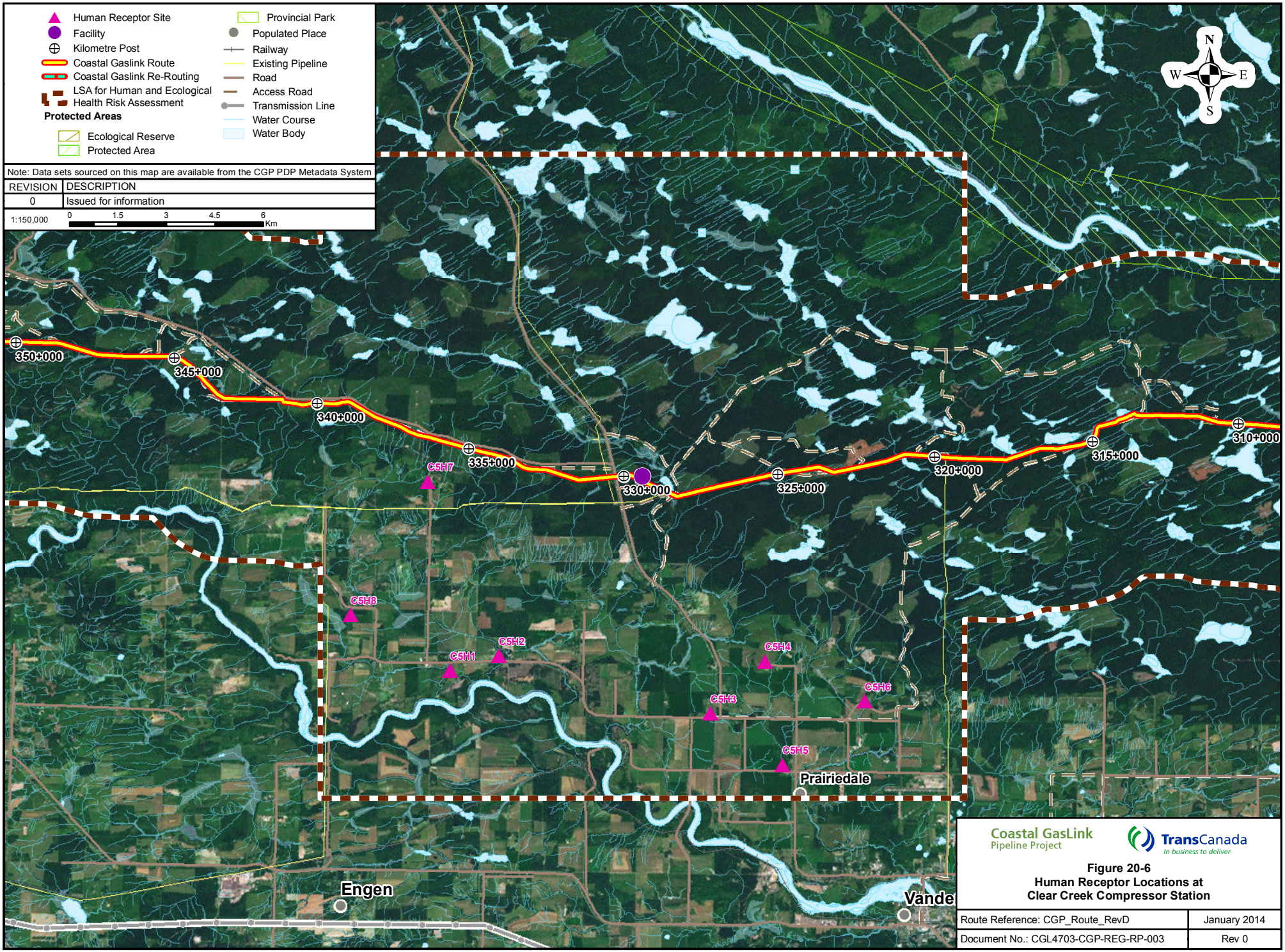

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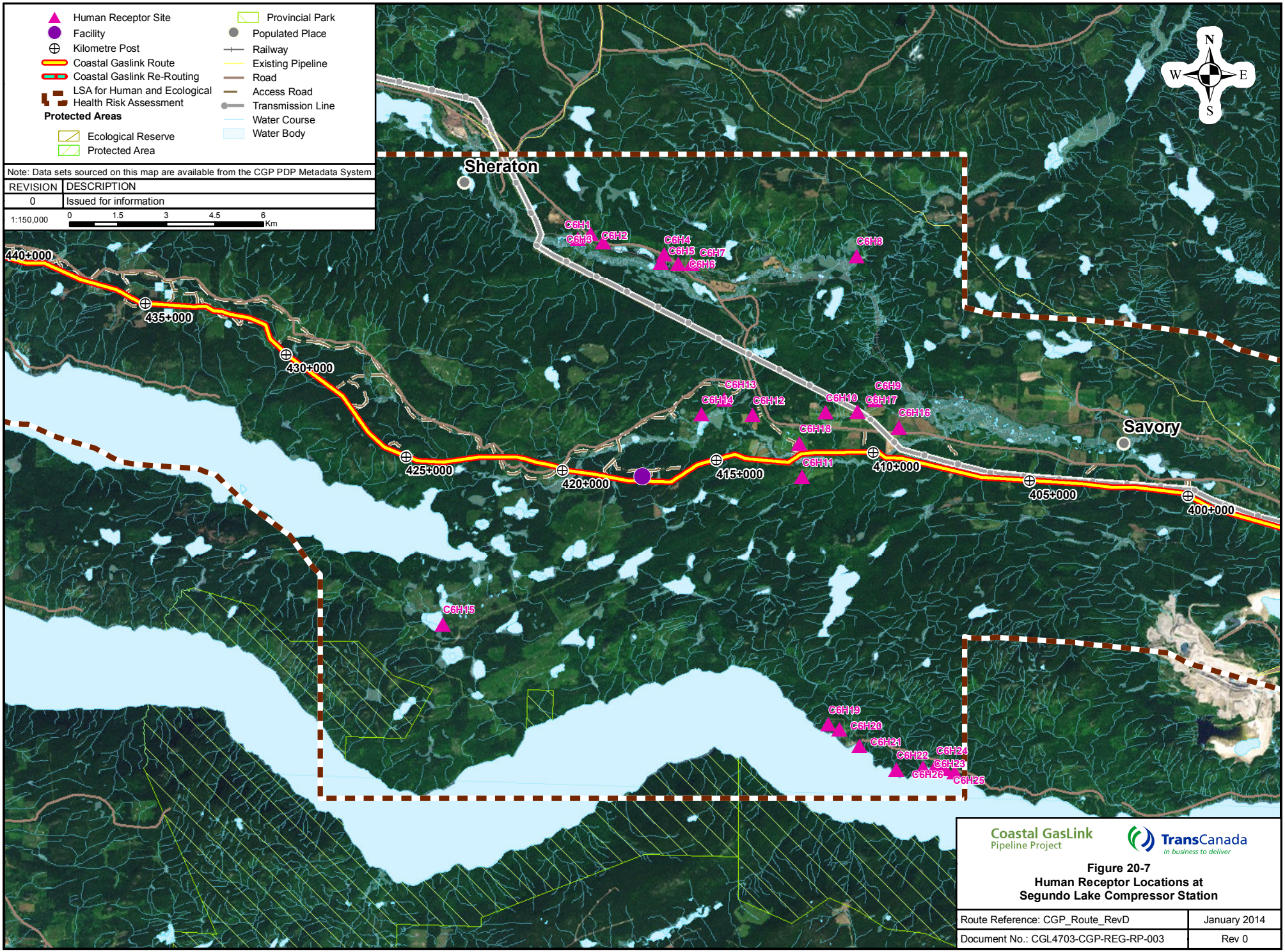

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Figure 20-7
Human Receptor Locations at Segundo Lake Compressor Station

Route Reference: CGP_Route_RevD	January 2014
Document No.: CGL4703-CGP-REG-RP-003	Rev 0

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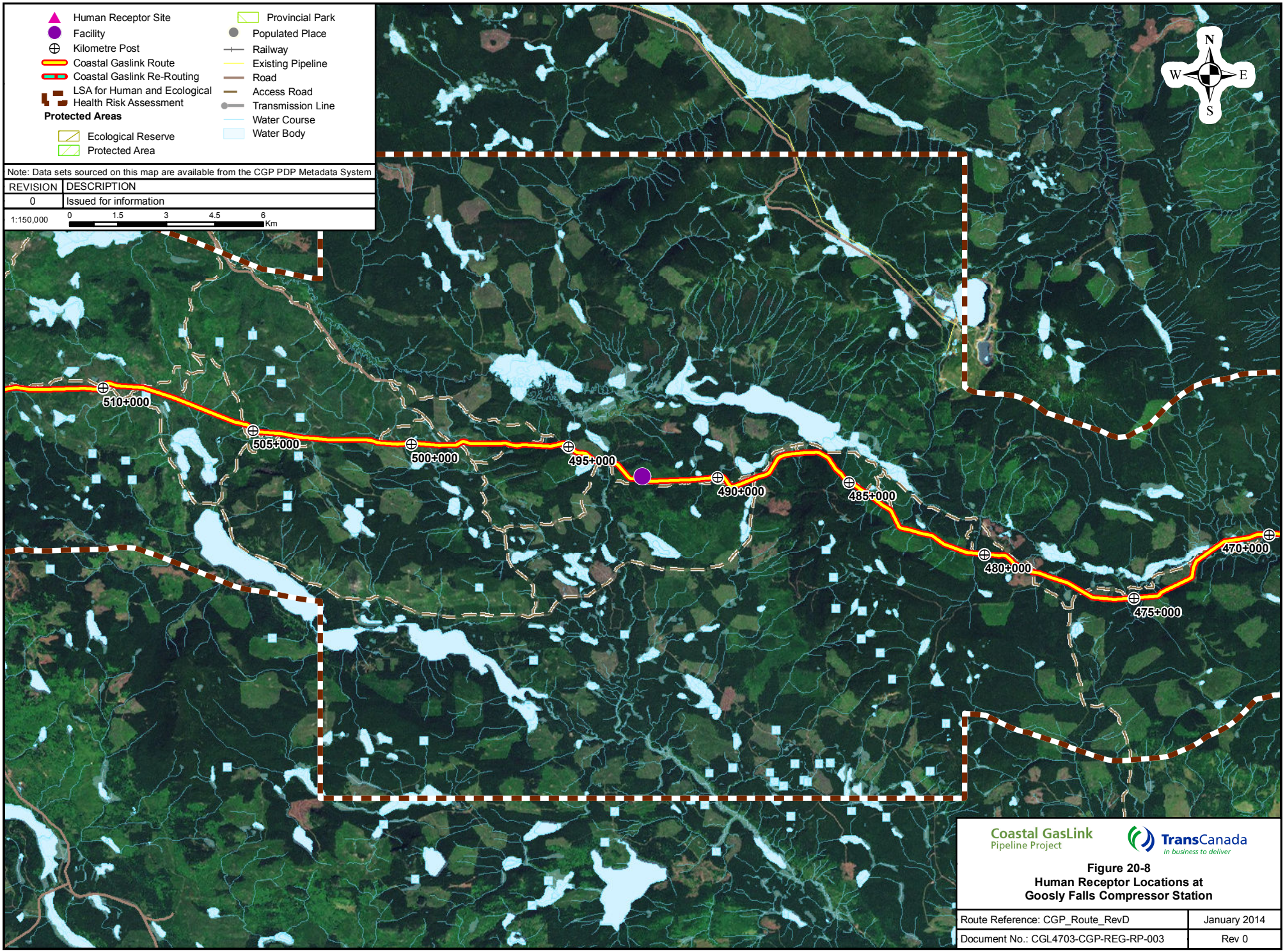

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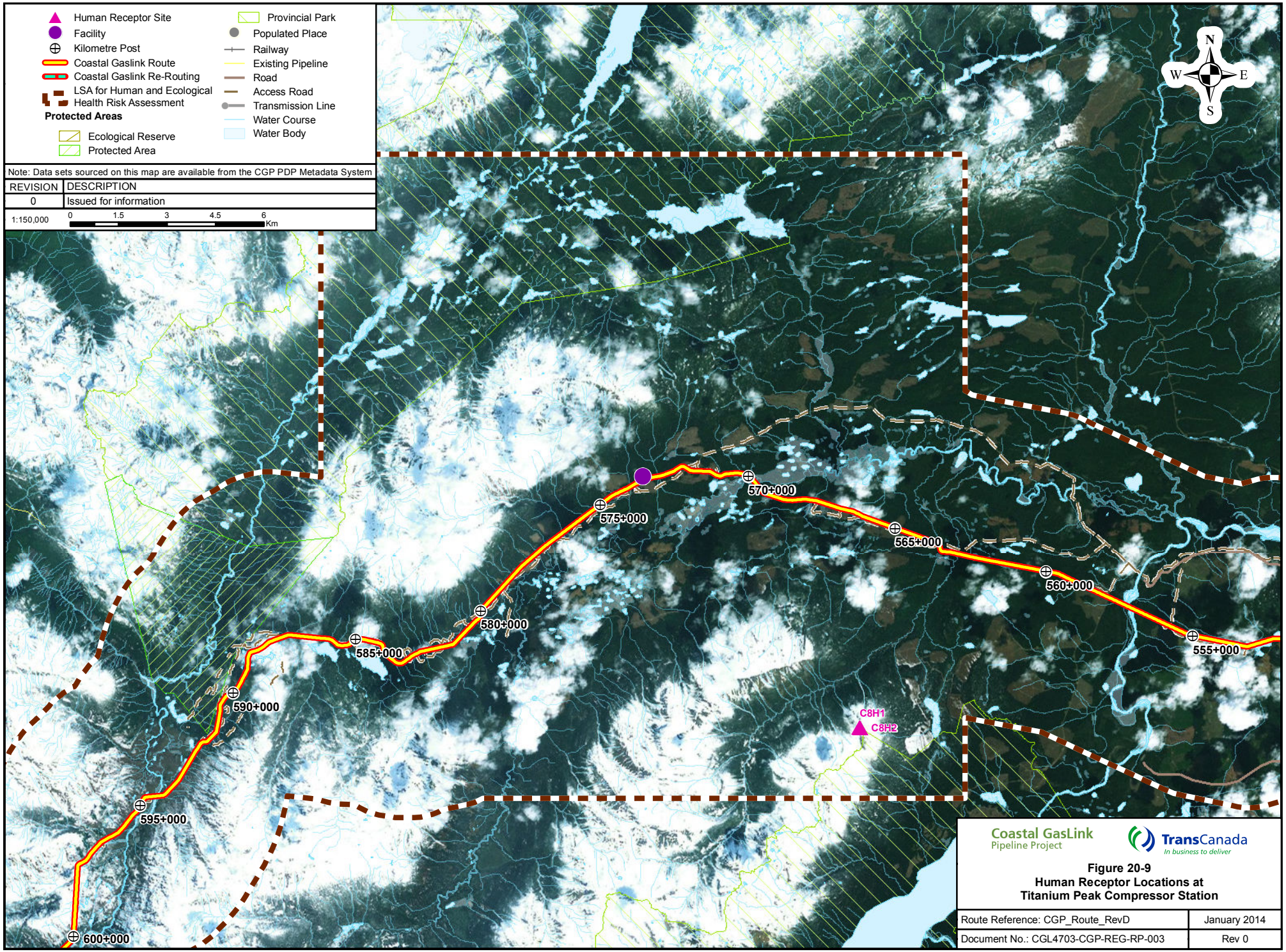
Human Receptor Site
Facility
Kilometre Post
Coastal Gaslink Route
Coastal Gaslink Re-Routing
LSA for Human and Ecological Health Risk Assessment
Protected Areas
Ecological Reserve
Protected Area
Provincial Park
Populated Place
Railway
Existing Pipeline
Road
Access Road
Transmission Line
Water Course
Water Body
Note: Data sets sourced on this map are available from the CGP PDP Metadata System
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Coastal GasLink Pipeline Project
TransCanada
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Figure 20-9
Human Receptor Locations at
Titanium Peak Compressor Station
Route Reference: CGP_Route_RevD
January 2014
Document No.: CGL4703-CGP-REG-RP-003
Rev 0
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20.4 BASELINE INFORMATION AND PROJECT SETTING

This section provides an overview of baseline health conditions over the region of BC traversed by the proposed Project. The section also discusses environmental, biological and Traditional Land Use information available from other baseline technical data reports, as they relate to human and ecological health conditions. An overview of baseline air quality, noise, surface water quality, vegetation and wetland communities, fish and fish habitat, and wildlife information is provided in the context of the proposed Project and incorporating available Aboriginal Traditional Knowledge (ATK), including TEK and TLU. The purpose of collecting ATK was to incorporate Aboriginal views and knowledge into the assessment of potential project-related health risks. The ATK and biophysical data provides relevant baseline information used in determining the required scope of assessment, and supports the evaluation of how proposed Project activities could affect human and ecological health risks.

The proposed route extends approximately 650 km through various major river basins across four physiographic regions of British Columbia. The physiographic regions include the Great Plains, the North and Central Plateaus and Mountains, the Interior Plateau, and the Coast Mountains. The ecoregions that the route passes through include the Sub-boreal Interior, Central Interior, and Coast and Mountains. Major rivers that are crossed include the Peace, Fraser, Skeena and Kitimat River basins. Baseline biophysical conditions vary widely across the length of the proposed route.

Baseline information is available on vegetation communities (Appendix 2-J), bird and wildlife assemblages (Appendix 2-L), hydrology (Appendix 2-H), and water quality (Appendix 2-I), and Traditional Land and Resource Use (Section 16).

20.4.1 Baseline Public Health

Public health status is a broad descriptor which includes the sum of all factors that influence public health. This may include the availability and accessibility of medical facilities, doctors, nurses and others who provide health services. It also includes social, economic, educational, environmental factors that influence a population's perception and definition of health.

British Columbia is divided into five Health Regions (Northern, Interior, Fraser, Vancouver Coastal and Vancouver Island). The Northern Health Region is further divided into the following Health Services Delivery Area (HSDA): Northwest, Northern Interior and Northeast. The proposed route is within the boundaries of the Northern Health Region and passes through all three HSDAs. When available, statistics are reported for each HSDA.

Overall, British Columbia has among the healthiest people in Canada with the highest provincial survival rate of heart disease, lowest incidence of cancer and the highest cancer survival rates (BC Ministry of Health 2013). However, residents of northern British Columbia on average tend not to be as healthy as residents in the south of the province. The five largest health issues in the Northern Health Region include cancer, cardiovascular disease, unintentional injuries, mental disorders and chronic respiratory disease (BC Ministry of Health 2013). The Northern Health Region also experiences higher rates of smoking, heavy drinking, obesity, physical inactivity, unemployment and lone-parent families compared to the provincial average. Population age structure also influences population health. The estimated total population in the Northern Health Region in 2010 was 286,819. The age structure included 26.1% infants and children (age 0 to 19), 62.7% adults (age 20 to 64) and 11.2% elderly (age 65+) (BC Cancer Agency 2011).

Occupational health concerns can also be different in northern BC compared to southern BC, particularly in relation to industrial camp worker stress and access to health care and social support. Various factors affect worker health including the nature of the work (e.g., camp shift work lasting 12 hr per day for 2 to 3 weeks or more; weather variability; lack of sunlight during winter), outdoor work-related hazards, communicable diseases, problematic substances, cleanliness and physical conditions of the camp, degree of remoteness (away from family and friends, boredom, lack of urban amenities), and access to health care and services (Northern Health 2012). Industrial camps can also negatively affect families and communities by placing stress on community health services and infrastructure.

Summary statistics for HSDAs and for BC-wide data are presented in Appendix B, Table B-1 and were compiled from Statistics Canada (2013a, 2013b) using the following databases: Vital Statistics (data from 2007 to 2009), Statistics Canada Community Health Survey (data from 2010), Statistics Canada Cancer Registry Database (data from 2009), and Statistics Canada Discharge Abstract Database (data from 2011). These baseline health statistics relate to:

- General health and well-being
- Overall mortality rates
- Specific mortality rates (cancers, circulatory, respiratory, unintentional, suicides, premature [including homicides], and avoidable mortalities)
- Cancer incidence rates
- Mental health disease incidence rates
- Obesity rates
- Workplace health

General Health and Well-Being

Perceived health may be interpreted by the population as including physical, mental and social well-being in general. It may capture measures of health that are not reflected in incidences of injury, disease and mental health issues. Perceived health is based on individuals aged 12 and over who report perceiving their own health status as being excellent, very good, fair or poor. Between 53% and 61% of people in the Northern Health Region perceive their health to be very good or excellent, which is similar to the provincial average of 60% (Appendix B, Table B-1).

Life expectancy at birth is the number of years a person would be expected to live in total. Life expectancy at age 65 is the expected additional number of years a person would be expected to live. Both measures are widely used as an indicator of population health as defined by Health Canada and Statistics Canada. Life expectancies in the Northern Health Region are a few years lower than the provincial average

Mortality Rates

Mortality rates are important indicators of general society well-being. All types of mortality were reported to be higher in the Northern Health Region compared to the province overall (Appendix B, Table B-1). This included infant mortality rates, overall mortality, cancers (prostate, colorectal and lung cancers; breast cancers were at similar rates to the province), respiratory diseases, unintentional (accidents), suicides, premature mortality, and avoidable mortality from both preventable and treatable diseases. Rates of suicide and self-inflicted injuries causing death are indicators of mental illness or perceived mental health. Unintentional deaths include accidents, while premature deaths include non-accidents such as homicides. Avoidable mortality from preventable and treatable causes are indicators of overall health status associated with the availability and effectiveness of health care.

Information regarding mortality rates are only indicators of general well-being in a population. The rates do not necessarily indicate any causal effect from social or economic issues and are not appropriate for use in such a manner. The variations in mortality rates between HSDAs do not necessarily suggest significant differences in the current health status of these regions.

Cancer Incidence

The underlying basis of cancer is genetic in nature. Risk factors for cancer include genetic predisposition (i.e., family history of cancer), diet, exercise, smoking, infection (e.g., human papilloma virus), and exposure to ionizing radiation and carcinogenic substances.

Approximately 45% of men and 40% of women will develop cancer within their lifetimes (Canadian Cancer Statistics 2013). The annual incidence rate of cancers is

0.37% for BC and 0.40 to 0.47% for the Northern Health Region (Appendix B, Table B-1).

There are natural differences in cancer rates in various organs. Certain areas of the body are more likely than others to be exposed to ionizing radiation and chemical carcinogens that could affect cancer risk. Certain tissues (e.g., skin) are also more likely to develop cancer than other tissues because of differences in rates of cell growth and replication or differences in the number of events needed to cause particular cancers. Variations in cancer rates in different organs from different regions should not be interpreted as a significant difference.

Cardiovascular Disease

Cardiovascular diseases injure the cardiovascular system including the heart, blood vessels of the heart, or the veins and arteries throughout the body and brain. These diseases include atherosclerosis (i.e., hardening of the arteries), strokes and heart attacks and other forms of heart failure. The risk factors for cardiovascular diseases include smoking, alcohol, physical inactivity, obesity, high blood pressure, high blood cholesterol, diabetes and air quality (Public Health Agency of Canada 2009). The US Environmental Protection Agency reports that air quality, particularly particulate matter less than 2.5 microns ($PM_{2.5}$) can have detrimental effects on human health related to the heart, nervous and vascular systems (US Environmental Protection Agency 2012). In Canada, cardiovascular disease is a leading cause of mortality. Self-reported incidence of heart disease in Canada is approximately 4.8%. British Columbia ranks the third lowest for incidence of heart disease (3.9%) (Public Health Agency of Canada 2009).

Neurodegenerative Disease

Neurodegenerative diseases are debilitating conditions in which nerve cells are progressively damaged and/or lost, resulting in problems with movement and/or mental functioning. Neurodegenerative diseases include Alzheimer's, Parkinson's, multiple sclerosis, Huntington's and motor neuron disease. Risk factors for Alzheimer's and Parkinson's disease include age, heredity, gender and exposure to certain chemicals; particularly chemicals affecting the nervous system such as pesticides. For other neurodegenerative diseases, risk factors often include a combination of genetic and environmental influences.

Alzheimer's disease is the most common neurodegenerative disease and affects approximately 1 in 11 Canadians over the age of 65 (approximately half a million people). In BC, there are approximately 70,000 people living with Alzheimer's and nearly 10,000 of these people are under the age of 65 (Alzheimer Society 2013). Parkinson's disease is the second most common neurodegenerative disease affecting approximately 1% of Canadians over the age of 65. There are approximately 34,000

to 60,000 cases of Parkinson's in Canada and 4,500 to 8,000 cases in British Columbia (WorkSafe BC 2011).

Mental Health

Perceived mental health statistics include the population aged 12 and over who reported their own perception of mental health. Perceived mental health provides a general indication of people suffering from mental disorders or issues of a lesser magnitude including mental or emotional problems and distress, which are not necessarily reflected in perceived health. Perceived mental health was very good or excellent in 71% of BC respondents and 63 to 73% of those asked in the Northern Health Region (Appendix B, Table B-1). The rate of hospitalization due to mental illness was much higher in northern BC (1.02%) than in BC overall (0.59%).

Mental illness requiring hospitalization should not be interpreted to be the result of any causative agent. Confounding factors may include lack of hospitals or mental health institutions to treat individuals, difference in service delivery models, and accessibility of specialized, residential and ambulatory services to address mental illnesses. Therefore, this indicator cannot be used to estimate the prevalence of mental disorders in the general population. Some mental illnesses requiring hospitalization include schizophrenia, delusional or psychotic disorders, mood affective disorders, anxiety disorders and personality and behaviour disorders.

Obesity

Incidence rates of obesity and overweight are based on Health Canada's weight classifications using the Body Mass Index. The Body Mass Index is a method of classifying body weight according to health risk. This method defines individuals as underweight, normal weight, overweight or obese. There are many risk factors that influence obesity rates including genetic predisposition (i.e., family history of obesity), smoking, diet, exercise and certain diseases. Obesity is linked with many types of chronic diseases including hypertension, type II diabetes, cardiovascular disease, osteoarthritis and certain types of cancer including esophageal, breast, colon, kidney, pancreas and possibly other types. Obesity is also linked with general health and well-being and quality of life.

The rate of obese and overweight individuals in the Northern Health Region ranged from 55 to 62% compared to the provincial rate of 45% (Appendix B, Table B-1).

The overall trend across Canada is that rates of obesity are rising annually.

Workplace Health and Safety

The frequency of workplace injury in British Columbia has been steadily declining since 2003. In British Columbia, the average injury rate is 2.3 claims per 100 person-years. Injury rates in the Northwest and Northeast HSDA are below the provincial

average, while the Northern Interior has injury rates equivalent of the provincial average. In British Columbia, 38% of all claims are considered serious injury claims. The lowest percent of serious injury claims is in the Northwest HSDA (33%), followed by Northeast (38%). Northern Interior experiences the highest rate of serious injury claims among all claims filed (46%). The most common serious injury claim was overexertion related to bodily motions, accounting for 45%. The most common types of injury (all severity levels) were back strain (22%) and other types of strain (34%) (Worksafe BC 2012).

Fatalities as a percentage of new injuries have remained steady in BC. Fatality rates as a percentage of injuries range between 0.12% to 0.16% between 2003 and 2012. Annually, the majority of workplace fatalities were related to asbestos exposure, followed by other accidental injuries and motor vehicle incidents (Worksafe BC 2012).

Prevention activities are important to reducing incidences of workplace injury. Activities include site inspections, education, consultations and investigation efforts. Hours dedicated to prevention activities has been steadily increasing among BC employers since 2008 (Worksafe BC 2012).

20.4.2 Traditional and Recreational Land and Resource Use

The proposed Project occurs in areas important for a variety of traditional land uses, including hunting, trapping, fishing, gathering vegetation, and cultural pursuits year-round.

Three wildlife management regions extend over the proposed route, relevant to land users who may be travelling in the vicinity of proposed Project infrastructure for limited periods and may thus have the potential to be exposed to Project emissions or discharges (Table 14-12). The primary species targeted by hunters and guide outfitter operations in these regions include black bear, elk, mule deer, moose, and white-tailed deer, with lesser numbers of mountain goat, wolf, grizzly bear, lynx, cougar, wolverine hunted (Table 14-17). Fifty three trapping territories extend over the proposed route. Three fish management regions are traversed by proposed route include Omineca A, Omenica B and Skeena regions. Approximately 31 lakes and 11 popular rivers within the Traditional Land and Resource Use (TLRU) LSA provide fishing opportunities to catch trout, Arctic grayling, whitefish, burbot, kokanee, northern pike, walleye, yellow perch, and white sturgeon (Section 14.4.4). A wide variety of vegetation are harvested by Aboriginal groups from lands along the proposed route.

Domestic water supply in the Land and Resource Use LSA is available from surface water and groundwater sources for drinking water, domestic, industrial, agricultural or recreational purposes. Based on hydrologic evaluation of surface and groundwater

systems over the HHERA LSA, there were no overlaps between the proposed route and wells, community watersheds, or points of diversion.

20.4.3 Surface Water and Sediment Quality

Surface water quality was characterized from single grab samples collected at 67 representative stream crossing sites along the proposed route (Appendix 2-H). Surface water quality data obtained from the BC MOE Environmental Monitoring System (EMS) database supplemented this dataset. These baseline data were screened against Health Canada's Guidelines for Canadian Drinking Water Quality (Health Canada 2012) to evaluate potential health risks to people. In Section 7, Aquatic Environment, the same surface water quality data were screened against water quality guidelines for the protection of aquatic life (WQG-FAL), indicating background exceedances of cadmium, vanadium, antimony, conductivity and sulphate. The screening of water quality using WQG-FAL also serves to flag chemical of potential concern for ecological receptors linked to the aquatic ecosystems within the HHERA LSA (Ecological Health Section 20.6).

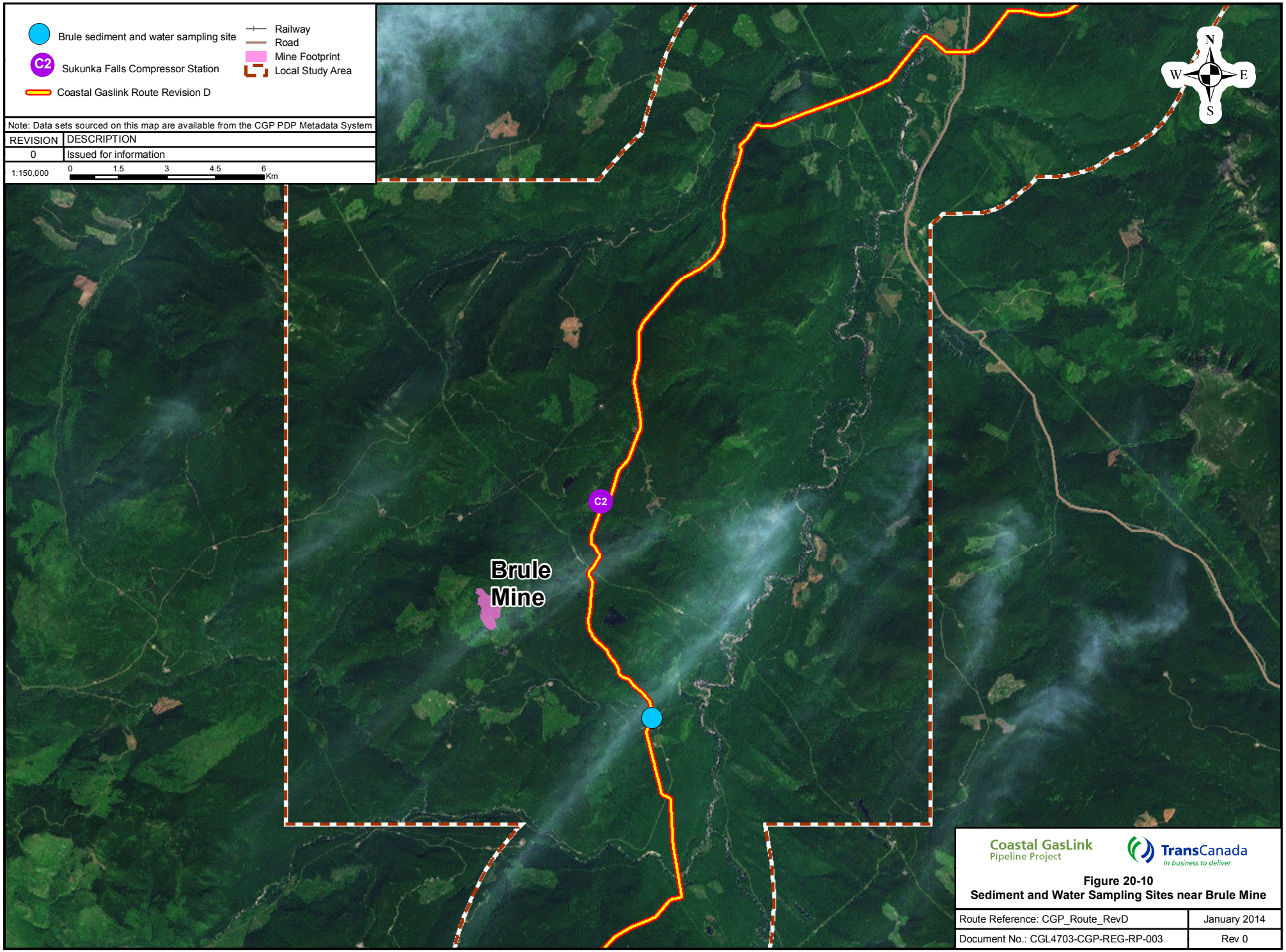
The drinking water quality guidelines for the contaminants of concern for this proposed Project are based on aesthetic objectives including changes in taste, odour, or staining effects on plumbing, and do not correspond to toxicological thresholds for human health. The baseline water quality data results indicate natural exceedance of the aesthetics-based guidelines for aluminum, iron, manganese in approximately 20% of samples. One sample of the 67 samples collected was above the health-based guideline for total manganese (site 242 in Nechako Plateau region), and one sample exceeded the health-based guideline for total selenium (site 21C in Southern Rocky Mountain Foothills region). No polycyclic aromatic hydrocarbons (PAH) were detected in any of the samples. Approximately 95% of samples showed no extractable petroleum hydrocarbons (EPH). Where detected, the baseline EPH concentrations were quite low (within a factor of five of the method detection limit). Samples from two of the sites (Southern Hazelton Mountains hydrologic zone) listed within the BC MOE EMS database showed exceedance of electrical conductivity and sulphate.

A baseline survey of sediment quality was conducted in June 2013, at three locations along the pipeline to characterize historic contamination levels from active and decommissioned mining projects (Figures 20-10, 20-11 and 20-12; Appendix B, Table B-2). These sites include:

1. Brule stream site – UTM Zone 10 U. Easting 578963; Northing 6136416. The stream site is located along the proposed route at KP 90.5, which is downstream of the Brule coal mine (Figure 20-10). The mine is located approximately 6 km west of the proposed route and 1.5 km south of the proposed Sukunka Falls compressor station.

2. Endako stream site – UTM Zone 10 U. Easting 369280; Northing 5993846. The stream site is located along the proposed route at KP 389.0, which is the closest downstream site of the Endako molybdenum mine operating since 1965 (Figure 20-11). The mine is located approximately 6 km southwest of the stream site. However, the closest point between the proposed route and the Endako mine is 2 km.

3. Equity lake site – UTM Zone 9 U. Easting 673386; Northing 6005318. The water sampling site is located 200 m north of KP 485.0 at Goosly Lake (Figure 20-12). Goosly Lake is the receiving environment for surface runoff from the decommissioned Equity silver mine. The mine is located approximately 5 km northeast of the sampling site and 9 km east of the proposed Goosly Falls compressor station.



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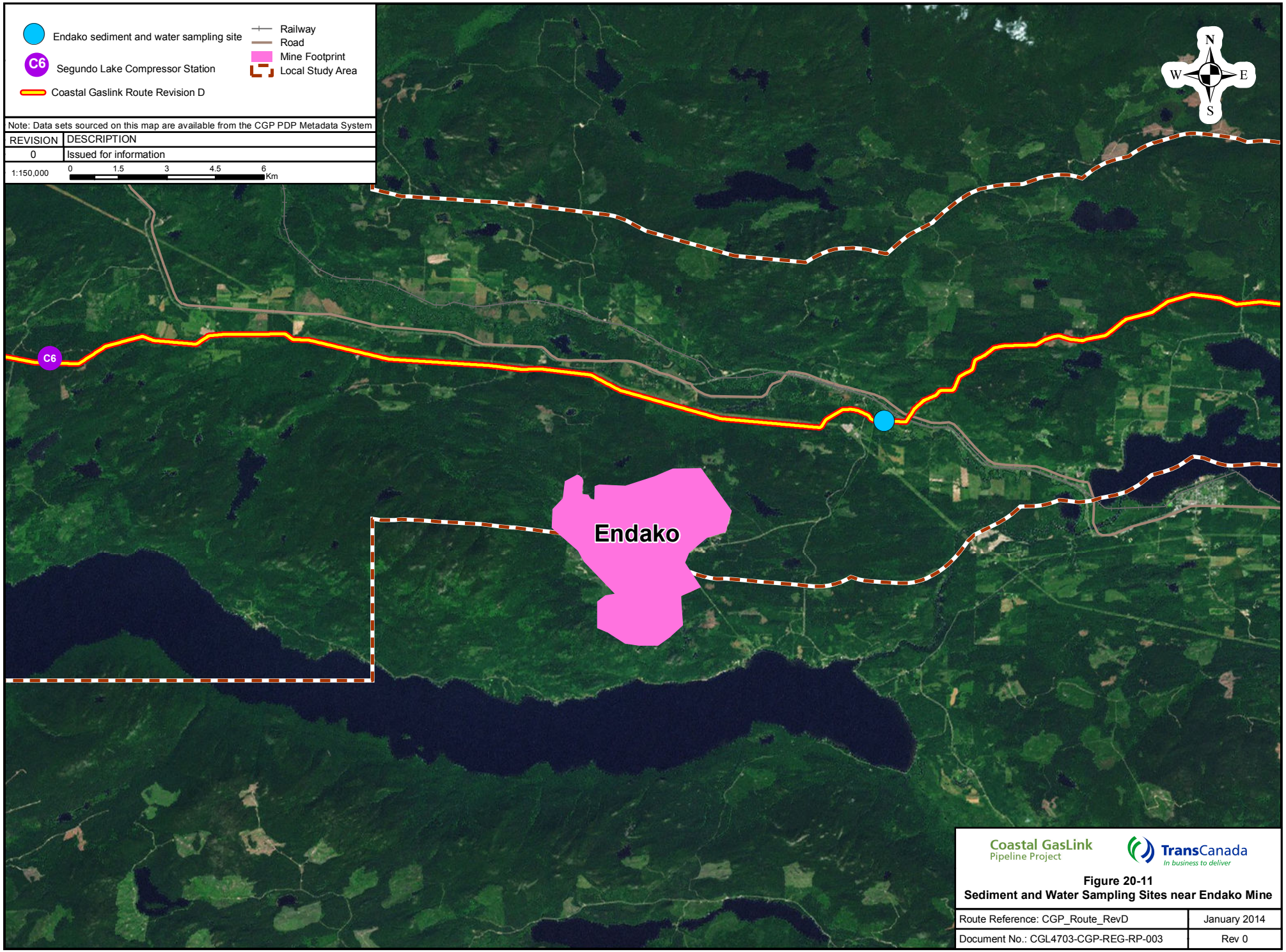

Note: Data sets sourced on this map are available from the CGP PDP Metadata System

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Figure 20-11
Sediment and Water Sampling Sites near Endako Mine

Route Reference: CGP_Route_RevD	January 2014
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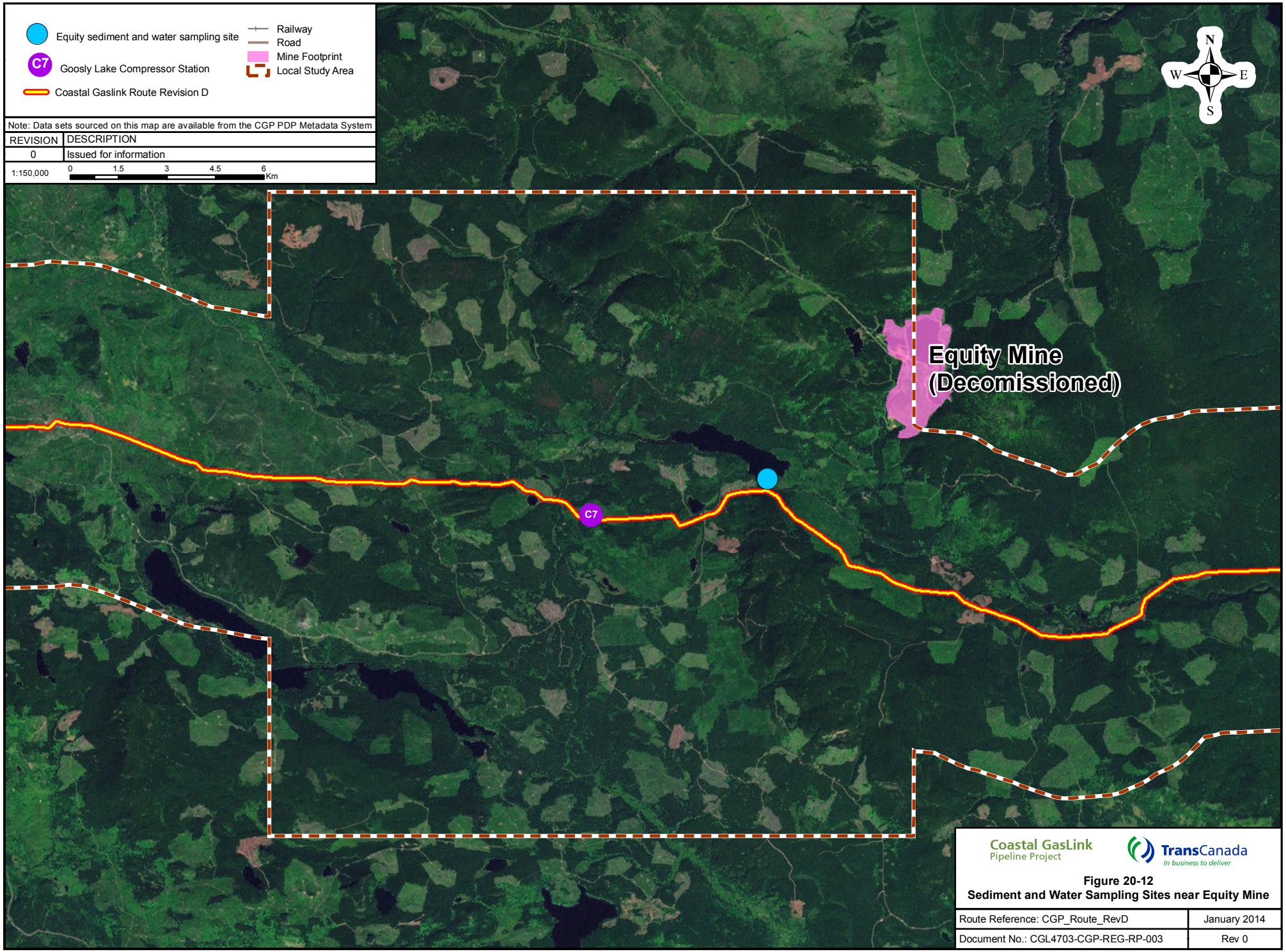

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Figure 20-12
Sediment and Water Sampling Sites near Equity Mine

Route Reference: CGP_Route_RevD	January 2014
Document No.: CGL4703-CGP-REG-RP-003	Rev 0

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Stream and lake sediment was sampled at these locations due to public concerns for the aquatic environment raised by members of the Working Group as well as Aboriginal groups and the public as result of historical contamination caused by the Equity silver mine and landfills, and the potential for pipeline construction and operations to disturb the contaminated sediments in the aquatic environment. The Brule underground coal mine and Endako molybdenum mine were also identified as active mining projects in the vicinity of the proposed Project and closest watercourse to these mines crossed by the proposed Project were included in the sediment sampling program.

Baseline sediment chemistry data was used to quantify existing historic contamination. This data may be used to support future monitoring programs in relation to concerns about cumulative environmental effects. Surface water quality samples were also collected at these locations.

Three replicate samples were collected from spatially separated locations at each site. Sediment pH, organic carbon, total sulphur, and metals were analyzed for each sample. PAHs, light extractable petroleum hydrocarbons (LEPH) and heavy extractable petroleum hydrocarbons (HEPH) were analyzed in one replicate per site.

The sediment quality data was screened against CCME sediment quality guidelines for the protection of freshwater aquatic life (Appendix B, Table B-2). All samples were coarse grained, and pH varied from 6 at Goosly Lake, 7.2 at the Endako site and 8.5 at the Brule site. No LEPH was detected at any site, while HEPH was detected at the Goosly Lake site.

Cadmium exceeded the CCME freshwater interim sediment quality guideline (ISQG) in all three samples at Brule site but did not exceed at the other two sites. Arsenic slightly exceeded ISQG in all samples from the Endako site. In general, metal concentrations were highest at the Brule mine compared to the other two sites. reflecting historic mine activity or naturally elevated levels of mineralization in this area.

Most PAHs were not detected in any of the samples. Endako and Goosly Lake sites showed almost no detection of any PAH. The Brule site had measurable concentrations of eight lighter molecular weight PAHs. Concentrations of chrysene, fluorine and naphthalene exceeded the CCME ISQG, while phenanthrene and 2-methylnaphthalene exceeded the CCME freshwater probable effects level (PEL). This indicates organic contamination in this stream which may be related to the use and storage of diesel fuel on-site or the release of the chemicals from mined coal.

20.4.4 Air Quality and Noise

Baseline noise and air quality data are reported in Appendices 2-D and 2-E, respectively.

The baseline air quality is based on data from four northern BC communities near two of the proposed compressor stations. These are conservative baseline values because they were taken near urban emission sources which are not typically reflective for a rural compressor station location.

The 1-hr 98th percentiles (values that will be exceeded 2% of the time on average) indicate that baseline air quality are well below the most stringent of Canadian and BC Ambient Air Quality Objectives (AAQO), reflecting remote rural settings:

- 3.7 ug/m^3 SO_2 (representing less than 1% of the most stringent AAQO)
- 44.2 ug/m^3 NO_2 (representing 11% of the most stringent AAQO)
- 20.9 ug/m^3 $PM_{2.5}$ (representing 62% of the most stringent AAQO)
- 1,077 ug/m^3 CO (representing 8% of the most stringent AAQO)

Baseline ambient sound levels (ASL) were established following BC OGC and Health Canada guidance using conservative estimates combined with field measurements of sound levels. Other energy facilities were within the acoustic LSA of only one of the eight proposed compressor station locations (KP 0 Wilde Lake compressor station). At this station, the baseline ASL from eight receptor locations was 45 dBA (daytime), ranged from 35 to 38 dBA (nighttime), and ranged from 45 to 47 dBA (day-night average sound level). Conservative estimates of baseline ASL were applied to the other seven proposed compressor station locations following Health Canada guidance (35 dBA Ldn), and BC OGC guidance (45 dBA Leq-day and 35 dBA Leq-night).

20.4.5 Vegetation and Wetlands

Publicly available ATK information indicates that some Aboriginal groups routinely collect medicinal and food plants in their territories. Medicinal plants were used for the treatment of pain, diabetes, bronchitis, diaper rash, nausea, cold or flu and diarrhea as well as sleeps aids, wound treatment, and detoxification (NGPLP 2010).

Vegetation plays an important role in supporting a healthy ecosystem, providing food and shelter for wildlife. Lichen are an important indicator of ecosystem health and a food source for caribou. Studies completed for other development projects in the vicinity of the proposed route indicated that quality and access to berries in this region has been negatively affected by chemical herbicide application and clear cutting. Aboriginal group members have also expressed concerns about herbicide and pesticide use for vegetation clearing.

Utilitarian vegetation TEK described by participants during the field studies for the proposed Project included use as a navigational marker, for building canoes, for cooking, for carving and building totems, to make bows, arrows, and rattles, for smoking meat and fish and for carving storytelling and ceremonial masks (Appendix 2-J).

The desktop review of ATK for wetlands showed that effects on wetlands were a primary concern of Aboriginal groups. Aboriginal concerns include potential wetland effects from habitat loss, reduced productivity of rare medicinal plants, and effects on soil causing potential contamination of runoff from development within wetlands. Aboriginal group participants recognize wetlands as important habitat for fish, wildlife, waterfowl, songbirds, migratory birds, and serve as sources of food and medicinal plants.

According to previous studies completed for other development projects in the vicinity of the proposed route, groundwater, referred to as “healing waters”, is perceived to be affected by pipeline trenching and installation activities (NGPLP 2010). Other concerns focused on wetland construction potentially affecting prime habitats for many wildlife and plant species that sustain Aboriginal groups culturally and nutritionally, and the potential for degradation of surface water (NGPLP 2010) (Appendix 2-K).

20.4.6 Fish

Baseline fisheries studies indicate that 52 species of fish are distributed within the four major watersheds including the Peace, Thompson, Skeena and Kitimat systems. Rainbow trout dominated all systems. The Skeena and Kitimat fish communities are comprised mainly of salmonids. The Fraser showed similarities to these western systems but had the highest diversity of fish and included white sturgeon. Fish assemblages in the Upper and Lower Peace River basins differed more broadly from the other basins (Appendix 2-G).

The target species and degree of fish harvest by Aboriginal peoples also varied through the four watersheds. A review of available ATK for fish and fish habitat identified that fish are integral to Traditional diets and cultural practices of many Aboriginal groups. Water quality is considered of utmost importance to the well-being of ecosystems in the Peace River region (AMEC 2008), and this view is shared amongst Aboriginal groups in the other systems including the Fraser River basin (Whelen and Bradley 2010, WRGI 2007, BC EAO 2008), and the Skeena and Kitimat Rivers (Whelen and Bradley 2010). Fish are a crucial part of Aboriginal traditional culture, both as a social activity and a source of food.

Char, lake trout, pike, sucker, rainbow trout, and whitefish were listed as important sources of food for Aboriginal groups within the Peace River drainage basin (AMEC 2008). Aboriginal groups within the Fraser River basin are concerned that

development may contaminate rivers and lakes and that pipeline construction may disturb groundwater, and downstream environments. Concerns include the potential for construction to cause sedimentation and turbidity which could affect fish populations downstream of watercourse crossings, in particular Stuart River salmon, and a reduction of aquatic diversity. In the Skeena watershed, Aboriginal groups are concerned that construction activities may affect an already diminishing salmon population and may also restrict their ability to carry out cultural practices (NGPLP 2010). Within the Kitimat and Clore River basins, Aboriginal groups are concerned that construction activities adversely affect fish spawning and fish habitat (NGPLP 2010). Overall, concerns were raised regarding effects of development on water quality and the potential for downstream contamination resulting in direct and indirect effects on fish populations and available fish harvests for traditional land use, cultural and food purposes (NGPLP 2010).

20.4.7 Wildlife

Wildlife are an important cultural and functional resource for Aboriginal groups spanning the proposed corridor, based on ATK research for the Land Resource Management Plans (LRMP) of Dawson Creek, Prince George, Vanderhoof, Lakes, Morice, and Kalum areas (Applied Aquatic Research 2007, Office of the Wet'suwet'en 2013). Traditional harvesting, including hunting and trapping of a variety of animals and harvest of birds, continues to be an important element of livelihood and culture of some communities in the Dawson Creek and Prince George LRMPs, where moose is most commonly hunted but many other animals also serve as sources of food, fur and cultural resources.

Within the Vanderhoof, Lakes, Morice and Kalum LRMP areas, Aboriginal groups are generally concerned about the potential effects of development on animal welfare. Aboriginal groups in these areas have specific concerns regarding the effect of development on wildlife, effects on cultural activities such as hunting, fishing, trapping, gathering berries and medicines. Aboriginal groups are also concerned about the potential effect of development to grizzly bear, mountain goat and caribou habitat (Applied Aquatic Research 2007). Other concerns include the need for wildlife monitoring, wildlife corridors, and mitigation of roadkill (Appendix 2-L).

20.5 HUMAN HEALTH EFFECTS ASSESSMENT

20.5.1 Potential Adverse Effects, Mitigation and Environmental Management Strategies

The potential adverse health effects associated with the construction, operations, decommissioning and abandonment of the proposed Project on human health were based on the results of a screening level risk assessment. This considered available ATK, TEK, and TLU information, the results of consultation with potentially affected Aboriginal groups, and the technical assessments prepared for other disciplines (Section 16, and Appendices 2-D, 2-E, 2-G, 2-I, 2-J, 2-K and 2-L).

Much of the mitigation listed in the assessment of related valued components acts to mitigate potential adverse health effects on people or to ecological receptors by controlling the release or potential for spills of contaminants, dust or noise. This includes:

- mitigation of noise levels to avoid disturbance to local residents or to wildlife (Section 6.5)
- mitigation of air emissions and fugitive dust (Section 6.6)
- mitigation of sedimentation and erosion in freshwater environments from construction and operation of roads, dust from topsoil stockpiles, instream crossings and other structures, to avoid potential adverse effects on surface and groundwater quality (Section 7.7, 7.8 and 21.9)
- mitigation of surface transport of blasting residues into local waterways (Sections 7.5 and 7.7)
- mitigation of potential acid rock drainage (ARD) generation leading to potential adverse water quality effects (Section 5.7)
- mitigation of potential for minor spills, and adequate storage and transport protection, planning and spill contingency for fuels and chemicals (Section 21.2)

Given the mitigation listed above, there is no additional mitigation recommended specifically to protect human health.

The following potential health concerns and issues have been raised by Aboriginal groups, public and regulatory stakeholders, or are based on the professional judgment and past project experience:

1. Degradation of ambient air quality from air emissions or fugitive dust, potentially leading to adverse respiratory and irritant effects in sensitive individuals.
2. Increase noise levels and introduction of low frequency or blasting noises that may disturb nearby residents.
3. Degradation of local water quality or sediment quality in streams and lakes resulting from minor fuel spills, erosional/dust inputs, blasting residue undergoing

surface transport to local streams, contaminated groundwater inputs (from other industries, or release waters from hydrostatic testing at crossings) accessed during digging and trenching, or potential ARD. Concern that these changes to water or sediment quality could be associated with potential contaminant exposure to people based on drinking water and recreational water uses.

4. Degradation of the quality of traditional and country foods resulting from minor fuel spills, erosional/dust inputs, contaminated groundwater inputs, handling of herbicide-treated trees or ARD, resulting in potential contaminant exposure to plants, fish or animals that leads to trophic transfer to people consuming local traditional and country foods.

These potential health concerns were evaluated using a conceptual site model to determine if potential health risks could exist in relation to these health concerns. For a human health risk to be plausible, three elements are required:

1. A stressor (i.e., hazardous chemical or noise) must be present
2. A receptor (i.e., humans) must be present
3. An exposure pathway for the stressor to contact the receptor must be present

While the presence of all three elements are required for a health risk to be present, it does not imply there will be a health risk. An exposure to a stressor must be of substantial magnitude and duration in order to elicit a biological effect with a reasonable level of confidence.

Based on the location and nature of the proposed Project in relation to TLRU human receptor locations present within the HHERA LSA, and proposed air emission rates and typical associated noise levels, both air quality and noise KIs for human health were carried forward in the assessment (Appendix B, Table B-3). Potential adverse air quality effects arising from fugitive dust will be mitigated for all Project phases through appropriate controls of air particulate matter emission rates. Potential emissions from burning slash timber will occur as localized events, occurring once along each section of the route. The potential air emissions from garbage incineration will be avoided by prohibiting this activity for the proposed Project (Section 6.6). In addition, a number of measures to control the release of dust during digging, trenching and road construction and traffic will be implemented. It is reasonable to conclude that potential changes to local air quality or noise levels could be associated with potential adverse human health effects.

Table 20-3: Potential Adverse Effects, Mitigation and Residual Adverse Effects of the Proposed Project on Human Health

Project Phase	Potential Adverse Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Effect(s)
Air Quality Effects on Human Health				
Construction	Increased concentrations of one or more Criteria Air Contaminants (CACs) above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals	All Project components	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals.
Operations	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals.	All Project components	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals.
Decommissioning and Abandonment	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive individuals.
Noise Effects on People				
Construction	Increased noise levels above PSLs and background, leading to disturbance of residents.	All Project components	Section 6.5.2	Increased noise levels above PSLs and background, leading to disturbance of residents.
Operations	Increased noise levels above PSLs and background, leading to disturbance of residents.	All Project components	Section 6.5.2	Increased noise levels above PSLs and background, leading to disturbance of residents.
Decommissioning and Abandonment	Activities for removal of ground facilities (valve and compressor stations) may increase noise levels above PSLs and background, leading to disturbance of residents. No potential adverse noise effects from the pipeline, which will be abandoned in place with no disturbance.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Section 6.5.2	Increased noise levels above PSLs and background, leading to disturbance of residents.

Table 20-3: Potential Adverse Effects, Mitigation and Residual Adverse Effects of the Proposed Project on Human Health (cont'd)

Project Phase	Potential Adverse Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Effect(s)
Degradation of Water or Sediment Quality				
Construction	Increased concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from topsoil stockpiles, erosion of trenches or roadways, or leaching from ARD or historic contaminated site sources. This could lead to potential adverse health effects on people via drinking water or recreational water use.	All Project components	Sections 5 and 7	No residual effect has been identified.
Operations	Increased concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from topsoil stockpiles, erosion of trenches or roadways, or leaching from ARD or historic contaminated site sources. This could lead to potential adverse health effects on people via drinking water or recreational water use.	All Project components	Sections 5 and 7	No residual effect has been identified.
Decommissioning and Abandonment	Activities for removal of ground facilities (valve and compressor stations) may increase concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from topsoil stockpiles, erosion of trenches or roadways, or leaching from ARD or historic contaminated site sources. This could lead to potential adverse health effects on people via drinking water or recreational water use. No potential adverse effects from the pipeline, which will be abandoned in place with no disturbance.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5 and 7	No residual effect has been identified.

Table 20-3: Potential Adverse Effects, Mitigation and Residual Adverse Effects of the Proposed Project on Human Health (cont'd)

Project Phase	Potential Adverse Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Effect(s)
Degradation of Soil Quality				
Construction	Increased concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, or leaching from ARD sources. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to potential adverse human health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Operations	Increased concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, or leaching from ARD sources. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to potential adverse human health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Decommissioning and Abandonment	Activities for removal of ground facilities (valve and compressor stations) may increase concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, leaching from ARD sources. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to potential adverse human health effects. No potential adverse effects from the pipeline, which will be abandoned in place with no disturbance.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5, 7 and 8	No residual effect has been identified.

Table 20-3: Potential Adverse Effects, Mitigation and Residual Adverse Effects of the Proposed Project on Human Health (cont'd)

Project Phase	Potential Adverse Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Effect(s)
Degradation of Traditional and Country Foods Quality				
Construction	Increased concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or leaching from ARD sources. This could lead to exposure through chemical transfer from soil to vegetation or wildlife through the food chain to humans through traditional and country foods consumption, leading to potential adverse human health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Operations	Increased concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or leaching from ARD sources. This could lead to exposure through chemical transfer from soil to vegetation or wildlife through the food chain to humans via traditional and country foods consumption, leading to potential adverse human health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Decommissioning and Abandonment	Activities for removal of ground facilities (valve and compressor stations) may increase concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or leaching from ARD sources. This could lead to exposure through chemical transfer from soil to vegetation or wildlife through the food chain to humans via traditional and country foods consumption, leading to potential adverse human health effects. No potential adverse effects from the pipeline, which will be abandoned in place with no disturbance.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5, 7 and 8	No residual effect has been identified.

The health concerns associated with a potential contaminant release (fuel spills, other chemical spills, dust/erosional inputs, blasting residue inputs, ARD discharges, contaminated groundwater inputs) and subsequent contamination of local water, sediment, soil and traditional and country foods were evaluated using the standard risk assessment framework.

Under normal conditions during Project phases, minor spills of fuel or other chemicals (e.g., lubricants, oils, solvents used in vehicles or compressor stations, or waste materials extracted from the gas) may occasionally occur in localized sites such as vehicle refueling areas, compressor stations and vehicle parking areas.

The localized and controlled use of herbicides to control targeted noxious or weed species at proposed meter stations, compressor stations or along the proposed route is a standard practice in BC. This activity could potentially cause localized health risks to people if not properly managed.

It is noted that minor gas leaks along the proposed route could release limited quantities of natural gas to the environment. This would result in release of product that would dissipate rapidly and would not represent a human health risk due to the lack of plausible exposure scenarios. The health assessment does not consider the case of moderate or large-scale spill scenarios of fuel or other materials, because these scenarios are discussed under accidents or malfunctions (Section 21, Accidents or Malfunctions).

In various parts of British Columbia, a herbicide known as monosodium methanearsenate (MSMA) was sprayed on trees in an attempt to control the spread of mountain pine beetles. Potential concern regarding the release of residual arsenic through the felling and handling of MSMA-treated trees was identified. The proposed route does pass through MSMA units identified in maps from the Ministry of Forests Lands and Natural Resource Operations. However, Coastal GasLink's 2013 timber assessment through these areas did not identify any MSMA treated trees within the study area. Therefore there is very low potential for project-related disturbance of MSMA trees or release of arsenic that would lead to potential health concerns. No residual adverse effect was associated with this concern and it was not carried forward in this assessment.

The potential for fugitive dust deposition, erosional sediment transport and debris release into local waterways from active construction areas was considered. This could result in degraded surface water quality and reduced quality of aquatic habitat for algae, invertebrates and fish populations. These potential adverse effects are not related to chemical exposures to humans or ecological receptors, but represent a physical effect that could affect water quality (turbidity), cause burial of aquatic biota and eggs, and affect fish behaviours of feeding and predator-prey interactions. The physical deposition of dust and erosional materials to the aquatic environment is evaluated in the assessments of Surface Water (Section 7.7) and Protection of Recreationally, Commercially and Culturally Important Fish and Fish Habitat (Section 7.5). The chemical composition of topsoil, road dust and quarry substrates would be expected to be relatively chemically inert and similar to other PM substrates for each region. Therefore, the potential for contaminant exposure resulting from deposition of particulates to land or waterbodies was not associated with potential chemical exposures to people, and was not carried forward in this assessment.

The potential for ARD generation was evaluated through a desk top review (Section 5.7). Quarry materials to be used in the construction of access roads and land bases for compressor stations would not be sourced from ARD-generating rock. Further investigation was recommended for two highly mineralized regions (KP 444-500 near Equity Mine, and KP 520-534) and additional site-specific mitigation may be proposed should ARD be confirmed. The generation of ARD, if not adequately mitigated, could potentially result in chemical exposure to people through drinking water or through food chain transfer into traditional or country foods.

Construction of the proposed Project may involve blasting rock in some areas. Explosives use could lead to potential nitrogen loading to aquatic systems, which could cause increased concentrations of nitrogenous compounds (i.e., nitrate, nitrite) which could lead to exposures to people consuming downstream surface or groundwaters, if not adequately managed.

Consideration was given to concerns regarding the potential for historical contaminants in soils and groundwater to be accessed as a result of construction activity. Surveys of federal and provincial databases were conducted to identify historical contaminated sites that could potentially influence the proposed Project (Section 14, Land and Resource Use). The surveys focused on industrial or commercial land use within a 500 m radius around areas of interest (AI).

The survey did not identify any federally regulated contaminated sites. However, the BC Site Registry yielded three contaminated sites. Two of these are near KP 391.6 with one being classified as Inactive – No Further Action, and the other classified as Active – Under Remediation. The latter site is a former electrical substation situated 680 m south of the proposed route and is therefore not anticipated to have interactions with the proposed Project.

The third contaminated site, also classified as Active, is the former Methanex methanol facility situated at the pipeline terminus near Kitimat. A detailed site investigation (DSI) of the former Methanex site was conducted (Golder 2009) and submitted to the BC Ministry of Environment. The DSI characterized the existing distribution of contamination in soil, groundwater, soil vapour and surface water at the site. Chemicals of potential concern were identified based on the applicable BC Contaminated Sites Regulations (CSR) standards.

The assessment of potential risks to human health and the environment was used to support remediation and risk management plans. The DSI identified the presence of contamination in soils that should be managed appropriately based on recommendations within the DSI to ensure safe handling during site excavation or construction activities.

The DSI indicated the presence of methyl tertiary butyl ether (MTBE) in groundwater at the eastern terminal facilities which the construction of the proposed pipeline

would be expected to expose based on current information. This presents concerns of the pipeline acting as a preferential pathway for movement of contaminants via the groundwater into the Kitimat River and the estuarine environment. The soil substrate consists of sandy gravel composites and therefore would allow MTBE to move from site to surrounding offsite areas including Kitimat River.

The DSI indicated that no MTBE was detected in spring water samples collected at three points along the river, despite MTBE being present in the small creek southeast of the Methanex plant. This indicates that although soil conditions allow for movement of MTBE in groundwater, and that some surface water on site contains MTBE, this is not currently resulting in detectable levels of MTBE in the adjacent Kitimat River. Furthermore, MTBE concentrations were orders of magnitude below the CSR standard for aquatic life (freshwater) of 34 mg/L based on groundwater attenuation to surface waters, and five times lower than the BC MOE water quality guideline for protection of freshwater aquatic life (3.4 mg/L). Therefore, the data do not indicate the potential for unacceptable health risks to ecological receptors in the Kitimat River based on the possibility of MTBE mobilizing along the pipeline-soil interface and migrating towards the river.

From the perspective of human health, MTBE was measured in groundwater and in a creek southeast of Methanex site (as previously mentioned, at concentrations slightly above the CSR drinking water standards). As a result, the DSI concluded that well water should not be consumed from the former Methanex site and that installation and monitoring of a well would require a qualified professional. This recommendation is protective of human health by avoiding exposure via drinking water from the site.

Based on the findings of the DSI which were supported by Golder's HHERA and management plans, the development of the pipeline ROW under Kitimat River and onto the former Methanex site is not expected to result in appreciable changes to local water quality that could lead to unacceptable health risks to people or to ecological receptors. Therefore, no residual adverse effect on human health was identified, and this potential effect was not carried forward in this assessment.

Hydrostatic testing at watercourse crossings may involve release of water from the pipe to local lands (Section 7.7 and 7.8). Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and water quality is protected in local aquatic environments. Water quality of release water may contain small amounts of rust particles from the pipe or trace amounts of hydrocarbons.

20.5.2 Potential Residual Adverse Effects

The potential residual adverse environmental effects on human health associated with the proposed Project are listed in Table 20-4.

Nine of the potential adverse effects on human health are assessed to not result in a residual adverse effect because of the effective application of mitigation outlined in Table 20-3 and in consideration of the low degree of plausibility and magnitude of potential chemical exposure pathways given the nature of the proposed Project. The rationale is provided below:

Degradation of Water or Sediment Quality

Concerns regarding degradation of water and sediment quality relate to minor spills, localized herbicide use, ARD generation, blasting residues, and release of hydrostatic test water to local waterbodies.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. Documentation and records of spills will be prepared and reported to Project management, to assess safety trends and to properly manage spill scenarios and adjust procedures and training if necessary in order to reduce the likelihood of other minor spills. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation and management measures, the relative isolation of the proposed Project infrastructure from residences, and adequate spill response training and equipment, the exposure level for chemical spills to reach people is considered negligible and no residual effects were identified.

The handling, storage, use and disposal of herbicides is well understood and managed to mitigate health risks to people and to the environment. The periodic application of herbicide in select areas for the proposed Project is considered to represent negligible health risks to people. Direct exposures to people will be avoided by applying herbicides using adequate PPE and ensuring that people are not in the vicinity of the treatment area. Indirect exposures to people based on consumption of traditional or country foods will be avoided by using herbicides with short half-lives, in small quantities and focusing application only on target noxious weeds. No residual adverse effects are identified.

The potential for a pathway from mineralized ARD zones to affect human or ecological health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD presents a risk to local waterbodies, additional mitigation is recommended to cap or cover the ARD substrate as required. Therefore,

this activity would not be expected to be linked to potential contamination of water and sediment quality and no residual adverse effects were identified.

Blast residues of ammonia, nitrate and nitrite may also result in minor increases in localized areas of waterways for short periods. Blasting activity at this scale of use does not typically exert changes in water chemistry that would be detected above background variation. These potential concerns will also be addressed through proper management and use of blasting material such as ammonium nitrate. These nitrogenous compounds do not accumulate in tissues. For these reasons, the potential for blasting residues to cause adverse effects has not been carried forward in the health risk assessment due to a lack of a plausible exposure scenario. No residual adverse effects are identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to people because the iron would not be expected to be absorbed in detectable levels by people drinking local waters. Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and water quality is protected in local aquatic environments. Through the application of this mitigation, no residual adverse effects are identified.

Degradation of Soil Quality

Concerns regarding degradation of soil quality relate to minor spills, potential ARD generation, release of hydrostatic test water to local areas, and the improper handling of soil.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. Documentation and records of spills will be prepared and reported to project management, to assess safety trends and to properly manage spill scenarios and adjust procedures and training if necessary in order to reduce the likelihood of other minor spills. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation and management measures, the relative isolation of the proposed Project infrastructure from residences, and adequate spill response training and equipment, the potential for exposures of chemicals in soil to people is considered negligible and no residual adverse effects were identified.

The potential for a pathway from mineralized ARD zones to affect human health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD presents a risk to local soil quality, additional mitigation is recommended to cap the ARD substrate as required. This would mitigate potential generation of acid drainage, avoiding mobilization of metals to the environment. Therefore, this activity would not be expected to be linked to potential contamination of local soils and no residual adverse effects were identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to people because the iron would not be expected to be absorbed in detectable levels by people coming in contact with soils that received test waters. Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and local soil quality is protected. Therefore, through the application of this mitigation, no residual adverse effects are identified.

Degradation of Traditional and Country Foods Quality

Concerns regarding degradation of traditional and country foods quality relate to minor spills, localized herbicide use, ARD generation, blasting residues, and release of hydrostatic test water to local waterbodies.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. Documentation and records of spills will be prepared and reported to Project management, to assess safety trends and to properly manage spill scenarios and adjust procedures and training if necessary in order to reduce the likelihood of other minor spills. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation and management measures, the relative isolation of the proposed Project infrastructure from residences, and adequate spill response training and equipment, the potential for spills to be taken up by local plants or animals and then consumed by people is considered negligible and no residual adverse effects were identified.

The handling, storage, use and disposal of herbicides is well understood and managed to mitigate health risks to people and to the environment. The periodic application of herbicide in select areas for the proposed Project is considered to represent negligible

health risks to people. Exposures to people based on consumption of traditional or country foods will be avoided by using herbicides with short half-lives, in small quantities and focusing application only on target noxious weeds. No residual adverse effects are identified.

The potential for a pathway from mineralized ARD zones to affect human or ecological health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD potential is rated high, additional mitigation is recommended to cap the ARD substrate as required, to mitigate potential metal mobilization, transport and uptake in plants and animals that could then be consumed as foods by people. Therefore, this activity would not be expected to be linked to potential degradation of traditional and country foods quality and no residual adverse effects were identified.

Blast residues of ammonia, nitrate and nitrite may also result in minor increases in localized areas of waterways for short periods. Blasting activity at this scale of use does not typically exert changes in water chemistry that would be detected above background variation. These potential concerns will also be addressed through proper management and use of blasting material such as ammonium nitrate. These nitrogenous compounds do not accumulate in tissues. For these reasons, the potential for blasting residues to cause adverse effects has not been carried forward in the health risk assessment. No residual adverse effects are identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to people because the iron would not be expected to be absorbed in detectable levels by plants or animals that may be consumed by local people. Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and water quality is protected in local aquatic environments. Through the application of this mitigation, no residual adverse effects are identified.

20.5.3 Characterization of Potential Residual Adverse Effects

The potential residual adverse effects of the proposed Project on human health were characterized (Table 20-4). The rationale used to characterize each of the residual adverse environmental effects is provided below.

Air Quality Health Risks on Human Health

The potential for air emissions to result in potential human health risks was evaluated along the proposed route for the construction and decommissioning and abandonment phases using a qualitative approach. More substantial emissions were expected during

operations, specifically from the proposed compressor stations. Therefore the operations phase was modeled quantitatively for potential adverse air quality effects, and model results were then screened against appropriate AAQO and Canada Wide Standards based on conservative worst case air model assumptions. (Section 6.6). The potential for human health risks was based on screening predicted air quality at human receptor locations surrounding each proposed compressor station. Human receptor locations were identified using Google-earth imagery and database searches (Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community) to identify farms and residences (Figure 20-2 to 20-9).

Human receptors were identified within the 20 km x 20 km HHERA LSA at five of the eight proposed compressor stations, including Wilde Lake (KP 0, 81 receptors), Racoon Lake (KP 249.4, 1 receptor), Clear Creek (KP 329.5, 8 receptors), Segundo Lake (KP 417.5, 26 receptors) and Titanium Creek (KP 573.5, 2 receptors). Three compressor stations did not appear to have human receptor locations situated within their respective HHERA LSA boundary, including Sukunka Falls station (KP 83.3), Mount Bracey (KP 162.9), and Goosly Falls (KP 492.4).

Air dispersion model results were reported for the predicted maximum concentrations based on the application case (i.e., existing background disturbance to air quality, combined with disturbance attributed to the proposed Project) for each of the eight proposed compressor stations during operations (Appendix B, Table B-3), for the following CACs and time-weighted averages:

- SO_2 (1 hour (h), 3h, 24h and Annual)
- NO_2 (1h, 24h and Annual)
- CO (1h, 8h)
- $PM_{2.5}$ (24h and Annual)
- $PM_{2.5}$ (98^{th} percentiles used: 24h and Annual)
- Total Volatile Organic Compounds (VOC; 1h, 24h and Annual)

No predicted values exceeded BC AAQO or Canada Wide Standards, with the maximum values ranging from 1 to 87% of objectives, therefore no health risks are anticipated from operation of the proposed Project compressor stations. The relative contribution of the proposed Project to the background air quality was also calculated, using the highest maximum air concentration of the eight stations and dividing by background air concentration. For SO_2, the proposed Project would increase concentrations by 2 to 21%, but predicted ambient air quality would remain at only 1 to 5% of the AAQO. The proposed Project was predicted to increase NO_x by up to five-fold, related to low background levels, but would remain at 69% of the AAQO. Carbon monoxide levels were predicted to increase by up to a third but would represent only 23% of the AAQO. The proposed Project was predicted to increase

$PM_{2.5}$ concentrations by 9 to 82%, and this would represent 82 to 87% of the applicable AAQO. Total VOCs were predicted to range from 42 to 102 ug/m^3 (1-hr), 18 to 46 ug/m^3 (24-hr), and 1.7 to 4.2 ug/m^3 (Annual). There are no BC air quality objectives or Canada Wide Standards for total VOCs. VOCs will be intermittently released through venting of facilities during maintenance activity. The predicted change in VOC concentrations is expected to be minimal in terms of ambient levels originating from forest fires (Section 6.6), and thus is not associated with predicted health risks to people.

At five of the eight stations, human receptors were identified within the HHERA LSA, of each compressor station and maximum concentrations for the application case are reported by receptor location (Appendix B, Table B-4). No exceedances of BC AAQO or CWS are predicted at any of the receptor locations. Background air quality concentrations are shown for reference to predicted proposed Project contributions to the application case.

Table 20-4: Characterization of Potential Residual Adverse Effects on Human Health

Potential Residual Adverse Effect(s)	Spatial Boundary[a)]	Temporal Context			Magnitude	Likelihood
		Duration	Frequency	Reversibility		
Air Quality Health Effects on Human Health						
Degraded air quality leading to inhalation health risks in people during construction.	LSA	Short-term	Occasional	Short-term	Negligible to Low	Low
Degraded air quality leading to inhalation health risks in people during operations.	LSA	Long-term	Occasional	Long-term	Low	Low
Degraded air quality leading to inhalation health risks in people during decommissioning and abandonment.	LSA	Short-term	Occasional	Short-term	Negligible to Low	Low
Noise Disturbance Effects on People						
Increased noise levels leading to disturbance to people during construction	LSA	Short-term	Continuous	Short-term	Negligible to Low	Low
Increased noise levels leading to disturbance to people during operations	LSA	Long-term	Continuous	Short-term	Low	Low
Increased noise levels leading to disturbance to people during decommissioning and abandonment	LSA	Short-term	Occasional	Short-term	Negligible to Low	Low

Note:
[a] LSA = Human and Ecological Health LSA

During the construction phase, ambient air quality could potentially be affected by emissions from vehicles and machinery, and from fugitive dust sources. Combustion emissions could contribute to increased CAC concentrations in the vicinity of proposed Project access roads along the proposed route, and at proposed metering stations and compressor stations. Fugitive dust sources include dust from roads that are released as a result of traffic, wind erosion of topsoil stockpiles, and from clearing during site preparation .

During the decommissioning and abandonment phase, ambient air quality could potentially be affected by emissions and dust from vehicles and machinery during as a result of decommissioning activities (i.e., removal of above ground facilities, site recontouring, reclamation of disturbed areas) and through road closing activities. Combustion emissions could contribute to increased CAC concentrations in the vicinity of the proposed Project access roads and along the proposed route. However, the activities are limited to the removal of surface facilities such as permanent access roads, compressor and valve stations, while the pipeline will be abandoned in place to reduce disturbance along the proposed route.

Degraded Air Quality Leading to Inhalation Health Risks in People During Construction

The potential residual adverse effect on human health risks from degraded air quality associated with construction emissions and fugitive dust emissions to the surrounding airshed was assessed. The rationale for the human health risk assessment is provided below.

- Context: For the human health risk assessment, the potential adverse effects of the Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals (the young, the old, and those with pre-existing conditions) based on the use of appropriate AAQO that is protective of these sensitive individuals. Resilience of individuals would be difficult to characterize without conducting site-specific studies of community health which are beyond the scope of the risk assessment and the requirements of the Application. Therefore, sensitivity and resilience were not characterized separately in this risk assessment. This follows standard risk assessment guidance by Health Canada.
- Spatial boundary: Human and Ecological Health LSA - this was the area in which human receptors were identified and assessed.
- Duration: Short-term - the assessment was conducted using worst case predicted air concentrations that would occur over a time-weighted average period ranging from one hour to one year. The more typical air concentrations that would be expected to occur on a day-to-day basis within the HHERA LSA would be much lower than those maximum values conservatively applied to screen human health risks in this report. Also, active construction would only occur in an area for a short portion of the entire construction phase, therefore the short-term rating applies. CACs would be emitted mainly during working hours, representing a portion of each day
- Frequency: Occasional - air emissions (i.e., fugitive dust and CACs from machinery and vehicles during construction) would be sporadic and intermittent over the assessment period.
- Reversibility: Short-term - identified health risk would apply only through the construction phase.
- Magnitude: Negligible to low - some CACs were not predicted to change appreciably from baseline concentrations (and therefore had negligible magnitude) and others could potentially show a detectable increase from baseline but would remain below regulatory health-based standards (classified as low magnitude).
- Likelihood: Low - residual health risks to people are unlikely to occur, because of the conservatism built into the air dispersion model, the use of maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Degraded Air Quality Leading to Inhalation Health Risks in People During Operations

The potential residual adverse effect on human health risks was assessed in regards to potential changes in air quality that may be associated with operational air emissions (primarily from operation of the Compressor Stations) and fugitive dust to the surrounding airshed.

The rationale for the human health risk assessment is provided below:

- Context: For the human health risk assessment, the potential adverse effects of the proposed Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals (the young, the old, and those with pre-existing conditions) based on the use of appropriate AAQO that is protective of these sensitive individuals. Therefore, sensitivity and resilience were not characterized separately in this risk assessment. This follows standard risk assessment guidance by Health Canada.
- Spatial boundary: Human and Ecological Health LSA - this was the area in which human receptors were identified and assessed.
- Duration: Long-term - emissions would be released throughout operational life of the proposed compressor stations. This is a conservative approach, given that the maximum predicted air concentrations were used in screening health risks. The more typical air concentrations that would be expected to occur on a day-to-day basis within the HHERA LSA would be much lower than those maximum values conservatively applied to screen human health risks in this report.
- Frequency: Occasional - based on the nature of predicted emissions from operations sources (i.e., compressor stations, vehicles, fugitive dust). This is a conservative approach, given that it would be expected that much of the time, air concentrations would be lower than the maximum values used in the assessment.
- Reversibility: Long-term - identified health risks would apply for the duration of the operation phase.
- Magnitude: Low - all predicted maximum concentrations during the operations phase, representing conservative (overestimated) exposure scenarios for human receptors, were below all of the AAQO and CWS (Appendix B Tables B-3 and B-4). These maximum concentrations would occur at or very close to fenceline of each compressor station, and concentrations would quickly drop to baseline levels within a short distance.
- Likelihood: Low - residual health risks to people are unlikely to occur, because of the conservatism built into the air dispersion model, the use of maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Degraded Air Quality Leading to Inhalation Health Risks in People During Decommissioning and Abandonment

The potential residual adverse effect on human health risks from degraded air quality associated with emissions and fugitive dust to the surrounding airshed during decommissioning and abandonment was assessed. The rationale for the human health risk assessment is provided below.

- Context: For the human health risk assessment, the potential adverse effects of the Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals (the young, the old, and those with pre-existing conditions) based on the use of appropriate AAQO that is protective of these sensitive individuals. Therefore, sensitivity and resilience were not characterized separately in this risk assessment. This follows standard risk assessment guidance by Health Canada.
- Spatial boundary: HHERA LSA - this was the area in which human receptors were identified and assessed. The affected area for this work would be fairly limited to small areas associated with compressor, meter or valve stations, while the pipeline would be abandoned in place.
- Duration: Short-term - the assessment was conducted using worst case predicted air concentrations that would occur over a time-weighted average period ranging from one hour to one year. The more typical air concentrations that would be expected to occur on a day-to-day basis within the LSA would be much lower than those maximum values conservatively applied to screen human health risks in this report. Also, active decommissioning would only occur in an area for a short portion of the entire phase, therefore the short-term rating applies. Furthermore, CACs would be emitted mainly during working hours, representing a portion of each day.
- Frequency: Occasional - air emissions (i.e., fugitive dust and CACs from machinery and vehicles during decommissioning) would be sporadic and intermittent over the assessment period.
- Reversibility: Short-term - identified health risk would apply only through the decommissioning phase while emissions occurred. Following the cessation of emissions, health risks would be eliminated.
- Magnitude: Negligible to low – This is the same rating of magnitude that was assigned for the construction phase. Some CACs were not predicted to change appreciably from baseline concentrations (and therefore had negligible magnitude) and others could potentially show a detectable increase from baseline but would remain below regulatory health-based standards (classified as low magnitude).
- Likelihood: Low – it is unlikely that residual health risks to people would occur, because of the conservatism built into the air dispersion model, the use of

maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Noise Disturbance Effects on People

Quantitative noise modeling results are provided in Section 6.5. No noise thresholds were predicted to be exceeded at fenceline or at human receptor locations for any Project phase.

Increased Noise Levels Leading to Noise Disturbance on People During Construction

The noise effects assessment quantitatively modelled predicted noise levels from construction of facilities including horizontal directional drilling (Section 6.5). The noise assessment predicted no exceedance of noise thresholds, resulting in no significant adverse noise effects. The proposed construction activities would not be audible to the nearby residents most of the time.

The rationale for the effect characterization is provided below.

- Context: The noise assessment followed guidance provided by BC OGC and Health Canada to assess potential disturbance effects from the proposed Project. Background noise levels, project activity types and land uses were used in determining the permissible sound levels for day and night time, for the various project activities and phases (Section 6.5). Generally, compressor stations were situated in remote areas away from human habitation with the exception of the Wilde Lake Compressor Station which has existing energy facilities within its HHERA LSA.
- Spatial boundary: Health LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary in which the noise assessment is based, following regulatory guidance.
- Duration: Short-term - activity will occur during daytime for the construction phase, except trenchless installation methods which may occur 24 hrs a day.
- Frequency: Continuous - activity and associated noise will be occurring continuously throughout the construction phase.
- Reversibility: Short-term - following cessation of construction activity, noise emissions and disturbance, if present, would be reversed.
- Magnitude: Negligible to Low - residual noise levels meet Health Canada and BC OGC thresholds for construction activities.
- Likelihood: Low – it is unlikely that residual noise disturbances would occur, based on the quantitative noise modelling undertaken and resulting predicted noise levels remaining below thresholds for the human receptor locations within 1.5 km of the compressor stations.

Increased Noise Levels Leading to Noise Disturbance on People During the Operations Phase of the Proposed Project

The noise effects assessment quantitatively modelled predicted noise levels from operation of the proposed compressor stations (Section 6.5). The noise assessment predicted no exceedance of noise thresholds, resulting in no significant noise effects within 1.5 km of stations or at human receptor locations. Cautionary thresholds for low frequency noise (LFN) were exceeded (Table 6-17). However, no LFN tonality is expected, and predicted noise levels are conservative; actual noise levels will likely be lower than predicted values. Furthermore, noise complaints generally occur 5dB higher than the cautionary threshold, and these higher levels are not predicted at any receptor location. Therefore, no LFN noise complaints are expected for any of the proposed compressor stations during the operations phase. The proposed pipeline operations activities would not be audible to the nearby residents most of the time and would not be expected to result in noise disturbance.

The rationale for the effect characterization is provided below.

- Context: The noise assessment followed guidance provided by BC OGC and Health Canada to assess potential disturbance effects from the proposed Project. Background noise levels, project activity types and land uses were used in determining the permissible sound levels for day and night time, for the various project activities and phases (Section 6.5). Generally, compressor stations were situated in remote areas away from human habitation with the exception of the Wilde Lake Compressor Station which has existing energy facilities within its HHERA LSA.
- Spatial boundary: Health LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary in which the noise assessment is based, following regulatory guidance.
- Duration: Long-term - operation of the proposed compressor stations will occur through the operations phase for the life of the Project).
- Frequency: Continuous - activity and associated noise will be occurring continuously throughout the operations phase.
- Reversibility: Short-term - following cessation of operations activity, noise emissions and disturbance, if present, would be reversed.
- Magnitude: Low - residual noise levels would increase slightly from baseline but would meet Health Canada and BC OGC noise thresholds for operations activities, and LFN noise levels do not produce harmonic tonality or reach levels typically associated with noise complaints.
- Likelihood: Low – it is unlikely that residual noise disturbances would occur, based on the quantitative noise modeling undertaken and resulting predicted noise

levels remaining below thresholds for the human receptor locations and at 1.5 km distance from compressor stations.

Increased Noise Levels Leading to Noise Disturbance on People During Decommissioning and Abandonment

The noise effects assessment assumed that noise levels during the decommissioning and abandonment phase would be equal or less than noise generated during the construction phase (Section 6.5.2). The noise assessment predicted no exceedance of noise thresholds, resulting in no significant adverse noise effects at fenceline or at human receptor locations during construction. Noise levels are expected to be much lower during decommissioning and abandonment activities compared to the construction phase because activities will be very localized and occur only at specific locations along the pipeline (e.g., compressor station sites, access roads, valve sites). Therefore, no adverse noise disturbance effects are anticipated for the decommissioning and abandonment phase.

The rationale for the effect characterization is provided below.

- Context: The noise assessment followed guidance provided by BC OGC and Health Canada to assess potential disturbance effects from the proposed Project. Background noise levels, project activity types and land uses were used in determining the permissible sound levels for day and nighttime, and for the various project activities and phases (Section 6.5). Generally, compressor stations were situated in remote areas away from human habitation with the exception of the Wilde Lake Compressor Station which has existing energy facilities within its HHERA LSA.
- Spatial boundary: Health LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary in which the noise assessment is based, following regulatory guidance.
- Duration: Short-term - activity will occur during only a part of the decommissioning and abandonment phase for each location.
- Frequency: Occasional - activity and associated noise will be occurring occasionally during different aspects of decommissioning and abandonment activities at the various locations of the proposed route and facilities.
- Reversibility: Short-term - following cessation of activity, noise emissions and disturbance, if present, would be reversed.
- Magnitude: Negligible to Low - residual noise levels meet Health Canada and BC OGC noise thresholds for decommissioning and abandonment activities.
- Likelihood: Low – it is unlikely that residual noise disturbances would occur, based on the quantitative noise modeling undertaken and resulting predicted noise

levels remaining below thresholds for the human receptor locations and at fenceline.

20.5.4 Potential Residual Adverse Effects - Determination of Significance and Confidence

Significance thresholds for human health are defined for key indicators as increases in stressor exposure levels that exceed the AAQOs, or, where baseline concentrations exceed the AAQOs, where increased exposure levels exceed the baseline concentrations by more than the risk acceptability benchmarks established by regulatory agencies.

Established health-based objectives, criteria, guidelines and toxicological exposure limits are used for the various exposure pathways in characterizing human health risks and determining significance of effects. For human health this is done at the individual level.

As discussed in Section 20.5.1, several potential environmental changes that could lead to a contaminant exposure to people and indicate the potential for health risks were considered. These potential changes that were identified in the conceptual site model include potential degradation of water or sediment quality, degradation of soil quality, or degradation of traditional and country foods quality, leading to human health risks. There were no plausible exposure pathways identified for these KIs, or where there was a potential pathway, the anticipated level of potential exposure was considered undetectable from baseline ranges or would be negligible.

Table 20-5 provides a summary of the determination of significance and confidence in the prediction of the potential residual adverse effects identified in Section 20.5.3.

Table 20-5: Determination of Significance and Confidence for Potential Residual Adverse Effects on Human Health

Potential Residual Adverse Effect(s)	Determination of Significance and Confidence	Recommended Follow-up and Monitoring
Degraded air quality leading to inhalation health risks to people during construction	Not significant High confidence	Monitoring of air emissions
Degraded air quality leading to inhalation health risks to people during operations	Not significant High confidence	Monitoring of air emissions
Degraded air quality leading to inhalation health risks to people during decommissioning and abandonment	Not significant High confidence	Monitoring of air emissions
Noise leading to disturbance to local residents during construction	Not significant High confidence	None
Noise leading to disturbance to local residents during operations	Not significant High confidence	None
Noise leading to disturbance to local residents during decommissioning and abandonment	Not significant High confidence	None

Degraded Air Quality Leading to Inhalation Health Risks to People During Construction

The residual adverse effect of degraded air quality during the construction phase is rated as not significant. This is based on the negligible to low magnitude of increase in CAC concentrations, remaining below the regulatory standards for air quality protective of sensitive human receptors. This indicates that there are no identified health risks even for the most sensitive individuals in the communities (e.g., children, infants, elderly, and those with pre-existing respiratory or cardio-vascular conditions). The air model used very conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase, which would have the highest emission rates. Therefore, the construction phase air quality would be expected to be better than that predicted and assessed with the air model. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which have been approved and recommended by BC MOE and US EPA, and are therefore standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed by air quality and will be adequate to meet the future needs of the HHERA.

The residual adverse effect of degraded air quality leading to human health risks during construction is considered to be not significant, and determined with high confidence.

Degraded Air Quality Leading to Inhalation Health Risks to People During Operations

The residual adverse effect of degraded air quality during the operations phase is rated as not significant. This is based on the negligible to low magnitude of increase in CAC concentrations, remaining below the regulatory standards for air quality protective of sensitive human receptors. This indicates that there are no identified health risks even for the most sensitive individuals in the communities (e.g., children, infants, elderly, and those with pre-existing respiratory or cardio-vascular conditions). The air model used very conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which are standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed by Air Quality.

The residual adverse effect of degraded air quality leading to human health risks during operations is considered to be not significant, and determined with high confidence.

Degraded Air Quality Leading to Inhalation Health Risks to People During Decommissioning and Abandonment

The residual adverse effect of degraded air quality during the decommissioning and abandonment phase is rated as not significant. This is based on the negligible magnitude of increase in CAC concentrations, remaining below the regulatory standards for air quality protective of sensitive human receptors. This indicates that there are no identified health risks even for the most sensitive individuals in the communities (e.g., children, infants, elderly, and those with pre-existing respiratory or cardio-vascular conditions).

The air model used very conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase. Air quality would be expected to change less during decommissioning and abandonment than during operations. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which are standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed by Air Quality.

The residual adverse effect of degraded air quality leading to human health risks during decommissioning and abandonment is considered to be not significant, and determined with high confidence.

Noise Leading to Disturbance of Local Residents During Construction

The residual adverse effect of noise to potentially disturb local people during the construction phase is rated as not significant. This is based on the negligible to low magnitude changes in ambient noise levels that were quantitatively modelled and indicated no exceedance of noise thresholds (Section 6.5.2). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local people during construction is considered to be not significant and determined with high confidence.

Noise Leading to Disturbance of Local Residents During Operations

The residual adverse effect of noise to potentially disturb local people during the operations phase is rated as not significant. This is based on the low magnitude changes in ambient noise levels that were quantitatively modeled and indicated no exceedance of noise thresholds (Section 6.5.2). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local people during operations phase is considered to be not significant and determined with high confidence.

Noise Leading to Disturbance of Local Residents During Decommissioning and Abandonment

The residual adverse effect of noise to potentially disturb local people during the decommissioning and abandonment phase is rated as not significant. This is based on the negligible to low magnitude changes in ambient noise levels that were quantitatively modeled and indicated no exceedance of noise thresholds (Section 6.5.2). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local people during decommissioning and abandonment is considered to be not significant and determined with high confidence.

20.5.5 Cumulative Adverse Effects Assessment Overview

Cumulative adverse effects are defined as changes to the environment that are caused by a proposed Project in combination with other past, present or future human disturbance including development. It is recognized that cumulative adverse effects may be different in nature or extent from the effects of the individual activities.

Projects and Activities Considered for the Cumulative Effects Assessment

The list of potential projects and activities outlined in Appendix 3-A of Volume 3 of the Application was reviewed to determine which projects and activities are located within the Health RSA in order to assess if there is overlap in potential residual human health risks related to air and noise emissions.

20.5.6 Cumulative Effects, Mitigation and Environmental Management Strategies

Regarding air quality and noise emissions, there were no planned future facility emission sources identified within the Health RSA. Past projects have no bearing on current or future air or noise conditions. Contributions to ambient air quality and noise levels within the RSA from current projects are already included within the background input to the effects assessment modelling for the project effects. Therefore, current projects were already considered in the effects assessment and therefore are not addressed in the cumulative adverse effects section for health. Because there are no planned future facility emissions identified, no cumulative air quality assessment or noise assessment was conducted. The potential for cumulative adverse noise effects related to forestry and farming activities overlapping the Wilde Lake compressor station was rated as negligible.

Therefore, a cumulative health assessment has not been undertaken. The potential for cumulative adverse health effects does not exist for the proposed Project. No mitigation is required in addition to mitigation strategies proposed for air quality (Section 6.6.1) and noise (Section 6.5.2).

20.5.7 Conclusion

Predicted ambient air quality and noise levels remained well below the regulatory thresholds. There were no significant residual human health risks associated with the proposed Project. There are no potential cumulative human health risks associated with the Project.

20.6 ECOLOGICAL HEALTH EFFECTS ASSESSMENT

20.6.1 Potential Adverse Effects, Mitigation and Environmental Management Strategies

The potential adverse effects associated with the construction, operations, decommissioning and abandonment of the proposed Project on ecological health were based on the results of a screening level risk assessment. This considered information from ATK and the technical assessment results from other disciplines (Sections 14, 16, and Appendices 2-H, 2-J, 2-K and 2-L).

Much of the mitigation listed by other disciplines acts to mitigate potential adverse health effects on people or to ecological receptors, by controlling the release or potential for spills of contaminants, dust or noise:

- mitigation of noise levels (Section 6.5)
- mitigation of air emissions and fugitive dust (Section 6.6)
- mitigation of sedimentation and erosion in freshwater environments from construction and operation of roads, dust from topsoil stockpiles, instream crossings and other structures (Section 7.5 and 7.7)
- mitigation of surface transport of blasting residues into local waterways (Section 7.7)
- mitigation of potential for minor spills, and adequate storage and transport protection, planning and spill contingency for fuels and chemicals (Section 21.2)

There is no additional mitigation recommended to protect ecological health.

The following potential health concerns and issues have been raised by Aboriginal groups, public and regulatory stakeholders, or are based on professional judgment and past project experience:

1. Degradation of ambient air quality from air emissions or fugitive dust, potentially leading to adverse respiratory and irritant effects in wildlife.

2. Increase noise levels and introduction of low frequency or blasting noises that may disturb wildlife and birds.
3. Degradation of local water quality or sediment quality in streams and lakes resulting from minor fuel spills, erosional/dust inputs, blasting residue undergoing surface transport to local streams, contaminated groundwater inputs (from other industries) accessed during digging and trenching, or potential acid rock drainage (ARD). Concern that these changes to water or sediment quality could be associated with potential contaminant exposures to freshwater ecological receptors (i.e., algae, invertebrates, fish).
4. Minor fuel spills, erosional/dust inputs, contaminated groundwater inputs, or ARD releases, leading to potential contaminant exposure of plants, fish or animals leading to potential adverse food chain transfer and ecological health effects.

These potential health concerns were evaluated using a conceptual site model to determine if potential health risks could exist in relation to these health concerns. For an ecological health risk to be plausible, three elements are required:

1. A stressor (i.e., hazardous chemical or noise) must be present
2. A receptor (i.e., species sensitive to the stressor) must be present
3. An exposure pathway for the stressor to contact the receptor must be present

While the presence of all three elements is required for an ecological health risk to be present, it does not imply there will be a risk. Exposure to a stressor must be of substantial magnitude and duration in order to elicit a biological effect with a reasonable level of confidence.

Emissions from heavy machinery and vehicles used in project activities, and operational emissions from the compressor stations lead to the inclusion of these two effects in the assessment. Potential adverse air quality effects arising from fugitive dust will be mitigated for all project phases through appropriate controls of particulate matter emissions. In addition, a number of measures will be used to control the release of dust during construction of the proposed Project (i.e., pipeline, facility construction, temporary and permanent access, and traffic). These measures are listed in Sections 6.5.2 (for Noise) and 6.6.1 (for Air Quality). The potential adverse effects of CAC emissions on ambient air quality during worst case scenarios were predicted using an air dispersion model (Appendix 2-E). The evaluation of potential adverse ecological health effects from changes to air quality conditions relied on the results of the air quality assessment for human health using Canada Wide Standards and Ambient Air Quality Objectives to screen predicted air quality. The potential for changes to noise levels to cause adverse ecological effects was also reliant on the screening of adverse noise effects on people. It was reasonable to consider that potential changes to local air quality or noise levels could be associated with potential

adverse ecological health effects, therefore air quality and noise KIs were carried forward in this assessment (Table 20-6).

The health concerns associated with the potential for a contaminant release (fuel spills, other chemical spills, dust/erosional inputs, blasting residue inputs, ARD discharges, contaminated groundwater inputs) leading to potential contamination of local water, sediment, soil and prey foods which could result in ecological exposure were evaluated using the standard risk assessment framework.

Under normal conditions during project phases, minor spills of fuel or other chemicals (e.g., lubricants, oils, solvents used in vehicles or compressor stations, or waste materials extracted from the gas) may occasionally occur in localized sites such as vehicle refueling areas, compressor stations and vehicle parking areas.

The localized and controlled use of herbicides to control targeted noxious or weed species at Project meter stations, compressor stations or along the proposed route is a standard practice in BC. This activity could potentially cause localized health risks to ecological species if not properly managed.

It is noted that minor leaks along the proposed route could release limited quantities of natural gas to the environment. The likelihood of such a scenario is extremely low. In such an event, released pressurized gas would rapidly volatilize and ascend into the air, diluting in the atmosphere and resulting in no material exposure risk predicted to wildlife. The health assessment does not consider the case of moderate or large-scale spill scenarios of fuel or other materials, which are discussed in Section 21.

The potential for fugitive dust deposition, erosional sediment transport and debris release into local waterways from active construction areas was considered. This could result in degraded surface water quality and reduced quality of aquatic habitat for algae, invertebrates and fish populations. These potential adverse effects are not related to chemical exposures to ecological receptors, but represent a physical effect that could affect water clarity, burial of aquatic biota and eggs, and affect fish behaviours including feeding and predator-prey interactions. The physical deposition of dust and erosional materials to the aquatic environment is evaluated in the assessments of Surface Water (Section 7.7) and Protection of Recreationally, Commercially and Culturally Important Fish and Fish Habitat (Section 7.5). The chemical composition of topsoil, road dust and quarry substrates would be expected to be relatively chemically inert and similar to other PM substrates for each region. Therefore, the potential for contaminant exposure resulting from deposition of particulates to land or waterbodies was not associated with potential chemical exposures to ecological receptors, and was not carried forward in this assessment.

The chemical composition of topsoil, road dust and quarry substrates would be expected to be relatively chemically inert and similar to other particulate matter substrates in adjacent undisturbed locations along the route. The potential for ARD

generation was evaluated through a desktop review (Section 5.7). Quarry materials to be used in the construction of access roads and land bases for compressor stations would not be sourced from ARD-generating rock.

The generation of ARD, if not adequately mitigated, could potentially result in chemical exposure to ecological species direct contact or through ingestion of water or prey food items. Further investigation was recommended for two highly mineralized regions (KP 444–500 near Equity Mine, and KP 520-534) and additional site-specific mitigation may be proposed if ARD is confirmed.

Construction of the proposed Project may involve blasting rock in some areas. The use of explosives could lead to potential nitrogen loading to aquatic systems, if not properly managed. This could cause increased concentrations of nitrogenous compounds (i.e., nitrate, nitrite) which could lead to exposures to aquatic biota (e.g., fish) in waterbodies downstream of residue inputs.

Concerns about the potential for historical contaminated soils or groundwater to be accessed as a result of construction activity are not considered plausible. Surveys of federal and provincial databases were conducted to identify historical contaminated sites that could interact with the proposed Project (Section 14). Surveys were conducted within a 500 m radius at areas of interest (AI) based on historical industrial or commercial land use. No federally regulated contaminated sites were found. The BC Site Registry yielded three contaminated sites. Two areas near KP 391.6 were identified, one classified as Inactive – No Further Action and one classified as Active – Under Remediation. The latter site was a former electrical substation situated 680 m south of the proposed route. The third site, also Active, was the former Methanex methanol facility situated at the pipeline terminus at KP 664.8. To address potential health concerns, a Limited Stage 1 Environmental Site Assessment (ESA) is recommended for the two known Active contaminated sites to obtain information delineating potential locations of contaminants in soil or groundwater. The final proposed Project design will take into consideration the location and nature of identified contamination. Pending the results of the Stage 1 ESA, a Stage 2 ESA may be needed to conduct more detailed soil and groundwater characterization. By implementing this process, BC Contaminated Sites Regulations will be followed, which will avoid contamination and contaminant pathways to human or ecological receptors. Therefore, no residual adverse effect on human health was identified, and this potential adverse effect was not carried forward in this assessment.

Hydrostatic testing at watercourse crossings may involve release of water from the pipe to local lands (Section 7.7 and 7.8). Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and water quality is protected in local aquatic environments. Water quality of release water may contain small amounts of rust particles from the pipe or trace amounts of hydrocarbons.

Table 20-6: Potential Adverse Effects, Mitigation and Residual Adverse Effects of Proposed Project on Ecological Health

Project Phase	Potential Adverse Environmental Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Environmental Effect(s)
Air Quality Effects				
Construction	Increased concentrations of one or more Criteria Air Contaminants (CACs) above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive ecological receptors	All Project components	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive species.
Operations	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive ecological receptors.	All Project components	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive ecological receptors.
Decommissioning and Abandonment	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive ecological receptors.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Section 6.6.1	Increased concentrations of CACs above AAQOs leading to potential adverse respiratory or inflammatory effects in sensitive ecological receptors.
Noise Effects on Wildlife				
Construction	Increased noise levels above PSLs and background, leading to disturbance of wildlife and potential adverse health effects from altered feeding, predator-prey interactions, breeding.	All Project components	Section 6.5.1	Increased noise levels above effect thresholds and background, leading to disturbance of wildlife and potential adverse health effects.
Operations	Increased noise levels above PSLs and background, leading to disturbance of wildlife and potential adverse health effects from altered feeding, predator-prey interactions, breeding.	All Project components	Section 6.5.1	Increased noise levels above PSLs and background, leading to disturbance of wildlife and potential adverse health effects.
Decommissioning and Abandonment	Increased noise levels above PSLs and background, leading to disturbance of wildlife and potential adverse health effects from altered feeding, predator-prey interactions, breeding.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Section 6.5.1	Increased noise levels above PSLs and background, leading to disturbance of wildlife and potential adverse health effects.

Table 20-6: Potential Adverse Effects, Mitigation and Residual Adverse Effects of Proposed Project on Ecological Health (cont'd)

Project Phase	Potential Adverse Environmental Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Environmental Effect(s)
Degradation of Water or Sediment Quality				
Construction	Increased concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from topsoil stockpiles, erosion of trenches or roadways, or acid rock drainage, or historic contaminated site sources. This could lead to potential adverse health effects on ecological receptors.	All Project components	Sections 5 and 7	No residual effect has been identified.
Operations	Increased concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from topsoil stockpiles, erosion of trenches or roadways, or acid rock drainage or historic contaminated site sources. This could lead to potential adverse health effects on ecological receptors.	All Project components	Sections 5 and 7	No residual effect has been identified.
Decommissioning and Abandonment	Increased concentrations of chemicals or TSS in local streams, lakes or wells from minor fuel spills or other chemical spills, surface transport of particulates or blast residues from removal of valves and compressor stations. This could lead to potential adverse health effects on ecological receptors	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5 and 7	No residual effect has been identified.
Degradation of Soil Quality				
Construction	Increased concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, or ARD issues. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to adverse ecological health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.

Table 20-6: Potential Adverse Effects, Mitigation and Residual Adverse Effects of Proposed Project on Ecological Health (cont'd)

Project Phase	Potential Adverse Environmental Effect	Project Component/ Location	Mitigation	Potential Residual Adverse Environmental Effect(s)
Operations	Increased concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, or metals from ARD sources. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to adverse ecological health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Decommissioning and Abandonment	Increased concentrations of chemicals in surface soils from minor fuel spills or other chemical spills, or metals from ARD sources. This could lead to direct exposure (incidental soil ingestion, or dermal contact) leading to adverse ecological health effects.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5, 7 and 8	No residual effect has been identified.
Uptake and Food Chain Transfer of Contaminants in Ecological Receptors				
Construction	Increased concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or metals from ARD sources. This could lead to exposure and uptake in ecological receptors, and potential food chain transfer, causing adverse ecological health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Operations	Increased concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or metals from ARD sources. This could lead to exposure and uptake in ecological receptors, and potential food chain transfer, causing adverse ecological health effects.	All Project components	Sections 5, 7 and 8	No residual effect has been identified.
Decommissioning and Abandonment	Increased concentrations of chemicals in surface soils, water, or sediment, from minor fuel spills or other chemical spills, or metals from ARD sources. This could lead to exposure and uptake in ecological receptors, and potential food chain transfer, causing adverse ecological health effects.	Very localized, restricted to remaining above ground facilities following decommissioning and abandonment.	Sections 5, 7 and 8	No residual effect has been identified.

20.6.2 Potential Residual Adverse Effects

The potential residual adverse environmental effects on ecological health associated with the proposed Project are listed in Table 20-7.

Nine of the potential adverse effects on ecological health are assessed to not result in a residual adverse effect because of the effective application of mitigation outlined in Table 20-3 and in consideration of the low degree of plausibility and magnitude of potential chemical exposure pathways given the nature of the proposed Project. The rationale is provided below:

Degradation of Water or Sediment Quality

Concerns regarding degradation of water and sediment quality relate to minor spills, localized herbicide use, ARD generation, blasting residues, and release of hydrostatic test water to local waterbodies.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. To reduce the likelihood of other minor spills, documentation and records of spills will be prepared and reported to Project Management to assess safety trends and to properly manage spill scenarios, and adjust procedures and training, if necessary. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation and management measures and adequate spill response training and equipment, the potential exposure pathways to ecological receptors are considered improbable and associated exposure levels are considered negligible and no residual adverse effects were identified.

The handling, storage, use and disposal of herbicides are well understood and managed to mitigate health risks to people and to the environment. The periodic application of herbicide in select areas for the proposed Project is considered to represent negligible health risks to people. Direct exposures to ecological receptors will be avoided by applying herbicides by hand to target only noxious weeds and to avoid spraying adjacent plants or soil, thereby reduces the potential for dispersion to surrounding areas. The focused application of herbicide in limited quantities and through adherence to pesticide management procedures will act to mitigate potential exposures to ecological receptors. No residual adverse effects are identified.

The potential for a pathway from mineralized ARD zones to affect ecological health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD presents a risk to local waterbodies, additional mitigation is recommended to cap or cover the ARD substrate as required. Therefore, this activity would not be expected to be linked to potential contamination of water and sediment quality and no residual adverse effects were identified.

Blast residues of ammonia, nitrate and nitrite may also result in minor increases in localized areas of waterways for short periods. Blasting activity at this scale of use does not typically exert changes in water chemistry that would be detected above background variation. These potential concerns will also be addressed through proper management and use of blasting material such as ammonium nitrate to reduce the potential for release to local waterways. For these reasons, the potential for blasting residues to cause adverse effects has not been carried forward in the health risk assessment due to a lack of a plausible exposure scenario. No residual adverse effects are identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to aquatic life because the iron would not be expected to be absorbed in detectable levels by aquatic receptors (i.e., not bioavailable). Release water would undergo routine testing and visual inspection at the beginning, middle and end of to ensure that permit objectives are met and water quality is protected in local aquatic environments. Through the application of this mitigation, no residual adverse effects are identified.

Degradation of Soil Quality

Concerns regarding degradation of soil quality relate to minor spills, potential ARD generation, and release of hydrostatic test water to local areas.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. To reduce the likelihood of other minor spills, documentation and records of spills will be prepared and reported to Project Management to assess safety trends and to properly manage spill scenarios, and adjust procedures and training, if necessary. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation

and management measures and adequate spill response training and equipment, the potential for ecological receptors to be exposed to chemicals from minor spills in soil is considered negligible and no residual adverse effects were identified.

The potential for a pathway from mineralized ARD zones to affect ecological health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD presents a risk to local soil quality, additional mitigation is recommended to cap the ARD substrate as required. This would mitigate potential generation of acid drainage, avoiding mobilization of metals to the environment. Therefore, this activity would not be expected to be linked to potential contamination of local soils and no residual adverse effects were identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to ecological receptors because the iron would not be expected to be absorbed in detectable levels (i.e., not bioavailable) by ecological species coming in contact with soils that received test waters. Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and local soil quality is protected. Therefore, through the application of this mitigation, no residual adverse effects are identified.

Uptake and Food Chain Transfer of Contaminants in Ecological Receptors

Concerns regarding the potential for contaminant uptake and food chain transfer in ecological receptors relate to minor spills, localized herbicide use, ARD generation, blasting residues, and release of hydrostatic test water to local waterbodies.

Spills would be spatially limited to a small area, and would be immediately contained to avoid spread or escape. Spills would then be cleaned up, and waste materials disposed of by following spill contingency protocols listed in the Environmental Management Plan (Section 25.1 and Appendix 2-A). These protocols are specific to the nature and concentrations of contaminants contained in waste soil, sediment or water. To reduce the likelihood of other minor spills, documentation and records of spills will be prepared and reported to Project management, to assess safety trends and to properly manage spill scenarios, and adjust procedures and training, if necessary. These protocols will also inform staff of proper emergency procedures in the case of minor spills in order to maintain the safety of workers, local people and the environment. Project staff will have safety training including knowledge of methods and materials involved in the emergency response plan. Based on these mitigation and management measures and adequate spill response training and equipment, the potential exposure pathways to ecological receptors are considered improbable and associated exposure levels are considered negligible, and no residual adverse effects were identified.

The handling, storage, use and disposal of herbicides are well understood and managed to mitigate health risks to ecological receptors. The periodic application of herbicide in select areas for the proposed Project is considered to represent negligible ecological health risks. Direct exposures to ecological receptors will be avoided by applying herbicides by hand to target only noxious weeds and to avoid spraying adjacent plants or soil, thereby reduces the potential for dispersion to surrounding areas. The focused application of herbicide in limited quantities and through adherence to pesticide management procedures will act to mitigate potential exposures to ecological receptors. No residual adverse effects are identified.

The potential for a pathway from mineralized ARD zones to affect ecological health through transfer of mobilized metals is mitigated through testing of rock materials in areas of high ARD potential identified in the ARD assessment (Section 5.7). In cases where ARD potential is rated high, additional mitigation is recommended to cap the ARD substrate as required, to mitigate potential metal mobilization, transport and uptake in plants and animals. The potential exposure pathways are considered improbable, with low associated potential exposure levels, and no residual adverse effects were identified.

Blast residues of ammonia, nitrate and nitrite may also result in minor increases in localized areas of waterways for short periods. Blasting activity at this scale of use does not typically exert changes in water chemistry that would be detected above background variation. These potential concerns will also be addressed through proper management and use of blasting material such as ammonium nitrate. For these reasons, the potential for blasting residues to cause adverse effects has not been carried forward in the health risk assessment due to a lack of a plausible exposure scenario. No residual adverse effects are identified.

Hydrostatic testing at watercourse crossings may involve release of water containing rust particulates and trace hydrocarbons. These rust particulates comprise iron oxides which are bound in particulate form, and are therefore not associated with potential health concerns to ecological receptors because the iron would not be expected to be absorbed in detectable levels (i.e., not bioavailable) by ecological species coming in contact with soils that received test waters. Release water would undergo routine testing and visual inspection at the beginning, middle and end of dewatering to ensure that permit objectives are met and water quality is protected in local environments. Through the application of this mitigation, no residual adverse effects are identified.

20.6.3 Characterization of Potential Residual Adverse Effects

The potential residual adverse effects of the proposed Project on ecological health were characterized (Table 20-7). The rationale used to characterize each of the residual adverse environmental effects is provided below.

Air Quality Health Risks to Ecological Receptors

The potential for air emissions to result in potential ecological health risks was evaluated along the pipeline for the construction phase using a qualitative approach. More substantial emissions were expected during operations, specifically from the compressor stations. Therefore the operations phase was modeled quantitatively for air quality effects, and model results were then screened against appropriate AAQO and CWS based on worst case air model assumptions to be conservative (Section 6.6). The potential for ecological health risks was based on screening predicted air quality at fenceline of each proposed compressor station. Ecological receptors were assumed to be present throughout each LSA, therefore fenceline (i.e., maximum air concentration in the LSA) was conservatively used for ecological exposure assessment (Figures 20-2 to 20-9).

Air dispersion model results were reported for the predicted maximum concentrations based on the application case (i.e., existing background disturbance to air quality, combined with disturbance attributed to the proposed Project) for each of the eight compressor stations during operations (Appendix B, Table B-3), for the following CACs and time-weighted averages:

- SO_2 (1 hour (h), 3h, 24h and Annual)
- NO_2 (1h, 24h and Annual)
- CO (1h, 8h)
- $PM_{2.5}$ (24h and Annual)
- $PM_{2.5}$ (98^{th} percentiles used: 24h and Annual)
- Total Volatile Organic Compounds (VOC; 1h, 24h and Annual)

No predicted values exceeded BC AAQO or Canada Wide Standards, with the maximum (fenceline) values ranging from 1 to 87% of objectives, therefore no health risks are anticipated from the proposed Project compressor stations (Appendix B, Table B-3). There are no AAQO or CWS for total VOCs. VOCs will be intermittently released during maintenance venting of facilities lines. Their magnitude is expected to be minimal in terms of ambient levels originating from naturally occurring forest fires, and thus is not associated with predicted health risks to wildlife receptors. These results indicate that the potential for project-related adverse health effects on the identified ecological receptors from compressor station emissions is negligible.

Compressor station emissions and fugitive dust were considered worst case scenarios for this proposed Project during operations, and showed insignificant increases in $PM_{2.5}$ relative to the AAQO. Therefore, fugitive dust sources were not modeled for the construction phase but were also assumed to be negligible based on application of appropriate mitigation and best management practices to control road dust and fugitive dust from topsoil storage, trenches and other sources.

Table 20-7: Characterization of Potential Residual Adverse Effects on Ecological Health

Potential Residual Adverse Environmental Effect(s)	Spatial Boundary[a)]	Temporal Context			Magnitude	Likelihood
		Duration	Frequency	Reversibility		
Air Quality Effects						
Degraded air quality leading to adverse inhalation health effects in wildlife during construction.	LSA	Short-term	Occasional	Short-term	Negligible to Low	Low
Degraded air quality leading to adverse inhalation health effects in wildlife during operations.	LSA	Long-term	Occasional	Long-term	Low	Low
Degraded air quality leading to adverse inhalation health effects in wildlife during decommissioning and abandonment.	LSA	Short-term	Occasional	Short-term	Negligible to Low	Low
Noise Effects to Ecological Receptors						
Increased noise levels leading to ecological health risks during construction	LSA	Short-term	Continuous	Medium-term	Negligible to Low	Low
Increased noise levels leading to ecological health risks during operations	LSA	Long-term	Continuous	Medium-term	Low	Low
Increased noise levels leading to ecological health risks during decommissioning and abandonment	LSA	Short-term	Occasional	Medium-term	Negligible to Low	Low

Note:
[a)] LSA = Human and Ecological Health LSA

During the construction phase, ambient air quality could potentially be affected by emissions from vehicles and machines, and from fugitive dust sources. Combustion emissions could contribute to increased CAC concentrations in the vicinity of the proposed Project access roads along the proposed route, and at metering station and compressor stations. Fugitive dust sources include dust from roads that are released from traffic, topsoil stockpiles, and from clearing during site preparation.

During the decommissioning and abandonment phase, ambient air quality could potentially be affected by emissions and dust from vehicles and machinery during as a result of decommissioning activities (i.e., removal of above ground facilities, site recontouring, reclamation of disturbed areas) and through road closing activities. Combustion emissions could contribute to increased CAC concentrations in the vicinity of the proposed Project access roads and along the proposed route. However, the activities are limited to the removal of surface facilities such as permanent access roads, compressor and valve stations, while the pipeline will be abandoned in place to reduce disturbance along the proposed route.

Degraded Air Quality Leading to Adverse Inhalation Health Effects in Wildlife During Construction

The potential residual adverse effect on ecological health risks from degraded air quality associated with construction emissions and fugitive dust to the surrounding airshed was assessed. The rationale for the ecological health risk assessment is provided below.

- Context: For the ecological health risk assessment, the potential adverse effects of the proposed Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals in a population based on the use of appropriate AAQO that is protective of these sensitive individuals. Resilience of individuals would be difficult to characterize without conducting site-specific studies of current wildlife population health which are beyond the scope of the risk assessment and the requirements of the Application. Therefore, sensitivity and resilience were not separately characterized in this risk assessment. This follows standard risk assessment guidance by Environment Canada.
- Spatial boundary: HHERA LSA - this was the area in which ecological receptors were identified and assessed.
- Duration: Short-term - because the assessment was conducted using worst case predicted air concentrations that would occur over a time-weighted average period ranging from one hour to one year. The more typical air concentrations that wildlife would be exposed to would be expected to be lower than the maximum predicted values, since wildlife are mobile and distributed throughout the HHERA LSA and beyond (i.e., home range). Also, active construction would only occur in an area for a short portion of the entire construction phase, therefore the short-term rating applies. CACs would be emitted mainly during working hours, representing a portion of each day
- Frequency: Occasional - air emissions (i.e., fugitive dust and CACs from machines and vehicles during construction) would be sporadic and intermittent over the assessment period.
- Reversibility: Short-term - identified health risks would apply only through the construction phase.
- Magnitude: Negligible to low - some CACs were not predicted to change appreciably from baseline concentrations (and therefore had negligible magnitude) and others could potentially show a detectable increase from baseline but would remain below regulatory health-based standards (classified as low magnitude).
- Likelihood: Low – it is unlikely that residual health risks to ecological receptors would occur, because of the conservatism built into the air dispersion model, the

use of maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Degraded Air Quality Leading to Inhalation Health Effects in Wildlife During Operations

The potential residual adverse effect on ecological health risks was assessed in regards to potential changes in air quality that may be associated with operational air emissions and fugitive dust to the surrounding airshed.

The rationale for the ecological health risk assessment is provided below:

- Context: For the ecological health risk assessment, the potential adverse effects of the Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals in a population based on the use of appropriate AAQO that is protective of these sensitive individuals. Resilience of individuals would be difficult to characterize without conducting site-specific studies of current wildlife population health which are beyond the scope of the risk assessment and the requirements of the Application. Therefore, sensitivity and resilience were not characterized separately in this risk assessment. This follows Environment Canada's standard risk assessment guidance.
- Spatial boundary: HHERA LSA - this was the area in which human receptors were identified and assessed.
- Duration: Long-term - the emissions would be released throughout operational life of the proposed compressor stations. This is a conservative approach, given that the maximum predicted air concentrations were used in screening health risks. The more typical air concentrations that would be expected to occur on a day-to-day basis within the HHERA LSA would be much lower than those maximum values conservatively applied to screen ecological health risks in this report.
- Frequency: Occasional - based on the nature of predicted emissions from operations sources (i.e., compressor stations, vehicles, fugitive dust). This is a conservative approach, given that it would be expected that much of the time, air concentrations would be lower than the maximum values used in the assessment. Furthermore, the mobility of wildlife and the fact that home ranges extending beyond the HHERA LSA would further reduce actual ecological exposures.
- Reversibility: Long-term - identified health risks would apply through the operations phase.
- Magnitude: Low - All predicted maximum concentrations during the operations phase, representing conservative (overestimated) exposure scenarios for ecological receptors, were below all of the AAQO and CWS (Appendix B, Table B-3). These maximum concentrations would occur at or very close to fenceline of each proposed compressor station location, and concentrations would quickly drop to baseline levels within a short distance.

- Likelihood: Low - it was judged to be unlikely that adverse residual health risks to ecological receptors would occur, because of the conservatism built into the air dispersion model, the use of maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Degraded Air Quality Leading to Inhalation Health Effects in Wildlife During Decommissioning and Abandonment

The potential adverse residual adverse effect on health risks to wildlife from degraded air quality associated with emissions and fugitive dust to the surrounding airshed during decommissioning and abandonment was assessed. The rationale for the ecological health risk assessment is provided below.

- Context: For the ecological health risk assessment, the potential adverse effects of the Project are evaluated in relation to health risks, not to health condition. The assessment screens potential health risks to sensitive individuals in a population based on the use of appropriate AAQO that is protective of these sensitive individuals. Resilience of individuals would be difficult to characterize without conducting site-specific studies of current wildlife population health which are beyond the scope of the risk assessment and the requirements of the Application. Therefore, sensitivity and resilience were not characterized separately in this risk assessment. This follows standard risk assessment guidance by Environment Canada.
- Spatial boundary: HHERA LSA - this was the area in which ecological receptors were identified and assessed. The affected area for this work would be fairly limited to small areas associated with compressor, meter or valve stations, while the pipeline would be abandoned in place.
- Duration: Short-term - the assessment was conducted using worst case predicted air concentrations that would occur over a time-weighted average period ranging from one hour to one year. The more typical air concentrations that would be expected to occur on a day-to-day basis within the HHERA LSA would be much lower than those maximum values conservatively applied to screen ecological health risks in this report. Also, active decommissioning would only occur in an area for a short portion of the entire phase, therefore, the short-term rating applies. Furthermore, CACs would be emitted mainly during working hours, representing a portion of each day.
- Frequency: Occasional - air emissions (i.e., fugitive dust and CACs from machinery and vehicles during decommissioning) would be sporadic and intermittent over the assessment period. The mobility of ecological receptors also indicates that frequency of exposure would be occasional or less frequent.
- Reversibility: Short-term - identified health risk would apply only through the decommissioning phase while emissions occurred. Following the cessation of emissions, health risks would be eliminated.

- Magnitude: Negligible to low, similar to the rating for the magnitude of potential health risks due to air quality degradation during the construction phase. Some CACs were not predicted to change appreciably from baseline concentrations (and therefore had negligible magnitude) and others could potentially show a detectable increase from baseline but would remain below regulatory health-based standards (classified as low magnitude).
- Likelihood: Low – it was judged to be unlikely that residual health risks to ecological receptors would occur, because of the conservatism built into the air dispersion model, the use of maximum air quality predictions from the model, and the conservative nature of the AAQOs used to screen air quality predictions.

Noise Disturbance to Ecological Receptors

Quantitative noise modeling results are provided in Section 6.5. No noise thresholds were predicted to be exceeded at 1.5 km or within the HHERA LSA during any Project phase.

Increased Noise Levels Leading to Ecological Health Effects During Construction

The noise effects assessment quantitatively modeled predicted noise levels from construction of facilities including horizontal directional drilling (Section 6.5.2). The noise assessment predicted no exceedance of noise thresholds for humans, resulting in no significant noise effects on local residents. The proposed construction activities would not be audible to the nearby residents most of the time. It was assumed that noise thresholds designed to protect people from noise disturbance would be protective of ecological populations. This was rationalized based on the fact that wildlife and birds are more mobile than human residents, and therefore wildlife would move away from noise sources.

The rationale for the effect characterization is provided below.

- Context: The HHERA LSA along the proposed route spans a variety of habitat types managed for a variety of land uses. However, the majority of the HHERA LSA is considered remote for the purposes of the assessment of noise effects on wildlife. Therefore, ecological receptors would be expected to be sensitive to noise disturbance, at least initially until accustomed to the noise. The resilience of ecological receptors would also be species-dependent but in general would be considered moderate for most species, and low for species that are not tolerant of noise disturbance.
- Spatial boundary: HHERA LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary centred on each proposed compressor station location. This is the area in which the noise assessment is based, following regulatory guidance.
- Duration: Short-term - activity will occur during daytime for the construction phase, except trenchless installation methods, which may occur 24 hours a day.

- Frequency: Continuous - activity and associated noise will be occurring continuously throughout the construction phase. This is considered conservative, since many ecological receptors would reside in the outer perimeter of the Health LSA, away from the 1.5 km buffer surrounding the compressor stations.
- Reversibility: Medium-term - following cessation of construction activity, noise effects on ecological receptors would cease, and populations would recover from localized disturbance.
- Magnitude: Negligible to Low - residual noise levels meet Health Canada and BC OGC noise thresholds for construction activities.
- Likelihood: Low – it was judged that residual noise disturbances would occur, based on the quantitative noise modeling undertaken and resulting predicted noise levels remaining below thresholds.

Increased Noise Levels Leading to Ecological Health Effects During Operations

The noise effects assessment quantitatively modeled predicted noise levels from operation of the proposed pipeline, compressor stations and ancillary sites (Section 6.5.3). The noise assessment predicted no exceedance of noise thresholds at the nearest receptor, resulting in no significant noise effects. Cautionary thresholds for low frequency noise (LFN) were exceeded (Table 6-16). However, no LFN tonality is expected, and predicted noise levels are conservative; actual noise levels will be likely lower than these predicted. Furthermore, residential noise complaints generally occur 5 dB higher than the cautionary threshold, and so it is assumed that these levels would similarly not affect ecological receptors. Therefore, no adverse LFN noise effects are expected. The proposed operations activities would not be audible to the nearby residents, and therefore it is assumed that disturbance to wildlife populations at fenceline (or further away within the HHERA LSA) would be relatively minor most of the time and would not be expected to result in noise disturbance. The rationale for the effect characterization is provided below.

- Context: The HHERA LSA along the proposed route spans a variety of habitat types managed for a variety of land uses. However, the majority of the HHERA LSA is considered remote for the purposes of the assessment of noise effects on wildlife. Therefore, ecological receptors would be expected to be sensitive to noise disturbance, at least initially until accustomed to the noise. The resilience of ecological receptors would also be species-dependent but in general would be considered moderate for most species, and low for species that are not tolerant of noise disturbance
- Spatial boundary: HHERA LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary in which the noise assessment is based, following regulatory guidance.
- Duration: Long-term - activity will occur during operations phase for the life of the proposed Project.

- Frequency: Continuous - the activity and associated noise will be occurring continuously throughout the operations phase. This is considered conservative, since many ecological receptors would reside in the outer perimeter of the HHERA LSA, away from the 1.5 km LSA surrounding the proposed compressor station locations. Therefore the frequency of noise exposure would likely be less than continuous.
- Reversibility: Medium-term - following cessation of operations activity, noise effects on ecological receptors would cease, and populations would recover from localized disturbance.
- Magnitude: Low - residual noise levels meet Health Canada and BC OGC noise thresholds for operations activities, and LFN noise levels do not produce harmonic tonality or reach levels typically associated with noise complaints. It is assumed that ecological populations would show similar or less sensitivity than nearby residents.
- Likelihood: Low – it is judged unlikely that residual noise disturbances would occur, based on the quantitative noise modeling undertaken and resulting predicted noise levels remaining below thresholds at fenceline.

Increased Noise Levels Leading to Ecological Health Effects During Decommissioning and Abandonment

The noise effects assessment assumed that noise levels during the decommissioning and abandonment phase would be equal or less than noise generated during the construction phase (Section 6.5.2). The noise assessment predicted no exceedance of noise thresholds, resulting in no significant noise effects at fenceline during construction. Noise levels are expected to be much lower during decommissioning and abandonment activities compared to the construction phase because activities will be localized and occur only as specific locations along the pipeline (e.g., compressor station sites, access roads, valve sites). Therefore, no noise disturbance effects are anticipated for the decommissioning and abandonment phase.

The rationale for the effect characterization is provided below.

- Context: The HHERA LSA along the proposed route spans a variety of habitat types managed for a variety of land uses. However, the majority of the HHERA LSA is considered remote for the purposes of the assessment of noise effects on wildlife. Therefore, ecological receptors would be expected to be sensitive to noise disturbance, at least initially until accustomed to the noise. The resilience of ecological receptors would also be species-dependent but in general would be considered moderate for most species, and low for species that are not tolerant of noise disturbance

- Spatial boundary: HHERA LSA boundary – this encompasses the 1.5 km radial Noise LSA boundary in which the noise assessment is based, following regulatory guidance.
- Duration: Short-term - activity will occur during only a part of the decommissioning and abandonment phase for each location.
- Frequency: Occasional - activity and associated noise will be occurring occasionally during different aspects of decommissioning and abandonment activities at the various locations of the proposed route and facilities.
- Reversibility: Medium-term - following cessation of decommission and abandonment activities, noise effects on ecological receptors would cease, and populations would recover from associated localized disturbance.
- Magnitude: Negligible to Low - residual noise levels meet Health Canada and BC OGC noise thresholds for decommissioning and abandonment activities.
- Likelihood: Low - it was judged unlikely that residual noise disturbances would occur, based on the quantitative noise modeling undertaken and resulting predicted noise levels remaining below thresholds.

20.6.4 Potential Residual Adverse Effects - Determination of Significance and Confidence

Significance thresholds for ecological health are defined for key indicators as increases in stressor exposure levels that exceed the AAQOs or where baseline ranges exceed the AAQOs, where increased exposure levels exceed the baseline concentrations by more than the risk acceptability benchmarks established by regulatory agencies.

Established health-based objectives, criteria, guidelines and toxicological exposure limits are used for the various exposure pathways in characterizing ecological health risks to populations and communities, and determining significance of potential adverse effects.

As discussed in Section 20.6.1, several potential environmental changes that could lead to a contaminant exposures to wildlife and indicate the potential for health risks were considered. These potential changes that were identified in the conceptual site model include potential degradation of water or sediment quality, degradation of soil quality, or degradation of food quality, leading to ecological health risks. There were no plausible exposure pathways identified for these key indicators, or where there was a potential pathway, the anticipated level of potential exposure was considered undetectable from baseline ranges or would be negligible.

Table 20-8 provides a summary of the determination of significance and confidence in the prediction of the potential residual adverse effects identified in Section 20.6.3.

Table 20-8: Determination of Significance and Confidence for Potential Residual Adverse Effects on Ecological Health

Potential Residual Effect(s)	Determination of Significance and Confidence	Recommended Follow-up and Monitoring
Degraded air quality leading to inhalation health effects in wildlife during construction	Not significant High confidence	Monitoring of air emissions
Degraded air quality leading to inhalation health effects in wildlife during operations	Not significant High confidence	Monitoring of air emissions
Degraded air quality leading to inhalation health effects in wildlife during decommissioning and abandonment	Not significant High confidence	Monitoring of air emissions
Noise effects leading to disturbance and health effects in wildlife during construction	Not significant High confidence	None
Noise effects leading to disturbance and health effects in wildlife during operations	Not significant High confidence	None
Noise effects leading to disturbance and health effects in wildlife during decommissioning and abandonment	Not significant High confidence	None

Degraded Air Quality Leading to Inhalation Health Effects in Wildlife During Construction

The residual adverse effect of degraded air quality during the construction phase is rated as not significant. This is based on the negligible to low magnitude of increase in CAC concentrations that are an order of magnitude or more below the regulatory standards for air quality protective of sensitive receptors. These regulatory standards are considered protective of the most sensitive receptor, therefore application of these standards to screen potential adverse ecological health effects is generally considered acceptable. The air model used conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase, which would have the highest emission rates. Therefore, the construction phase air quality would be expected to be better than that predicted and assessed with the air model. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which have been approved and recommended by BC MOE and US EPA, and are therefore standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed by air quality and will be adequate to meet the future needs of the HHERA.

The residual adverse effect of degraded air quality leading to ecological health risks during construction is considered to be not significant, and determined with high confidence.

Degraded Air Quality Leading to Inhalation Health Effects in Wildlife During Operations

The residual adverse effect of degraded air quality during the operations phase is rated as not significant. This is based on the negligible to low magnitude of increase in CAC concentrations, remaining an order of magnitude or more below the regulatory standards for air quality protective of sensitive receptors. These regulatory standards are considered protective of the most sensitive receptor, therefore application of these standards to screen potential adverse ecological health effects is generally considered acceptable. The air model used very conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which are standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed for air quality.

The residual adverse effect of degraded air quality leading to adverse ecological health effects during operations is considered to be not significant and determined with high confidence.

Degraded Air Quality Leading to Inhalation Health Effects in Wildlife During Decommissioning and Abandonment

The residual adverse effect of degraded air quality during the decommissioning and abandonment phase is rated as not significant. This is based on the negligible magnitude of increase in CAC concentrations, remaining an order of magnitude or more below the regulatory standards for air quality protective of sensitive receptors. These regulatory standards are considered protective of the most sensitive receptor, therefore application of these standards to screen potential adverse ecological health effects is generally considered acceptable. The air model used very conservative air quality predictions (based on the single highest maximum concentration out of all of the receptor locations, that may occur only for one hour a year) to evaluate the worst case scenario during operations phase. Air quality would be expected to change less during decommissioning and abandonment than during operations. There is a high degree of confidence in the assessment based on the use of CALPUFF and CALMET air models which are standard for the industry. Monitoring of air emissions is expected to be part of the mitigation and management strategy proposed by Air Quality.

The residual adverse effect of degraded air quality leading to ecological health effects during decommissioning and abandonment is considered to be not significant and determined with high confidence.

Noise Leading to Disturbance of Ecological Receptors During Construction

The residual adverse effect of noise to potentially disturb local wildlife during the construction phase is rated as not significant. This is based on the negligible to low magnitude changes in ambient noise levels that were quantitatively modeled and indicated no exceedance of noise thresholds (Section 6.5.2). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local wildlife during construction is considered to be not significant and determined with high confidence.

Noise Leading to Disturbance of Local Residents During Operations

The residual adverse effect of noise to potentially disturb local wildlife during the operations phase is rated as not significant. This is based on the low magnitude changes in ambient noise levels that were quantitatively modeled and indicated no exceedance of noise thresholds (Section 6.5.3). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local wildlife during operations phase is considered to be not significant and determined with high confidence.

Noise Leading to Disturbance of Local Residents During Decommissioning and Abandonment

The residual adverse effect of noise to potentially disturb local wildlife during the decommissioning and abandonment phase is rated as not significant. This is based on the negligible to low magnitude changes in ambient noise levels that were quantitatively modeled and indicated no exceedance of noise thresholds (Section 6.5.2). There is a high degree of confidence in the assessment based on the use of quantitative noise models, and the conservatism employed within the models in following guidance provided by BC OGC and Health Canada.

The residual adverse effect of noise to potentially disturb local wildlife during decommissioning and abandonment is considered to be not significant, and determined with high confidence.

20.6.5 Cumulative Adverse Effects Assessment Overview

Cumulative adverse effects are defined as changes to the environment that are caused by a proposed Project in combination with other past, present or future human

disturbance including development. It is recognized that cumulative adverse effects may be different in nature or extent from the effects of the individual activities.

Projects and Activities Considered for the Cumulative Effects Assessment

The list of potential projects and activities outlined in Appendix 3-A of Volume 3 of the Application was reviewed to determine which projects and activities are located within the HHERA RSA in order to assess if there is overlap in potential residual ecological health risks related to air and noise emissions.

20.6.6 Cumulative Effects, Mitigation and Environmental Management Strategies

Regarding air quality and noise emissions, there were no planned future facility emission sources identified within the HHERA RSA. Past projects have no bearing on current or future air or noise conditions. Contributions to ambient air quality and noise levels within the HHERA RSA from current projects are already included within the background input to the effects assessment modeling for the project effects. Therefore, current projects were already considered in the effects assessment and therefore are not addressed in the cumulative adverse effects section for health. Because there are no planned future facility emissions identified, no cumulative air quality assessment or noise assessment was conducted. The potential for cumulative adverse noise effects related to forestry and farming activities overlapping the Wilde Lake compressor station was rated as negligible. Therefore, a cumulative health assessment has not been undertaken. The potential for cumulative adverse health effects does not exist for the proposed Project. No mitigation is required in addition to the mitigation strategies proposed for air quality (Section 6.6) and noise (Section 6.5).

20.6.7 Conclusion

Predicted ambient air quality and noise levels remained well below the regulatory thresholds. There were no significant residual ecological health risks associated with the proposed Project. There are no potential cumulative ecological health risks associated with the Project.

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Appendices – Section 20
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Appendix 20A
Abbreviations

Acronym	Definition
AAQO	ambient air quality objectives
ARD	acid rock drainage
ATK	Aboriginal Traditional Knowledge
BC MOE	BC Ministry of Environment
CAC	criteria air contaminants
CEAA	Canadian Environmental Assessment Agency
CO	carbon dioxide
CSR	contaminated sites regulations
CWS	Canadian wide standards
DFO	Department of Fisheries and Oceans
EA	environmental assessment
EC	Environment Canada
FOC	Fisheries and Oceans Canada
H2S	hydrogen sulfide
HEPH	heavy extractable petroleum hydrocarbons
HHERA	human health and ecological risk assessment
ISQG	interim sediment quality guidelines
KI	key indicators
LEPH	light extractable petroleum hydrocarbons
LRMP	Land Resource Management Plan
LSA	local study area
NO2	nitrogen dioxide
PAH	polycyclic aromatic hydrocarbons
PEL	probable effects level
PM	particulate matter
PSL	permissible sound limit
pTDI	provisional tolerable daily intake
RSA	regional study area
SO2	sulphur dioxide
TDI	tolerable daily intake
TERA	TERA Environmental Consultants
TK	Traditional knowledge
TLU	Traditional land use
TRV	toxicity reference value
VC	valued component
WQG-FAL	water quality guidelines for the protection of freshwater aquatic life

Application for an Environmental Assessment Certificate

Appendix 20B
Tables

Table 20B-1: Baseline Public Health Statistics Regarding Incidence of General Health and Well-being, Mortality and Disease

	Health Service Delivery Area			British Columbia
	Northwest	Northern Interior	Northeast	
General Health and Well-Being, Types[7]				
Perceived health, very good or excellent (%)[1]	53.1	53.3	61.1	59.6
Life Expectancy at birth (years)[2]	77.9	78.6	78.4	81.7
Life expectancy at age 65 (years)[2]	18.6	18.7	18.5	20.7
Mortality Type, Incidence[7]				
Infant Mortality Rate (per 1,000 live births)[3]	4.9	4.9	4.7	4.2
Total, all causes of deaths [3]	659.9	670.1	690.2	523.1
All cancer, deaths [3]	171.4	203.9	191.6	152.5
Colorectal cancer, deaths [3]	19.9	24.5	19.0	15.4
Lung cancer, deaths [3]	50.0	66.9	52.1	40.2
Breast cancer, deaths [3]	17.6	19.6	28.9	19.3
Prostate cancer, deaths [3]	26.0	25.8	26.7	20.2
All circulatory disease, deaths [3]	196.5	183.4	196.9	189.5
Respiratory diseases, deaths [3]	62.5	59.5	57.8	45.3
Pneumonia and influenza, deaths [3]	17.8	16.1	20.2	13.8
Bronchitis, emphysema and asthma, deaths [3]	4.5	2.8	5.1	2.8
All other respiratory disease, deaths [3]	40.2	40.6	32.4	28.7
Unintentional injuries, deaths [3]	39.5	35.9	42.6	25.6
Suicides and self-infliced injuries, deaths [3]	16.7	10.4	8.6	8.8
Premature mortality [4]	357.8	322.2	341.1	236.8
Avoidable mortality from preventable causes [4]	190.6	157.1	169.4	113.0
Avoidable mortality from treatable causes [4]	75.9	73.3	84.8	56.1
Cancer Type, Incidence[7]				
All cancer incidence [5]	469.3	423.6	395.6	367.9
Colon cancer incidence [5]	70.2	50.4	72.1	44.2
Lung cancer incidence [5]	50.3	61.9	41.3	48.8
Breast cancer incidence [5]	97.0	106.0	96.9	92.9
Prostate cancer incidence [5]	146.3	130.0	128.3	119.9
Mental Health, Incidence[7]				
Perceived mental health, very good or excellent (%)[1]	63.4	67.1	73.2	71.0
Mental illness hospitalization rate [6]	1019.0	847.0	831.0	594.0
Patients with repeat hospitalization for mental illness (%)[6]	17.9	12.9	11.2	12.7
Obesity, Rates[7]				
Overweight or obese (%)[1]	62.1	54.9	58.2	44.7
Overweight (%)[1]	41.4	34.7	37.5	31.3
Obese (%)[1]	20.7	20.2	20.7	13.5

1 Statistics Canada, Canadian Community Health Survey 2009-2010.
2 Statistics Canada, Canadian Vital Statistics, Death Database and Demography Division 2007-2009.
3 Statistics Canada, Canadian Vital Statistics, Death Database and Demography Division 2005-2007.
4 Statistics Canada, Canadian Vital Statistics, Death Database and Demography Division 2006-2008.
5 Statistics Canada, Canadian Cancer Registry Database and Demography Division 2007-2009.
6 Statistics Canada, Discharge Abstract Database, Ontario Mental Health Reporting System 2009-2011.
7 Values as incidence per 100,000 individuals unless note otherwise. Breast cancer per female population. Prostate cancer per male population.

Table 20B-2: Baseline Sediment Quality at Edako, Goosly Lake and Brule Sites Along the Proposed CGL Project Corridor, June 2013

Parameter	Unit	CCME SQG FW-ISQG Guideline mg/kg	CCME SQG FW-PEL Guideline mg/kg	Detection Limit	Endako Site 2-1	Endako Site 2-2	Endako Site 2-3a	Endako Site 2-3b	Goosly Site 3-1	Goosly Site 3-2	Goosly Site 3-3a	Goosly Site 3-3b	Brule Site 1-1	Brule Site 1-2	Brule Site 1-3a	Brule Site 1-3b
Date Sampled					06/16/2013	06/16/2013	06/16/2013	06/16/2013	06/14/2013	06/14/2013	06/14/2013	06/14/2013	06/28/2013	06/28/2013	06/28/2013	06/28/2013
Lab Sample ID					4469420	4469421	4469422	4469423	4469790	4469792	4469793	4469794	4508588	4508589	4508590	4508591
					Zone 10U: 369280 E, 5993846 N				Zone 9U: 673386 E, 6005318 N				Zone 10U: 578963 E, 6136416 N			
Sieve Analysis - 75 microns (wet)	%			N/A	75.6	75.5	76.1		93.4	91.8	91.7		52.0	62.3	80.1	
Sieve Texture	NA				Coarse	Coarse	Coarse		Coarse	Coarse	Coarse		Coarse	Coarse	Coarse	
Organic Carbon - Total	%			0.02	0.50	0.55	0.39		0.40	0.79	0.54		3.86	4.30	2.17	
pH 1:2	pH units			0.1	7.1	7.2	7.4		6.1	6.0	6.0		8.7	8.5	8.5	
Total Sulphur	%			0.005	0.02	0.02	0.02									
Antimony	mg/kg			0.05	0.34	0.35	0.33		0.45	0.50	0.48		0.89	0.92	1.03	
Arsenic	mg/kg	5.9	17.0	0.1	6.1	6.1	6.0		5.1	5.1	4.9		4.2	4.3	5.1	
Barium	mg/kg			0.5	153	146	141		149	158	145		239	269	241	
Beryllium	mg/kg			0.02	0.38	0.38	0.36		0.29	0.30	0.31		0.39	0.41	0.47	
Boron (Hot Water Soluble)	mg/kg			0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1		0.3	0.3	0.2	
Cadmium	mg/kg	0.6	3.5	0.01	0.20	0.20	0.19		0.40	0.44	0.39		1.34	1.32	1.44	
Chromium	mg/kg	37.3	90.0	1	20	20	20		21	20	20		9	9	10	
Cobalt	mg/kg			0.1	10.0	10.0	10.0		9.5	10.0	9.3		5.1	5.0	5.2	
Copper	mg/kg	35.7	197.0	0.2	11.2	11.7	11.0		14.5	14.3	13.5		11.5	11.7	11.7	
Lead	mg/kg	35.0	91.3	0.1	4.6	4.6	4.5		4.8	4.9	5.0		6.1	6.4	7.3	
Mercury	mg/kg	0.17	0.486	0.01	0.03	0.03	0.03		<0.01	0.02	0.01		0.06	0.07	0.05	
Molybdenum	mg/kg			0.05	2.05	2.22	1.93		0.49	0.51	0.45		1.36	1.40	1.68	
Nickel	mg/kg			0.5	19.6	19.6	19.4		18.6	19.2	17.1		28.7	28.1	26.2	
Selenium	mg/kg			0.1	0.2	0.2	0.3		0.1	0.1	0.2		1.4	1.3	1.3	
Silver	mg/kg			0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05		0.16	0.16	0.15	
Thallium	mg/kg			0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05		0.13	0.15	0.15	
Tin	mg/kg			0.05	0.32	0.33	0.32		0.36	0.37	0.36		0.22	0.19	0.21	
Vanadium	mg/kg			1	51.0	51.0	50.0		68.0	71.0	65.0		26.0	26.0	29.0	
Zinc	mg/kg	123.0	315.0	1	74.0	74.0	73.0		70.0	73.0	72.0		104.0	113.0	122.0	

Table 20B-2: Baseline Sediment Quality at Edako, Goosly Lake and Brule Sites Along the Proposed CGL Project Corridor, June 2013 (cont'd)

Parameter	Unit	CCME SQG FW-ISQG Guideline mg/kg	CCME SQG FW-PEL Guideline mg/kg	Date Sampled / Lab Sample ID / Detection Limit	Endako Site 2-1	Endako Site 2-2	Endako Site 2-3a	Endako Site 2-3b	Goosly Site 3-1	Goosly Site 3-2	Goosly Site 3-3a	Goosly Site 3-3b	Brule Site 1-1	Brule Site 1-2	Brule Site 1-3a	Brule Site 1-3b
				Date Sampled	06/16/2013	06/16/2013	06/16/2013	06/16/2013	06/14/2013	06/14/2013	06/14/2013	06/14/2013	06/28/2013	06/28/2013	06/28/2013	06/28/2013
				Lab Sample ID	4469420	4469421	4469422	4469423	4469790	4469792	4469793	4469794	4508588	4508589	4508590	4508591
				Detection Limit	Zone 10U: 369280 E, 5993846 N				Zone 9U: 673386 E, 6005318 N				Zone 10U: 578963 E, 6136416 N			
Organics																
Acenaphthene	mg/kg	0.00671	0.0889	0.01				<0.01				<0.01				<0.01
Acenaphthylene	mg/kg	0.00587	0.128	0.01				<0.01				<0.01				<0.01
Anthracene	mg/kg	0.0469	0.245	0.02				<0.02				<0.02				<0.02
Benzo(a)anthracene	mg/kg	0.0317	0.385	0.02				<0.02				<0.02				<0.02
Benzo(a)pyrene	mg/kg	0.0319	0.782	0.05				<0.05				<0.05				<0.05
Benzo(b)fluoranthene	mg/kg			0.02				<0.02				<0.02				0.04
Benzo(g,h,i)perylene	mg/kg			0.05				<0.05				<0.05				<0.05
Benzo(k)fluoranthene	mg/kg			0.02				<0.02				<0.02				<0.02
Chrysene	mg/kg	0.0571	0.862	0.05				<0.05				<0.05				0.15
Dibenzo(a,h)anthracene	mg/kg	0.00622	0.135	0.02				<0.02				<0.02				<0.02
Fluoranthene	mg/kg	0.111	2.355	0.05				<0.05				<0.05				<0.05
Fluorene	mg/kg	0.0212	0.144	0.02				<0.02				<0.02				0.04
Indeno(1,2,3-c,d)pyrene	mg/kg			0.02				<0.02				<0.02				<0.02
Naphthalene	mg/kg	0.0346	0.391	0.01				<0.01				<0.01				0.31
Nitrobenzene - d5	%							93				94				98
Phenanthrene	mg/kg	0.0419	0.515	0.02				<0.02				<0.02				**0.61**
P-Terphenyl - d14	%							98				95				90
Pyrene	mg/kg	0.053	0.875	0.02				<0.02				<0.02				0.04
1-Methylnaphthalene	mg/kg			0.01				<0.01				<0.01				0.29
2-Fluorobiphenyl	%							89				91				97
2-Methylnaphthalene	mg/kg	0.0202	0.201	0.01				0.01				<0.01				**0.76**
LEPH C10-C19	mg/kg			20				<20				<20				<20
HEPH C19-C32	mg/kg			20				<20				67				<20

Values above the CCME Interim Sediment Quality Guideline for freshwater aquatic life are shaded grey

Values above the CCME Probably Effect Level for freshwater aquatic life are bolded in box

Table 20B-3: Maximum Predicted Application Case (Project + Background) Ambient Air Quality Concentrations at Compressor Stations

Parameter	Averaging Period	Background	Wilde Lake C/S	Sukunka Falls C/S	Mount Bracey C/S	Racoon Lake C/S	Clear Creek C/S	Segundo Lake C/S	Goosly Falls C/S	Titanium Peak C/S	Max Project Only Background %	BC AAQO or Canada Wide Standarda	Max Application AAQO %
			KP3	KP86	KP166	KP252	KP332	KP419	KP493	KP575			
SO2	1-hour	3.7	4.1	4.3	4.0	3.9	3.9	3.9	4.5	4.2	21	450	1
	3-hour	3.8	4.0	4.0	4.0	4.0	4.0	4.0	4.1	4.0	7	375	1
	24-hour	3.5	3.7	3.7	3.7	3.7	3.6	3.7	3.6	3.7	6	150	2
	Annual	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	2	25	5
NO2 b	1-hour	44	203	246	174	149	171	120	277	213	528	400	69
	24-hour	38	130	90	111	93	98	91	83	92	246	200	65
	Annual	12	17	22	20	19	19	19	19	20	82	60	36
CO	1-hour	1,077	1,443	1,358	1,355	1,324	1,378	1,253	1,396	1,316	34	14,300	10
	8-hour	993	1,284	1,146	1,164	1,172	1,207	1,106	1,151	1,104	29	5,500	23
	Annual	374	388	392	393	390	390	390	389	392	5	-	-
VOC	1-hour	-	102	55	88	60	71	42	74	53	-	-	-
	24-hour	-	46	27	32	31	35	24	26	18	-	-	-
	Annual	-	1.7	4.2	4.1	3.6	3.8	3.1	3.4	3.5	-	-	-
PM2.5	1-hour	21	30	35	28	26	26	26	38	33	82	-	-
	24-hour	16	19	19	20	19	18	19	18	19	32	25	82
	Annual	4.8	5.1	5.2	5.2	5.1	5.1	5.1	5.1	5.1	9	6	87

NOTES: All values are maximum predicted concentrations (Project + Background) per site per time-weighted averaging period, in ug/m3

a Most stringent Air Quality Objective.

b Total conversion of NOx to NO2.

Max Project Only / Background %: Calculated ratio of the Maximum Project Case air quality divided by background air quality

Max Application / AAQO %: Calculated ratio of the Maximum Application Case air quality divided by the most stringest AAQO or CWS objective

"-" = not available (assumed background VOC concentrations were zero).

SOURCES: British Columbia HLS 2009.