RSA	Short-term	Isolated	Medium-term to permanent	Low	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.12.3.1 Marine Fish and Fish Habitat Indicator – Intertidal Habitat

Intertidal habitats in Burrard Inlet have been extensively modified as a result of historical development. A study by Stantec Consulting Ltd. (Stantec) (2009) estimated that 69% of intertidal habitats in Burrard Inlet have been converted to riprap (52%) or retaining walls (17%). Natural rocky intertidal habitat, tidal flats/estuaries, and beaches comprise 13%, 11% and 7% of the shoreline, respectively.

Shoreline infilling for construction of the Westridge Marine Terminal will result in the loss of approximately 5,470 m^2 of intertidal habitat, most of which is riprap. This loss will be partially offset by the creation of an estimated 3,770 m^2 of new intertidal riprap habitat along the outer face of the fill area. All intertidal habitat affected by construction of the Westridge Marine Terminal has been classified as 'man-made' (BC Ministry of Forests 2005).

Of the three reasonably foreseeable developments that overlap with the Marine RSA, the Seaspan Modernization Project is the only one that will affect marine fish habitats. Construction of the load-out pier is expected to result in the loss of several hundred square metres of intertidal habitat. Shoreline at the development site has been classified as 'man-made' (BC Ministry of Forests 2005) and aerial imagery suggests that the intertidal habitat is composed entirely of riprap (PMV 2013i).

The cumulative effect of intertidal habitat loss in the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is considered to have a negative impact balance and is predicted to be of medium magnitude. The major contributor to this effect is the legacy of industrial and urban development that has linearized much of the natural shoreline and replaced structurally complex habitats with riprap and retaining walls. The Project's contribution to the cumulative loss of intertidal habitat is predicted to be of low magnitude (Table 8.12-2, point 1[a]) because only a small area of previously-modified intertidal habitat will be lost. Although this cumulative effect is permanent, the implementation of a marine fish habitat compensation/offset program will ensure that

there is no net loss of the productive capacity of fish habitat. The intertidal riprap habitat created as a product of infilling will also function as marine fish habitat, and is expected to be colonized by a suite of marine organisms similar to what is currently found at the site. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on intertidal habitat is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to intertidal habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative loss of intertidal habitat in the Marine RSA.

- Duration: short-term – the Project's contribution to a cumulative loss of intertidal habitat will result from shoreline infilling at the Westridge Marine Terminal, which is expected to take 1 to 2 months during the construction phase.

- Frequency: isolated – the Project's contribution to a cumulative loss of intertidal habitat will result from shoreline infilling at the Westridge Marine Terminal, which is confined to the construction phase.

- Reversibility: permanent – the Project's contribution to a cumulative loss of intertidal habitat is permanent.

- Magnitude: low – construction of the Westridge Marine Terminal will result in the loss of a relatively small amount of previously-modified intertidal habitat, which represents a small contribution to the overall cumulative effect.

- Probability: high – construction of the Westridge Marine Terminal will result in the loss of intertidal habitat and this will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to intertidal habitats within the Marine RSA, a good understanding of the residual Project effects on intertidal habitat and a good understanding of the reasonably foreseeable developments that have the potential to impact intertidal habitat in the Marine RSA.

8.12.3.2 Marine Fish and Fish Habitat Indictor – Subtidal Habitat

Historical development in Burrard Inlet has led to the loss of subtidal habitat, primarily through infilling of nearshore areas to increase useable land for industrial developments. Since the 1930s, approximately 363 ha of inlet area have been lost due to infilling (Stantec 2009). It is likely that earlier development in the late 1800s and early 1900s also contributed to the loss of natural subtidal habitats, although this has not been quantified.

Construction of the Westridge Marine Terminal will result in the loss of approximately 17,100 m^2 of subtidal habitat, primarily soft-sediment (sand and mud) with a small area of riprap. This loss will be partially offset by the creation of an estimated 5,550 m^2 of new subtidal riprap habitat along the outer face of the fill area. Rocky habitat is limited in Burrard Inlet, so although the subtidal riprap is anthropogenic, it will provide high value habitat for a variety of marine fish species, including rockfish, which associate with complex rocky habitats. Nevertheless, the Project's contribution to the cumulative loss of subtidal habitat is considered to have a negative impact balance.

A small amount of subtidal habitat will be lost due to construction of the Seaspan load-out pier. The proposed footprint of this in-water development is 1,720 m^2, most of which will be subtidal. Habitats in this area appear to be primarily soft-sediment, although aerial imagery suggests that subtidal riprap may also be present (PMV 2013i)

The cumulative effect of subtidal habitat loss in the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is predicted to be of medium magnitude. While construction of the Westridge Marine Terminal and the Seaspan load-out pier will result in relatively small losses of subtidal habitat, historical developments in Burrard Inlet have reduced the inlet area by at least 363 ha (Stantec 2009). Although subtidal habitat loss is permanent, both Trans Mountain and Seaspan will implement fish habitat compensation/offset programs to ensure that their respective

developments do not result in the loss of the productive capacity of fish habitats. Under the *Fisheries Act*, all unavoidable losses of fish habitat must be compensated/offset through the creation of new habitats or the restoration or enhancement of existing habitats.

The Project's contribution to the cumulative loss of subtidal habitat, therefore, is predicted to be of low magnitude (Table 8.12-2, point 2[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on subtidal habitat is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to subtidal habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative loss of subtidal habitat in the Marine RSA.

- Duration: short-term – the Project's contribution to a cumulative loss of subtidal habitat is limited to the construction phase, resulting from shoreline infilling at the Westridge Marine Terminal, which is expected to take 1 to 2 months, and pile installation, which will occur intermittently over a 2 year period.

- Frequency: isolated – the Project's contribution to a cumulative loss of subtidal habitat will result from shoreline infilling and pile installation at the Westridge Marine Terminal, which is confined to the construction phase.

- Reversibility: permanent – the Project's contribution to the cumulative loss of subtidal habitat is permanent.

- Magnitude: low – construction of the Westridge Marine Terminal will result in the loss of a relatively small amount of soft-sediment subtidal habitat, which will be offset by the creation of subtidal riprap habitat and the implementation of a marine fish habitat compensation/offset program.

- Probability: high – construction of the Westridge Marine Terminal will result in the loss of subtidal habitat and this will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on subtidal habitat and a good understanding of the reasonably foreseeable developments that have the potential to impact subtidal habitat in the Marine RSA.

8.12.3.3 Marine Fish and Fish Habitat Indictor – Dungeness Crab

Cumulative Decrease in Productive Capacity of Suitable Habitat for Dungeness Crab

Historical infilling and shoreline modification in Burrard Inlet has likely reduced the productive capacity of Dungeness crab habitat within the Marine RSA; however, the Inlet remains a productive area for Dungeness crab, supporting commercial, recreational and Aboriginal fisheries (DFO 2012). Marine habitat losses associated with construction of the Westridge Marine Terminal and the Seaspan load-out pier will act cumulatively with historical developments to reduce the overall availability of Dungeness crab habitat in the Marine RSA, and this is considered to have a negative impact balance. The associated loss of productive capacity will be temporary, as both Trans Mountain and Seaspan will implement fish habitat compensation/offset programs to ensure there is no net loss of productive capacity. Although specific compensation/offset measures have not yet been determined for the Project, the preferred option involves the construction of a series of subtidal rock reefs near the Westridge Marine Terminal. These reefs would provide rearing habitat for recently-settled Dungeness crab larvae and foraging habitat for sub-adult and adult crabs. A diverse community of algae and invertebrates would colonize the reefs within a period of two to three years after their construction, increasing productivity and prey availability in the local area.

With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of Dungeness crab habitat is predicted to be of low magnitude and reversible in the medium-term (Table 8.12-2, point 3[a]). A summary of the rationale for all

of the significance criteria for the Project's contribution to cumulative effects on the productive capacity of Dungeness crab is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab in the Marine RSA.

- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab are limited to the construction phase.

- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab are confined to the construction phase.

- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of Dungeness crab habitat; full recovery of productive capacity may take 2 to 3 years following the installation of compensation/offset features.

- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of Dungeness crab habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation/offset program.

- Probability: high – construction of the Westridge Marine Terminal will affect Dungeness crab habitat resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on Dungeness crab habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of Dungeness crab habitat in the Marine RSA.

Cumulative Injury or Mortality of Dungeness Crab

Shoreline infilling and dredging activities during construction of the Westridge Marine Terminal are expected to contribute to a cumulative loss of a small number of Dungeness crabs, and this is considered to have a negative impact balance. A crab salvage program will be implemented whereby adult crabs are collected from within the Project Footprint using baited traps and relocated to a suitable area outside of the Marine Fish and Fish Habitat LSA. Salvages will be conducted immediately prior to the commencement of infilling and dredging so as to reduce the number of crabs that could potentially relocate to within the construction area. It is unknown whether Seaspan will implement a similar salvage program for their load-out pier project; however, the in-water footprint of the development is small (~1,720 m^2), suggesting that few Dungeness crabs will be harmed or killed during construction. Given the abundance of Dungeness crabs within the Marine RSA, the abundance of suitable Dungeness crab habitat, and with consideration of the mitigation measures that will be implemented to specifically reduce injury or mortality to this species, the Project's contribution to the cumulative effect of injury or mortality of Dungeness crabs is predicted to be of low magnitude (Table 8.12-2, point 3[b]). This cumulative effect is considered to be reversible in the medium-term, as Dungeness crabs spawn annually and any local reduction in abundance is expected to be restored within 1 to 2 years of spawning and recruitment. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative injury or mortality of Dungeness crab is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause cumulative injury or mortality of Dungeness crab in the Marine RSA.

- Duration: short-term – the Project's contribution to cumulative injury or mortality of Dungeness crabs is limited to in-water construction activities at the Westridge Marine Terminal.

- Frequency: isolated – the Project's contribution to cumulative injury or mortality of Dungeness crabs will occur only during in-water works associated construction of the Westridge Marine Terminal.

- Reversibility: medium-term – a local reduction in the abundance of Dungeness crabs (*i.e.*, within the Project Footprint) is expected to be reversible within 1 to 2 years, as Dungeness crabs spawn and recruit on an annual basis.

- Magnitude: low – given the abundance of Dungeness crabs within Burrard Inlet, the loss of a relatively small number of individuals within the Project Footprint will not be detectable at the population level.

- Probability: high – construction of the Westridge Marine Terminal is likely to result in the loss of some Dungeness crabs, primarily juveniles that are too small to be captured and relocated by the proposed salvage program.

- Confidence: high – based on a good understanding of the in-water Project Footprint relative to the total available Dungeness crab habitat in the Marine RSA, a reasonable understanding of the distribution and abundance of Dungeness crabs in Burrard Inlet, and a good understanding of the reasonably foreseeable developments that have the potential to result in injury or mortality to Dungeness crab.

8.12.3.4 Marine Fish and Fish Habitat Indicator – Inshore Rockfish

Historical development in Burrard Inlet has likely reduced the availability of nearshore rocky habitat, resulting in a net decrease in the productive capacity of suitable habitat for inshore rockfish. However, the relatively low abundance of rockfish in Burrard Inlet and other developed areas of BC, including the Strait of Georgia, is primarily due to a history of overexploitation (Yamanaka and Logan 2010). The life history characteristics common to most rockfish, which include slow growth, late maturation and high site fidelity, make them particularly susceptible to rapid depletion in the face of heavy fishing pressure (Berkeley *et al.* 2004, Parker *et al.* 2000, Yamanaka and Logan 2010). The rockfish conservation area (RCA) located at the Westridge Marine Terminal is 1 of 164 such protected areas in BC, and is part of a broader conservation strategy for inshore rockfish (Yamanaka and Logan 2010).

Construction of the Westridge Marine Terminal will only temporarily diminish the productive capacity of inshore rockfish habitat. Once completed, the infill area will actually increase the availability of complex rocky habitat in the subtidal environment, and while the habitat is anthropogenic (riprap), it is expected to be of high value to species such as copper and quillback rockfish, which exhibit a strong preference for rocky substrates of high rugosity (Love *et al.* 2002). In addition, the implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of productive capacity of inshore rockfish habitat. The preferred option for compensation/offsetting involves the construction of a series of subtidal rock reefs near the Westridge Marine Terminal, within the Eastern Burrard Inlet RCA. One of the primary objectives of this strategy would be to increase the availability and quality of rockfish habitat within the RCA.

Construction of the Seaspan load-out pier is not expected to result in a measurable effect on the productive capacity of inshore rockfish habitat. While a small amount of intertidal and subtidal riprap may be lost, most of the seafloor area affected is soft sediment, which has low value to most demersal rockfish species. In addition, the in-water footprint of the development (~1,720 m^2) is small and the affected habitat is in a highly industrialized area. Any loss of productive capacity resulting from construction of the load-out pier will be offset through fish habitat compensation/offsetting.

The Project's contribution to the cumulative decrease in productive capacity of suitable habitat for inshore rockfish is considered to have a negative impact balance. While rockfish abundance in Burrard Inlet is greatly reduced compared to historical levels, this is primarily due to a long history of overexploitation (Yamanaka and Logan 2010). With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of inshore rockfish habitat is predicted to be of low magnitude (Table 8.12-2, point 4[a]). This cumulative effect will be reversed once biotic communities have become fully established on the subtidal riprap and compensation/offset habitats, which is expected to take 2 to 3 years. A summary of the rationale for all of

the significance criteria of the Project's contribution to cumulative effects on inshore rockfish is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for inshore rockfish in the Marine RSA.

- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for inshore rockfish are limited to the construction phase.

- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for inshore rockfish are confined to the construction phase.

- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of inshore rockfish habitat; full recovery of productive capacity may take 2 to 3 years following the installation of compensation/offsetting features.

- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of inshore rockfish habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation/offset program.

- Probability: high – construction of the Westridge Marine Terminal will affect a small amount of existing rock (riprap) habitat resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on inshore rockfish habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of inshore rockfish habitat in the Marine RSA.

8.12.3.5 Marine Fish and Fish Habitat Indicator – Pacific Salmon

Historical shoreline developments in Burrard Inlet, particularly in the Inner Harbour, have linearized much of the natural shoreline and replaced structurally complex habitats with riprap and retaining walls (Stantec 2009). This substantial habitat modification has reduced the productive capacity of Pacific salmon habitat within the Marine RSA, particularly for juveniles, which use nearshore habitats extensively for rearing prior to embarking on seaward migrations (Haggarty 2001).

Construction of the Westridge Marine Terminal will result in the loss of intertidal and subtidal habitats, and this will act cumulatively with the effects of historical developments in the Marine RSA. The Project-specific effects on the productive capacity of Pacific salmon habitat are, however, expected to be minimal. The shoreline within the Project Footprint is primarily anthropogenic and Project construction will effectively replace intertidal habitats like-for-like (*i.e.*, riprap with riprap). Nevertheless, the Project's contribution to the cumulative decrease in productive capacity of Pacific salmon habitat is considered to have a negative impact balance. The loss of productive capacity resulting from in-water construction activities will be offset through the implementation of a marine fish habitat compensation/offset program. The preferred option of subtidal rock reefs would provide high-value foraging and rearing habitat for juvenile salmon. The reefs would increase the structural complexity of nearshore habitats in the local area, enhance productivity (*i.e.*, algal growth) and increase prey availability for a variety of marine fish species, including Pacific salmon.

Construction of the Seaspan load-out pier may result in a small reduction in the productive capacity of Pacific salmon habitat; however, the small footprint of this development and the industrial nature of the site suggest that effects will be minimal. Similar to Trans Mountain, Seaspan will implement a fish habitat compensation/offset program to ensure there is no net loss of productive capacity of Pacific salmon habitat.

The cumulative effect of a decrease in the productive capacity of Pacific salmon habitat within the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is predicted to be of medium magnitude. However, the major contributor to this effect is the legacy of industrial and urban development that has diminished the natural integrity of shoreline habitats throughout much of Burrard Inlet.

With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of Pacific salmon habitat is predicted to be of low magnitude (Table 8.12-2, point 5[a]). While the productive capacity of Pacific salmon habitat will be temporarily reduced as a result of Project construction, this cumulative effect will be reversed once biotic communities have become fully established on the intertidal and subtidal riprap and the compensation/offsetting habitats. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on Pacific salmon is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for Pacific salmon in the Marine RSA.

- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for Pacific salmon are limited to the construction phase.

- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for Pacific salmon are confined to the construction phase.

- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of Pacific salmon; full recovery of productive capacity may take 2 to 3 years following the installation of compensation features.

- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of Pacific salmon habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation program.

- Probability: high – construction of the Westridge Marine Terminal will affect intertidal and subtidal habitats used by Pacific salmon, primarily juveniles, resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on Pacific salmon habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of Pacific salmon habitat in the Marine RSA.

8.12.3.6 Combined Cumulative Effects on Marine Fish and Fish Habitat

Over a century of development in Burrard Inlet has resulted in the modification of a substantial amount of shoreline habitat within the Marine RSA, as well as the infilling of a large area of subtidal habitat (Stantec 2009). These extensive changes to the Burrard Inlet marine ecosystem have undoubtedly reduced the productive capacity of fish habitat, with effects on a variety of marine organisms, including Dungeness crab, inshore rockfish and Pacific salmon. Natural shoreline habitats are still found in some areas of Burrard Inlet, particularly Indian Arm and to a lesser degree Port Moody Arm and the Central Harbour, and current best practices to manage project-specific effects will minimize additional loss of productive capacity of marine fish habitat.

Trans Mountain recognizes the ecological, economic and cultural importance of marine fish and their habitats, and is committed to minimizing adverse effects of the Project on the marine environment. Construction of the Westridge Marine Terminal will result in the loss of intertidal and subtidal habitat within the Project Footprint; however, the associated reduction of productive capacity will be offset through the

implementation of a marine fish habitat compensation/offset program. This program will be developed in consultation with DFO, Aboriginal communities, local stewardship groups and other interested parties, and will ensure that there is 'no net loss' of the productive capacity of marine fish habitat. In fact, the goal of the compensation program will be to increase productive capacity so that the Project has a net benefit to marine fish and fish habitat.

Of the three reasonably foreseeable developments located within the Marine RSA, only the Seaspan Modernization Project involves in-water works that could affect marine fish and fish habitat. The footprint of the proposed load-out-pier is small (~1,720 m^2) and the site is heavily industrialized, suggesting that effects on marine fish and fish habitat will be minimal. However, like Trans Mountain, Seaspan will implement a fish habitat compensation program to ensure there is no net loss of the productive capacity of fish habitat.

In consideration of the history of development in the Marine RSA and the extensive changes to shoreline habitats, the combined cumulative effects of historical developments, Project construction, and reasonably foreseeable developments on marine fish and fish habitat are considered to be of medium magnitude.

With the implementation of a suite of mitigation measures designed to minimize adverse effects of the Project on marine fish and their habitats (see Section 7.6.9), the Project's contribution to combined cumulative effects on the marine fish and fish habitat indicators are predicted to be of low magnitude (Table 8.12-2, point 6[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on the marine fish and fish habitat indicators is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause combined cumulative effects on marine fish and fish habitat in the Marine RSA.

- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to combined cumulative effects on marine fish and fish habitat are limited to the construction phase.

- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to combined cumulative effects on marine fish and fish habitat are confined to the construction phase.

- Reversibility: medium-term to permanent – while construction of the Westridge Marine Terminal will result in the permanent loss of some intertidal and subtidal habitat, implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of marine fish habitat.

- Magnitude: low – construction of the Westridge Marine Terminal will affect marine fish habitats in an area that has been previously modified by development (*i.e.*, most habitats are not natural); any and all losses of productive capacity will be offset through the implementation of a marine fish habitat compensation/offset program.

- Probability: high – construction of the Westridge Marine Terminal involves in-water works that will affect marine fish and fish habitat; these effects will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.

- Confidence: high – based on a good understanding of the historical changes to marine fish habitats within the Marine RSA, a good understanding of the residual Project effects on marine fish and fish habitat, a good understanding of the effectiveness of habitat compensation/offsetting measures and a good understanding of the reasonably foreseeable developments that have the potential to affect marine fish and fish habitat in the Marine RSA.

8.12.4 Summary

As identified in Table 8.12-2, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically

mitigated. Consequently, the Project's contribution to cumulative effects on marine fish and fish habitat within the Marine RSA will be not significant.

8.13 Marine Mammals

8.13.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments are identified within the Marine RSA that were considered for the qualitative evaluation of cumulative effects on the marine mammals indicator: Neptune Terminals Coal Handling Infrastructure Upgrade and Expansion; Richardson International Grain Storage Capacity Expansion; and Seaspan Shipyard Modernization. These developments are further described in Section 8.1.4 and Table 8A.1-6 of Appendix 8.1. All three reasonably foreseeable developments are located in the Inner Harbour, west of the Second Narrows, and are distant from the Marine Mammals LSA.

The only Project that will involve in-water works is the Seaspan Shipyard Modernization. The other two projects (Neptune and Richardson) are limited to the construction and expansion of on-land infrastructure. The Seaspan project will produce underwater noise during construction. However, all three Projects will be completed by early 2015 and there will be no temporal overlap with construction of the Westridge Marine Terminal, which is scheduled to commence no earlier than September 2015.

8.13.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with construction of the Westridge Marine Terminal on the marine mammals indicator were identified in Section 7.11.1.13. As previously noted in Section 7.11.1.13, no pathways of effects to marine mammals associated with operational activities of the Westridge Marine Terminal were identified. Out of the three reasonably foreseeable developments identified in Section 8.1.4 above, only the Seaspan Shipyard Modernization Project is likely to result in residual effects on marine mammals. Given that there will be no temporal overlap between development of this project and construction of the Westridge Marine Terminal, it was determined that there is no potential for cumulative effects on marine mammals during the construction phase of the Project. Furthermore, operational activities at the Westridge Marine Terminal are not expected to affect marine mammals; therefore, there is no potential for cumulative effects during the operations phase of the Project.

8.14 Marine Birds

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine bird indicators (*i.e.*, bald eagle, great blue heron, pelagic cormorant, Barrow's goldeneye, glaucous-winged gull and spotted sandpiper) that are anticipated to have an adverse combined Project-specific residual effect.

8.14.1 Reasonably Foreseeable Developments

Table 8A.1-6 of Appendix 8.1 provides a list of the reasonably foreseeable developments within BC and those located within the Marine RSA to be considered in the evaluation of cumulative effects on the Marine Bird indicators. There are three primary future developments located within the Marine RSA (Table 8.11-1) that would contribute to the cumulative effect of disturbance to marine birds from noise and activity during construction and operations: Neptune Bulk Terminals Ltd. Coal Handling Infrastructure Upgrade and Expansion Project; Richardson International Ltd. Grain Storage Capacity Project, and Seaspan Shipyard Modernization Project.

All three Projects are scheduled to be completed by spring 2015 and will have no temporal overlap with the construction of the Westridge Marine Terminal which is scheduled to commence no earlier than September 2015.

8.14.2 Potential Cumulative Effects

The three reasonably foreseeable Projects in Table 8.14-1 are scheduled to be completed prior to the onset of construction of the Westridge Marine Terminal on or after September 2015. Noise from

construction of these projects will not be cumulative with noise from construction of the Westridge Marine Terminal. The cumulative effects assessment for the Westridge Marine Terminal will; therefore, only address the potential cumulative effect of disturbances during operations. Refer to Section 7.6.12 for a Project-specific assessment of potential effects associated with construction of the Westridge Marine Terminal on marine bird indicators.

One of the foreseeable developments will involve in-water construction; the load-out pier of the Seaspan Shipyard Modernization Project. With consideration for the extent of disturbance, commercial infrastructure and daily activity in the current terminal, it is unlikely that the inside docking areas are currently visited by seabirds, apart from gull species. The intertidal areas consist of non-productive substrate without vegetation, and there is limited value as a source of food for birds or fish prey. There are abundant opportunities for perching on the existing infrastructure which are not anticipated to change substantially after construction of the load-out pier. There is negligible potential for cumulative effects from loss of marine shoreline or intertidal habitat to marine birds, and this will not be assessed further.

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on marine birds indicators were identified in Section 7.11.1.14 and are listed in Table 8.14-2 along with existing activities and reasonably foreseeable developments that could act in combination with the Project. Because there will not be cumulative effects associated with the risk of mortality or habitat loss, the cumulative effects assessment will consider only the potential for effects from the events of sensory disturbance.

TABLE 8.14-2

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE BIRDS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects on bald eagle.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
2. Combined effects on great blue heron.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
3. Combined effects on pelagic cormorant.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.

TABLE 8.14-2 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined effects on Barrow's goldeneye.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
5. Combined effects on glaucous-winged gull.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
6. Combined effects on spotted sandpiper.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.

Note: 1 RSA = Marine RSA.

8.14.3 Significance Evaluation of Potential Cumulative Effects

The Project's contribution to cumulative effects from the Westridge Marine Terminal operations include potential sensory disturbances from an increase in terminal noise, human activity, night lights, vessel berthing/deberthing activities, maintenance and inspection during operations, increased vessel activities and other local marine activities (*e.g.*, recreational boating, fishing and shoreline use), and the consequent alteration of normal distribution and patterns of marine bird habitat use to avoid particular foreshore areas. Previous research indicates that marine birds are disturbed by in-air noise levels greater than 90 dB per 20 µPa (Gladwin *et al.* 1988). Given the current context of dense marine foreshore development in Burrard Inlet, marine birds have been known to habituate to noise levels under 90 dB and to other sensory disturbances, such as marine activity, night-lighting, and vessel berthing and unberthing events that are periodic, predictable and not adverse experiences (Grubb *et al.* 2002, Steidl and Anthony 2000, Ward and Stehn 1989). Terminal operations are unlikely to have a substantial contribution to cumulative effects in the Marine RSA considering the context of high volume activity and marine industry within their current habitats.

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, or where quantitative thresholds are not relevant to the Marine RSA, the qualitative method that is based on information and guidance provided from available research literature, and the professional judgment of the assessment team. This qualitative approach is considered to be the appropriate method for evaluating and determining the significance of the anticipated Project's contribution to cumulative environmental effects.

Table 8.14-3 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine bird indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.14-3

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE BIRDS

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Marine Bird Indicator – Bald Eagle									
1(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
2. Marine Bird Indicator – Great Blue Heron									
2(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
3. Marine Bird Indicator – Pelagic Cormorant									
3(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
4. Marine Bird Indicator – Barrow's Goldeneye									
4(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
5. Marine Bird Indicator – Glaucous-winged Gull									
5(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Occasional	Short-term	Low	High	High	Not significant
6. Marine Bird Indicator – Spotted Sandpiper									
6(a) Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
7. Combined Cumulative Effects on Marine Birds									
7(a) Project contribution to combined cumulative effects on the marine birds indicators (1[a] to 6[a]).	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.14.3.1 Marine Birds Indicator – Bald Eagle

The bald eagle is a resident avian predator that feeds opportunistically on fish, waterbirds, small mammals and carrion in shallow water and along shorelines, and represents other raptor species which may also be using these shoreline and foreshore habitats. There are approximately 15 breeding pairs of bald eagle within the Marine RSA; however, there are also many more non-breeding individuals present during the fall and winter months (Cook 2008) when bald eagles are less territorial. Increased in-air noise, night-lighting and activity at the Westridge Marine Terminal may cause some individuals to avoid using preferred and/or important seasonal foraging or breeding habitats. Bald eagles have been documented to habituate to noise and human activity in developed areas (Grubb *et al.* 2002, McGarigal *et al.* 1991). Although it is difficult to assess the level of habituation in birds that reside in Burrard Inlet, some habituation is likely in such a busy industrial and commercially developed port where many breeding pairs currently reside. It is reasonable to assume bald eagle persistence is related to some level of anthropogenic tolerance, and this can be said for other raptor or foreshore species that the bald eagle, as an indicator, is representative of, such as vultures, osprey, Cooper's hawk, owls or great blue herons.

The Project's contribution to cumulative effects within the Marine RSA resulting from expansion of the Westridge Marine Terminal is not expected to be substantial beyond the Marine Birds LSA, and will be relatively minor proportion of the effects from existing and foreseeable developments. The Project's contribution to cumulative effects with respect to the bald eagle is primarily of concern in the area of overlap between the breeding territory of a pair of bald eagles, local tree roosts and intertidal zones, and the Westridge Marine Terminal; however, may potentially include the effects of increased vessel activity in the Marine RSA as a whole. Sensory disturbance (*i.e.*, terminal-related in-air noise and activity, increased vessel activity) is considered to have a negative impact balance through the potential for bald eagle avoidance of preferred hunting/foraging foreshore habitats; however, vessel activity is unlikely to present much of a concern for disturbance in the typical shoreline habitats used by this group of species. The potential for long-term periodic disturbances near the terminal may affect a small number of individuals outside the breeding season when eagles are less territorial. It is unlikely that there will be an adverse effect to the regional population which is abundant and stable.

The Project's contribution to the cumulative effects on bald eagles from sensory disturbance events is anticipated to be associated with the terminal and increased Project-related vessel activities within the Marine RSA will be temporary events Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from sensory disturbances. Consequently, with consideration for the existing highly developed environment within the Marine RSA, the stable and abundant local and regional bald eagle population, the likelihood of some level of habituation to local disturbances, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on bald eagle will occur over the long-term and to be of low magnitude and short-term reversibility (Table 8.14-3, point 1[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on bald eagles is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident territories of bald eagles.

- Duration: long-term – the events causing sensory disturbance to bald eagles is the contribution to the cumulative effect of repeated and regular Project-related disturbances during terminal and vessel operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to bald eagles is the contribution to the cumulative effect of Project–related terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to bald eagles will be reversible shortly after each disturbance event.

- Magnitude: low – the effects from the Project will be detectable at the individual level but marginal on the bald eagle population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and the potential for individual levels of habituation to disturbance.

- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to bald eagles.

- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between Project-related and local development activities and bald eagles using data specific to the Marine RSA.

8.14.3.2 Marine Birds Indicator – Great Blue Heron

Great blue herons nest colonially in woodland forest. Stanley Park, which extends to the shoreline of the Marine RSA, has a large active nesting colony. A small colony of a few breeding pairs is also located upstream of the Westridge Marine Terminal site in the riparian zone of Heron Creek. The indicator, great blue heron, forages opportunistically on fish, small mammal and invertebrate prey primarily taken within the intertidal zone and, as such, represent the many species of intertidal foragers that occur within the Marine RSA (*e.g.*, sandpiper species, waterfowl species, common raven, migrating birds). Increased noise and activity during terminal and shipping operations could potentially result in the avoidance by some individuals of preferred foraging habitats at foreshore areas (Gebauer and Moul 2001, Vennesland 2000) or local perches in trees or on terminal structures. Extended or high-level disturbance events, such as loud maintenance activity, short-term construction projects, or safety alarms could cause stress in some individuals depending on their degree of prior exposure to noises or terminal-related activities (Carney and Sydeman 1999, 2000). Because primary habitat use is foreshore-based, it is unlikely that increased vessel activity from the Project or other foreseeable developments will present more than a marginal potential for sensory disruptions. Recent scientific literature documents the sensitivities of great blue heron colonies to various sources and types of disturbance (Carney and Sydeman 1999, 2000, Vennesland 2000), the seriousness of which is often dependent on the existing environmental conditions and the familiarity of natal colonies to these disturbances prior to their occurrence. However, habituation has been observed in some population groups (Vennesland 2000), again dependent on local conditions at breeding colonies and natal rearing sites. Operational noise from the terminal is unlikely to extend substantially beyond the Marine Birds LSA, although, unusual or loud vessel activities may occur anywhere within the Marine RSA. The establishment of mitigation measures provided in the Westridge Marine Terminal EPP (Volume 6D) will reduce or avoid potential future noise disturbances to marine life.

The Project's contribution to cumulative effects overall within the Marine RSA will be a relatively minor proportion of the effects from existing activities and reasonably foreseeable developments. The Project's contribution to cumulative effects with respect to the indicator, great blue heron, and other represented species, is concerned with the area of overlap between high suitability foraging sites in shallow areas, and forest or structural roosting sites within the Marine Bird LSA and the Marine RSA. Sensory disturbance (*i.e.*, terminal-related in-air noise and activity, increased vessel activity) is considered to have a negative impact balance by causing marine bird avoidance of preferred foraging habitats. The potential for long-term periodic disturbances, because they are primarily associated with nightly lighting of the terminal, scheduled docking and filling operations, and associated worker activities near the terminal, and 24-hour potential disturbances from increased marine vessel activity, will affect a small number of individuals, both adults and juveniles that have dispersed within the Marine RSA. There is unlikely to be an adverse effect to the regional breeding population because noise will be mitigated through measures established in the Westridge Marine Terminal EPP (Volume 6D), and the breeding colonies are distant enough from the terminal to presume there is likely to be no effect from sensory disturbance.

The Project's contributions to cumulative effects on great blue heron within the Marine RSA from increased sensory disturbance are anticipated to be associated with the terminal and increased Project-related vessel activities, and will be temporary events lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce events of sensory disturbance during operations. Consequently, with consideration for the existing highly developed environment within the Marine RSA, the potential for the local breeding population of great blue herons to have some level of habituation, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on great blue herons is considered long-term in duration, to be of low magnitude effect and of short-term reversibility (Table 8.14-3, point 2[a]). A summary of the rationale for all of the significance criteria for the Project's contribution to cumulative effects on great blue herons is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the great blue heron.

- Duration: long-term – the events causing sensory disturbance to great blue herons is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to great blue herons is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to great blue herons will be reversible shortly after each disturbance event.

- Magnitude: low – the cumulative effects directly related to the Project will be detectable at the individual level but low on the regional population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, and with consideration for some potential individual habituation to disturbance.

- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to great blue herons.

- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project-related activities and great blue herons, and using data specific to the Marine RSA.

8.14.3.3 Marine Birds Indicator – Pelagic Cormorant

Several pelagic cormorant breeding colonies are located within the Marine RSA on rocky islets and bridge structures (Moul and Gebauer 2002). Pelagic cormorants prey on fish within the littoral-benthic zone, including the nearshore areas of the Westridge Marine Terminal and within the Marine RSA. Increased terminal and vessel activity in the overall Marine RSA could potentially disturb individuals using preferred open water and foreshore areas to feed, and/or rocky shorelines and terminal structures to perch and preen. Pelagic cormorants are considered particularly sensitive to boats with a low disturbance threshold to human activities in less disturbed and more natural habitats (Carney and Sydeman 1999, 2000). This species, as an indicator, represents other larger piscivoruous and typically sensitive marine birds that occur within the Marine RSA, such as western grebes and common loons. Habituation is known to occur in some species of marine birds, such as bald eagles and glaucous-winged gulls, and cormorants often take advantage of man-made structures to rest and nest; however, the species represented, such as western grebes are unlikely to be habituated and, in fact, have substantially decreased in local population numbers. Although it is difficult to assess the level of habituation in groups that reside in Burrard Inlet without site-specific research and monitoring efforts; habituation might be assumed for cormorant species that reside in such a busy industrial and commercially developed port where many pairs currently breed.

The Project's contribution to cumulative effects will be a relatively minor proportion of the effects from Project-related and other reasonable foreseeable operations. The Project's contribution to cumulative effects with respect to the pelagic cormorant is concerned with the suitable preening and foraging sites in and near to the terminal and within the larger Marine RSA. Sensory disturbances (*i.e.*, terminal-related in-air noise and activity, and increased vessel activity) are considered to have a negative impact balance through pelagic cormorant avoidance of preferred foraging and roosting habitats. The potential for long-term periodic disturbances is greatest near the Westridge Marine Terminal and will affect a small number of individuals distributed within the eastern portion of the Marine RSA. There is unlikely to be an adverse effect to the regional breeding population because noise levels will be mitigated through established measures provided in the Westridge Marine Terminal EPP (Volume 6D) and will be attenuated with increasing distance between the terminal and breeding colonies that are greater than 5 km from the terminal. In addition, new berths that will be constructed as a part of terminal expansion will provide increased long-term substrates for the re-establishment of benthic invertebrates and vegetation.

The Project's contribution to cumulative effects on pelagic cormorant from increased sensory disturbances is anticipated to be associated with the terminal and increased Project-related vessel traffic, will be temporary events lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Adherence to established mitigation measures will reduce or avoid effects to marine life during operation of the Westridge Marine Terminal and associated increased vessel traffic. Consequently, with consideration for the context of the dynamic and highly developed environment of the Marine RSA, the potential for some level of pelagic cormorant habituation to industrial activities, the potential for increased opportunistic use of man-made structures to perch and nest, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on pelagic cormorants will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 3[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on pelagic cormorants is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the pelagic cormorant.

- Duration: long-term – the events causing sensory disturbance to pelagic cormorant is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to pelagic cormorants is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to pelagic cormorant will be reversible shortly after each disturbance event.

- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but marginal on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and consideration for potential individual habituation to disturbance.

- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to pelagic cormorants.

- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between marine activities and pelagic cormorants but without sufficient data specific to the Marine RSA.

8.14.3.4 Marine Birds Indicator – Barrow's Goldeneye

Barrow's goldeneyes overwinter in the inlets and harbours of the Marine RSA using rocky shores to preen and rest. In subtidal areas, they feed on crustaceans and fish eggs. As such, they are indicators representing other resident and migrating marine birds that are benthic and invertebrate foragers within the Marine RSA, such as, surf scoters, common goldeneye and some waterfowl species. The existing Westridge Marine Terminal pilings provide a substrate for invertebrate prey. Increased in-air noise and activity at the terminal may disturb individuals that normally use these wharf habitats resulting in avoidance of preferred subtidal zones (Carney and Sydeman 1999, 2000) and consequent loss of foraging opportunities. Habituation is not common in seabird species, especially those that tend to use particular areas seasonally, such as goldeneye, alcids and other migratory species, and it is difficult to determine the potential for individual levels of habituation without site-specific monitoring. Constraints from obtaining important seasonal food requirements can result in reduced habitat effectiveness, energy budget constraints, and reduced individual fitness. The potential for long-term periodic disturbances from terminal activities and increased vessel operations will affect a seasonal number of individuals using the Marine RSA, especially at or near the terminal, and moving to and from preferred sheltered habitats in Indian Arm and Port Moody Arm. Noise and physical disturbances will attenuate with increase in distance of foraging birds, or rafts of birds, from the Westridge Marine Terminal and the central inlet.

The Project's contribution to cumulative effects within and near the Marine RSA will be a relatively minor proportion of the effects from marine activity associated with Project-related and other reasonably foreseeable marine terminal and vessel operations. The Project's contribution to cumulative effects with respect to the Barrow's goldeneye is concerned with suitable foraging and preening sites, primarily in and near the Marine Birds LSA but may extend to the Marine RSA with loud or unusual vessel activity. In-air noise and activity will potentially result in a negative impact balance through the avoidance of Barrow's goldeneye from productive nearshore foraging habitats. The potential for long-term periodic disturbances within the Marine RSA will affect a small number of individuals present on a seasonal basis (*i.e.,* overwintering); however, foraging capacity may improve over the life of the Project with the re-establishment of new benthic invertebrates, bi-valve populations and vegetation attached to the newly constructed wharfs.

The Project's contributions to cumulative effects on Barrow's goldeneye from increased sensory disturbance are anticipated to be associated with the terminal and increased Project-related vessel traffic and will be temporary events, lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, the potential for seasonal familiarity and some individual habituation to urban activity in overwintering areas, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on Barrow's goldeneye will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 4[a]). A summary of the rationale for all of the significance criteria for the Project's contribution to cumulative effects on Barrow's goldeneyes is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for preferred, seasonal, high suitability foraging habitats of the Barrow's goldeneye.

- Duration: long-term – the events causing sensory disturbance to Barrow's goldeneye is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to Barrow's goldeneye is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to Barrow's goldeneye will be reversible shortly after each disturbance event.

- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but negligible on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and seasonal use by Barrow's goldeneyes.

- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to Barrow's goldeneye.

- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneye, without data pertinent to the Marine RSA and the potential for some individual familiarity with local disturbances.

8.14.3.5 Marine Birds Indicator – Glaucous-Winged Gull

An abundant population of glaucous-winged gulls opportunistically fish and scavenge within the marine and upland environments of the Marine RSA (Suraci and Dill 2011). There are several breeding colonies present within the Marine RSA including a site within 1 km of the Westridge Marine Terminal on the south shore of Port Moody Arm. Man-made commercial structures including the existing terminal pilings and berths currently provide shelter and roosting habitat which may later be enhanced by new wharf structures added during the expansion of the Westridge Marine Terminal. Glaucous-winged gulls are indicators of a wide range of other marine birds that forage and nest within the Marine RSA due their

versatile habitat use and strong-association with human-influenced environments, and as in other species, their sensitivity during the breeding cycle, particularly during egg-laying and incubation.

Increased in-air noise, human activity, night-lighting and increased vessel movements may result in disturbance to individuals using these open water or shoreline habitats; however, for this species, habituation to anthropogenic disturbances is common and reasonable to assume in the urban and industrially developed context of marine habitats of Burrard Inlet. The Westridge Marine Terminal EPP (Volume 6D) has been developed to employ mitigation measures to avoid disturbance to marine life and includes consideration for sensitive wildlife periods (*i.e.*, the breeding period of glaucous-winged gulls from early May to late August at local breeding colonies). Noise levels capable of disturbing nesting birds will decrease with the distance of the nest sites from the source and are not expected to extend much beyond the Marine Birds LSA.

The Project's contribution to cumulative effects on glaucous-winged gulls within the Marine RSA will be a relatively minor proportion of the effects from combined sensory disturbance. The Project's contributions to cumulative effects on glaucous-winged gulls are anticipated to be associated with the terminal and increased Project-related vessel activity, and will be temporary events. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, the likelihood of habituation and opportunistic advantages to gulls provided by urban developed marine areas, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on glaucous-winged gulls will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 5[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on glaucous-winged gulls is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the glaucous-winged gull.

- Duration: long-term – the events causing sensory disturbance to glaucous-winged gulls is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.

- Frequency: occasional – the events causing sensory disturbance to glaucous-winged gulls is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently and sporadically throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to glaucous-winged gulls will be reversible shortly after each disturbance event.

- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but negligible to the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, the known anthropogenic association between gulls and human-influenced habitats, and the adherence to appropriate mitigation measures at the terminal.

- Probability: high – the Project is likely to contribute to the cumulative effects of increased sensory disturbances to glaucous-winged gulls.

- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and glaucous-winged gulls, the likelihood of some level of individual habituation to disturbance, and data pertinent to the Marine RSA.

8.14.3.6 Marine Birds Indicator – Spotted Sandpiper

Spotted sandpipers use a variety of aquatic habitats, nesting at shores under herbaceous ground cover and using mudflats, beaches, and breakwaters where they forage exclusively on invertebrates. The local population of spotted sandpipers is highest during migration and recent literature indicates the regional breeding population is stable (Gratto-Trevor *et al.* 2010). Like other sandpipers, they tend to flush easily

during human disturbance events. Spotted sandpipers are indicators of a diversity of small and large migratory sandpiper species, and resident passerines (such as song sparrows), which use the intertidal and foreshore areas seasonally to forage on insects and other invertebrates, and to nest in shoreline vegetation, nest boxes (such as Purple martin) and debris. The additional in-air noise, light and activity at the Westridge Marine Terminal and the increased vessel activity during operations may stress individuals that are using preferred and/or important intertidal habitats to forage and upland shoreline habitats for breeding and nesting. Continued disturbance events may result in an alteration of patterns of habitat use to avoid those disturbed areas, and/or alterations to critical energy budgets during the breeding season. Noise or unusual activity at the terminal may have some measureable adverse effect on spotted sandpipers which as a bird group tend to be reactive to non-natural environmental inputs. Levels of habituation are not very well understood in this species. Disturbance can adversely affect habitat effectiveness, alter energy budgets and reduce individual fitness (Carney and Sydeman 1999, 2000). No nests have been documented at the shoreline or within the Westridge Marine Terminal footprint to-date; however, new nests can be initiated at any suitable location each year. The Westridge Marine Terminal EPP (Volume 6D) has been developed to reduce or eliminate potential harm or disturbance to marine life during operations to include environmental monitoring for wildlife and consideration of sensitive wildlife breeding periods. Noise and activity are not expected to extend much beyond the Marine Birds LSA.

The Project's contribution to cumulative effects on spotted sandpipers within the Marine RSA is expected to be a relatively minor proportion of total combined effects. However, habitat use is primarily in intertidal and shoreline areas; therefore, vessel activity is likely to be less of a concern except during unusual or loud activities. The Project's contributions to cumulative effects on spotted sandpipers are anticipated to be associated with the terminal and increased Project-related vessels, and disturbance events will be temporary. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, seasonal breeding within the upper reaches of the Marine RSA, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on spotted sandpipers will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 6[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on spotted sandpipers is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident and migrating spotted sandpipers.

- Duration: long-term – the events causing sensory disturbance to spotted sandpipers is the Project's contribution to the cumulative effect of repeated and regular Project-related terminal and increased vessel activities during operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to spotted sandpipers is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.

- Reversibility: short-term – the cumulative effect of Project-related disturbances to spotted sandpipers will be reversible shortly after each disturbance event.

- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but anticipated to be low on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, and potential seasonable breeding within the Marine Birds LSA.

- Probability: high – the Project is likely to contribute to the cumulative effects of increased sensory disturbances to spotted sandpipers.

- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between marine activities and spotted sandpiper, sensitivity to disturbance events but without sufficient data specific to the Marine RSA.

8.14.3.7 Combined Effects on Marine Birds

The evaluation of the Project's contribution to the combined cumulative effects on the marine birds indicators from expansion of the Westridge Marine Terminal and increased Project-related vessels considers collectively the likelihood of potential residual effects on the following indicator species: bald eagle; great blue heron; pelagic cormorant; Barrow's goldeneye; glaucous-winged gull; and spotted sandpiper, and the larger diverse group of marine bird ecological guilds they represent. The potential Project-related cumulative effects are associated with sensory disturbance and consequent stress, behavioural alteration or changes in energy budget in each indicator. The potential cumulative effects of noise, human-activity, night-lighting, unusual events and increased vessel berthing/deberthing and movements within the Marine RSA may act in combination to affect marine birds as described above for each of the marine birds indicator species.

The potential impact balance to marine birds is considered negative. The implementation of mitigation measures described in Section 7.0 and the Westridge Marine Terminal EPP (Volume 6D) will reduce the severity of Project's contribution to cumulative effects arising from the Project and reasonably foreseeable developments. Burrard Inlet is one of the busiest ports on the Pacific Coast and effects are considered in the context of existing and predicted future high-volume industrial and commercial terminal and vessel activity within the Marine RSA, and the Project's modest contribution to that activity. The evaluation of effects takes into account that there is strict adherence to an existing regulatory framework for marine shipping operations. The combined contribution to cumulative effects on marine birds from the Project-related activities is considered to be of low magnitude, reversible in the short-term and of high probability (Table 8.14-3, point 7[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on marine bird indicators is provided below.

- Spatial Boundary: Marine RSA – combined Project-related contribution to cumulative effects on marine birds are assessed within the context of projected future marine activities interacting with Project-related activities in the Marine RSA.

- Duration: long-term – the events causing the combined Project-related contribution to cumulative effects on marine birds will occur during operations for the life of the Project.

- Frequency: periodic – the events causing sensory disturbance to marine birds is the combined Project-related contribution to cumulative effects of the repeated and regular terminal and increased vessel activities which will occur intermittently for the life of the Project.

- Reversibility: short-term – the combined Project-related contribution to cumulative effects from sensory disturbance causing behavioural alterations will be reversible shortly after each disturbance event.

- Magnitude: low – the combined Project-related contribution to cumulative effects will be detectable at the individual level and may have low to negligible effects on populations, particularly during sensitive breeding periods, in consideration of the high-volume of existing marine activity and extent of shoreline development that currently exists within the Marine RSA, and some level of individual habituation to disturbance.

- Probability: high – the Project is likely to contribute to combined adverse cumulative effects on marine birds from sensory disturbance to varying degrees, during some energetically taxing seasons, such as migration or breeding, and under some environmental conditions.

- Confidence: high – based on a good understanding by the assessment team on pathways of cumulative effect between the increased Project-related activities and marine birds, and with data relevant to the Marine RSA.

8.14.4 Summary

As identified in Table 8.14-3, there are no situations where there is a high probability of the occurrence of a permanent or long-term residual cumulative effect of high magnitude on marine birds from the Project.

Consequently, it is concluded that the Project's contribution to the cumulative effects of the Project on marine birds in the Marine RSA will be not significant.

8.15 Marine Species at Risk

As discussed in Section 7.6.13, potential effects of the Project on marine species at risk are assessed through the use of indicators in Section 7.6.9 Marine Fish and Fish Habitat and Section 7.6.12 Marine Birds. Consequently, the cumulative effects assessment on combined effects of the Project on indicator species at risk is conducted in Section 8.12 Marine Fish and Fish Habitat and Section 8.14 Marine Birds.

Similar to Section 7.0, although not all species at risk are discussed explicitly under each indicator, potential cumulative effects were assessed in consideration of all species at risk. The indicators used to represent marine fish and fish habitat and marine birds were carefully selected to ensure that the full range of potential Project effects and Project contribution to cumulative effects on marine species at risk was addressed and mitigation measures to reduce these effects will apply to all marine species at risk, not just the indicators. Sections 8.12 Marine Fish and Fish Habitat and Section 8.14 Marine Birds provide the significance rationale for applicable indicator species. No significant adverse cumulative effects on marine species at risk have been identified as a result of the pipeline and facilities component of the Project.

8.16 Summary of the Assessment of Potential Cumulative Effects

An evaluation of the significance of the Project's contribution to cumulative effects was conducted for each indicator determined to have a likely combined residual effect associated with the Project, as identified in Section 7.11. Furthermore, an evaluation of the significance of the Project's contribution to cumulative effects was also conducted for each element where more than one likely cumulative effect may act in combination.

The cumulative effects assessment followed a standard approach for each likely combined residual effect associated with the Project. Effects resulting from existing activities and predicted for reasonably foreseeable developments were considered individually and in combination with those associated with the Project. Existing activities that have contributed to cumulative effects include agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. Reasonably foreseeable developments that could contribute to cumulative effects include oil and gas developments (predominantly in Alberta), hydroelectric developments (in BC), transmission line developments, mining developments, transportation and infrastructure developments, utility activities, and marine developments and activities. Overall, the cumulative environmental effects associated with the construction and operation of the Project are similar to those routinely encountered during pipeline and facility construction in western Canada.

A number of potential cumulative effects associated with the following environmental elements were identified:

- physical elements such as soils and soil productivity, water quality and quantity, air emissions and acoustic environment;
- biological elements such as fish and fish habitat, wetland loss or alteration, vegetation, wildlife and wildlife habitat, and species at risk; and
- marine elements such as marine sediment and water quality, marine fish and fish habitat, marine birds and marine species at risk.

No potential cumulative effects were identified for marine mammals indicators since it was determined that there were no reasonably foreseeable developments that could act in combination with the Project to affect marine mammals in the Marine RSA.

The Project's contribution to a cumulative environmental effect is considered significant if the contribution is predicted to have a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. As identified in this cumulative effects

assessment, with the implementation of mitigation measures in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D), the Project's contribution to cumulative effects on the environmental indicators for the pipeline and facilities component of the Project is considered to be not significant.

8.17 References

8.17.1 Personal Communications

TERA wishes to acknowledge those people identified in the Personal Communications for their assistance in supplying information and comments incorporated in this report.

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