6 Greenhouse Gas Emissions (Climate Change)

This chapter provides an estimate of the greenhouse gas (GHG) emissions that will be emitted by the KSM Project (the Project), as related to the issue of climate change. GHGs are usually assessed in comprehensive environmental assessments in order to provide an indication of what a project's GHG emissions will be and to find ways to mitigate them early on in the project design and development process. As required in the Comprehensive Study Scope of Assessment and stipulated in the Application for Information Requirements (AIR), the main guidance document for the assessment of climate is *Incorporating Climate Change Considerations in Environmental Assessment* (CEA Agency 2003). Other applicable regulations and best practices documents are discussed in Section 6.1.4.

The Project will: (1) emit GHGs and (2) potentially be affected by climate change itself. Therefore, as recommended by the Canadian Environmental Assessment Agency (CEA Agency; 2003) guidance document, the KSM Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS) considers the GHG emissions by the Project as well as the effects of the environment (i.e., climate change) on the Project. GHG emissions from the Project are addressed in this chapter, and the potential effects of climate change on Project components are addressed in Chapter 34, Effects of the Environment on the Proposed Project.

As stated in the guidance document (CEA Agency 2003), unlike most other environmental effects on VCs, the contribution of an individual project to the effect of climate change cannot be measured due to the global scale, uncertainty, and complexity of assessing effects of collective anthropogenic GHG emissions on climate. Therefore, the only "effect" considered in this assessment is the direct change in atmospheric GHG levels as a result of the Project through the use of standardized GHG emissions accounting methods, and by comparing the results with industry norms. Similarly, rather than assessing cumulative effects, Project GHG emissions will be compared with provincial, federal, and international GHG emission levels, which represent relative effects at different scales. This comparative method is consistent with guidance by the CEA Agency (2003) and the majority of Canadian environmental effects assessments, which take the approach of comparing project GHG emission levels rather than looking at their climatic effects (Rescan 2006; Amec 2008; Teck Coal Limited 2011; Amec 2012).

GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons, and perfluorocarbons. GHG management relies on quantifying, monitoring, reporting, and verifying GHG emissions/sources and removals/sinks (International Standards Organization 2006). In order to assess GHG emissions from the Project, this assessment will provide an estimate of KSM Project GHG sources and sinks from components identified in the Pre-feasibility Study (PFS; Tetra Tech Wardrop 2012), as well as outline mitigation measures already incorporated into and supplemental to those already included in the Project's design. Primary GHGs from all sources of the Project are anticipated to be CO_2, CH_4, and N_2O, which will be assessed as follows:

1. *Facility level emissions*: these result from the fuel/energy needs of the Project including direct, on-site (Scope 1) sources, such as from diesel engines and blasting, and indirect sources such as imported electricity consumption from the Northwest Transmission Line (NTL; Scope 2), and activities owned/operated by contracted third parties such as on-site equipment operation and on- and off-site transport activities (Scope 3).[1]
2. *Land-use change GHG sources/sinks*: these result from changes to natural carbon stocks from Project activities such as conversion of forest, grassland, and wetland sinks by biomass clearing and burning, mitigated by restoration replanting.

6.1 Greenhouse Gas (Climate Change) Setting

6.1.1 Climate Change Overview

6.1.1.1 Scientific Background

Weather and climate are related, but distinct. Weather relates to localized, short-term meteorological conditions (i.e., temperature and precipitation), which are included in Chapter 7 of the Application/EIS pertaining to air quality, with baseline studies reported in Appendix 7-B. Climate can be studied at local scales, such as in boundary layer climatology (Oke and Rouse 1997), but climate is generally understood to be the long-term average weather pattern stemming from large-scale physical drivers (e.g., solar radiation levels and atmospheric composition). Climate change is defined as the difference in climate over a period of time with respect to a baseline or reference period that is typically three decades long (e.g., 1961 to 1990), corresponding to a statistically significant trend in mean climate, and persistent over a long period of time, which is typically decades or more (Environment Canada 2012a). Similarly, climate change projections are also typically made over 30-year periods (e.g., 1991 to 2020, 2021 to 2050, and 2051 to 2080). Averaging over decades is done in order to detect a clearer trend against the pronounced variability in climatic conditions on shorter time scales, including periodic (multi-year) fluctuations such as the El Niño Southern Oscillation. Long-term climate change is distinct from climatic variability and periodic fluctuations, as it is caused by shifts in large scale climate drivers and feedback mechanisms that give rise to climatic conditions.

What causes climatic changes to Earth's mean surface temperature throughout geological time is the result of a combination of physical processes, both internal and external, to the Earth's climatic system, which act as large-scale drivers. For instance, various forcing factors—such as changes in the sun's luminosity, fluctuations in the precession of the Earth's axis and orbit (Milankovich cycles), as well as volcanic activity—have been attributed to causing large scale warming or cooling in the past, such as the various ice ages in Earth's geological history (Hays, Imbrie, and Shackleton 1976; Scheider 2000).

One of the primary physical processes that influence global surface temperatures is the "greenhouse effect," caused by GHGs, which raise temperatures beyond what they would be in the absence of these gases (Kushnir 2000). Along with factors such as the amount of incoming

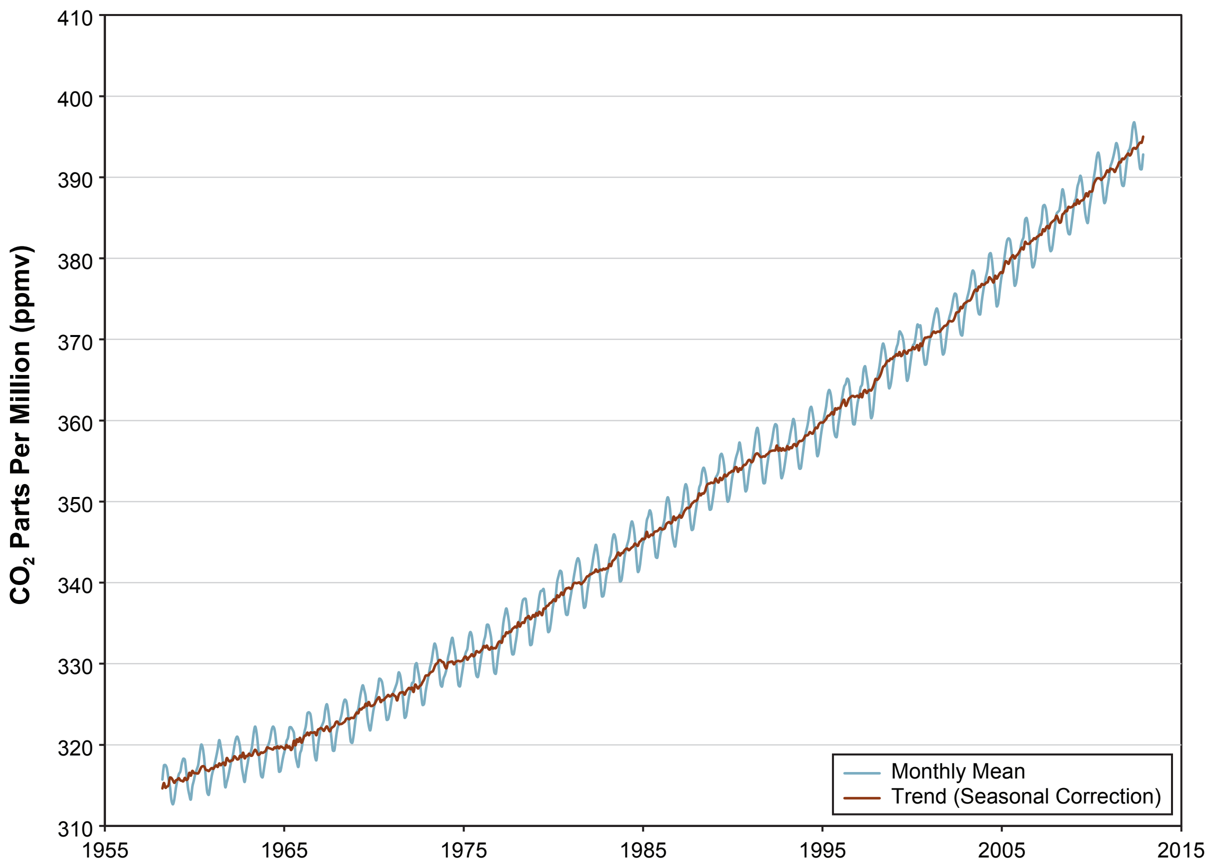
[1] Scope 1, 2 and 3 emissions are further defined in Section 6.6.1.2.

solar radiation and the reflectivity (albedo) / blackbody (absorptive) properties of the Earth's surface, the greenhouse effect affects the energy budget of the Earth due to the physical properties of GHGs that cause them to absorb and reradiate thermal infrared radiation. The greenhouse effect leads to a portion of infrared radiation being effectively trapped between the ground and the lower 10 km of the atmosphere, leading to surface warming. In this way, natural levels of GHGs in the atmosphere raise the Earth's average surface temperature to about 15ºC, which is more than 30ºC warmer than it would be without an atmosphere (Piexoto and Oort 1992; Kushnir 2000; Schroeder 2000).

This chapter pertains to the posited role of aggregate anthropogenic GHG emissions amplifying the greenhouse effect and potentially leading to a variety of global warming scenarios (Scheider 2000; IPCC 2001; Hegerl et al. 2007; IPCC 2007b; Statistics Canada 2008). While the physics operating on the processes behind the greenhouse effect have been known for over 100 years (Allmendinger 2007), the science of anthropogenic climate change has been contested (see note at the end of this section), so a brief outline is given below on some of the primary research and rationale behind the stance that Project GHGs need to be measured and mitigated as part of a collective effort to prevent potential adverse effects of aggregated GHG emissions from human sources amplifying the greenhouse effect and contributing to global warming.

Various studies have measured increased levels of GHGs in the Earth's atmosphere, particularly during the last century, with research on CO_2 being the most established. For instance, Figure 6.1-1 illustrates the Keeling Curve of measurements taken at the Mauna Loa observatory, Hawaii. This graph shows how measured atmospheric CO_2 has risen from about 315 parts per million by volume (ppmv) in 1958 to about 400 ppmv in May 2013 (Keeling et al. 1976; National Oceanic and Atmospheric Administration 2013). For comparison, analysis of indicator data from the Vostok ice cores in Antarctica found that CO_2 levels ranged from 180 ppmv during periods of lower temperature to 280 ppmv during warmer periods over an approximately 400,000 year record of past atmospheric composition, indicating that levels of CO_2 measured in the last few decades were unprecedented for at least 400,000 years (Petit et al. 1999). These findings have been corroborated through numerous other studies using a variety of paleoclimatic indicators, including extending the ice core record to 650,000 years (Siegenthaler et al. 2005).

Studies on the last century have found that global atmospheric concentrations of CO_2 have increased over 100 ppmv from their estimated level around the start of the Industrial Era (at around 1750) of 278 ppmv to the present level of 395 ppmv, and of this, about 84% is attributable to fossil fuel emissions, which now far exceed pre-industrial levels, while the rest is likely due to land-use changes such as deforestation (Keeling et al. 1976; BC MOE 2007; Hegerl et al. 2007; National Oceanic and Atmospheric Administration 2013). Reasons for this accumulation are thought to be that GHGs emitted by human activities collect and fully mix in the atmosphere, the lifetime of CO_2 in the atmosphere is 50 to 200 years (IPCC 2001), and flux rates of anthropogenic GHG emissions to the atmosphere are estimated to be larger than removal rates (Scheider 2000; Hegerl et al. 2007; IPCC 2007b; Weaver 2008).



Source: NOAA (2012).

SEABRIDGE GOLD
KSM PROJECT

Atmospheric CO_2, Measured at Mauna Loa, Hawaii (Keeling Curve)

Figure 6.1-1

Rescan
Engineers & Scientists

The level of confidence in the science of global warming from anthropogenic GHGs is reflected in the recent Intergovernmental Panel on Climate Change (IPCC) compendium report, which states that warming of the global climate system is unequivocal, that anthropogenic GHGs are the dominant source of this warming and that there is very high confidence in the analysis of human-caused climate change (Hegerl et al. 2007; IPCC 2007b).This stance is supported by statements—also declaring that it is unequivocal that global mean temperatures are rising, at least in part due to anthropogenic CO_2—issued by large scientific organizations such as the World Meteorological Organization (2011), the US National Academy of Science, the Chinese Academy of Sciences, the Science Council of Japan, the Académie des Sciences (France), the Italian Accademia Nazionale dei Lincei, the Russian Academy of Sciences, the Royal Society of the United Kingdom, and the Royal Society of Canada (National Academy of Science 2009).

It is noted that the science behind the theory of anthropogenic climate change summarized above is complex, that there is still uncertainty in climatic warming projections, and that this is a debated political policy topic (Seitz 2001; Dyer 2008; Hulme 2009; Idso and Singer 2009; Scheider 2009; Anderegg, Prall, and Harold 2010; Anderegg et al. 2010; Kitcher 2010; Nierenberg, Tschinkel, and Tschinkel 2010; Oreskes and Conway 2010). The AIR and the guidance document (CEA Agency 2003) for this chapter take a precautionary approach to climate change, which recognizes the body of scientific evidence that advocates for monitoring and mitigation of GHG emissions at the project level to address potential risks of anthropogenic climate change. The Canadian government has also signed onto the Copenhagen Accord of 2009, pledging to reduce GHG levels in order to address climate change, while the BC government has taken an even more proactive stance on mitigating GHGs (Section 6.1.2). Hence, while it is recognized that anthropogenic climate change is contested, this chapter is written in line with the precautionary approach of the AIR, CEAA guidance documentation, major world scientific organizations, and the governments of BC and Canada; the latter provides the main impetus for the KSM Project GHG effects assessment.

6.1.1.2 Climate Change Impacts and Adaptation

Potential increases in global temperatures from anthropogenic GHG emissions are associated with a range of climate change effects and potential adaptation strategies to reduce the risk associated with these effects (CEA Agency 2003; IPCC 2007a; BC MOE 2010b). The risks posed to the Project itself from climate change and adaptation strategies to reduce those risks are reported on in Chapter 34 - Effects of the Environment on the Proposed Project.

6.1.1.3 Traditional Knowledge and Understanding and Nisga'a Knowledge of Climate Change

Traditional knowledge and understanding (TK/TU) can complement and confirm scientific knowledge on climate change through providing local scale expertise and knowledge of climate history, identifying areas of interest and concern, and insights into adaptation, as well as long-term community-based monitoring (Riedlinger and Berkes 2001; Woo 2006). The IPCC Working Group II for the Fourth Assessment Report recognized traditional knowledge as an important information source for improving our understanding of climate change, and for developing comprehensive natural resource management and climate adaptation strategies (Anisimov et al. 2007). TK/TU is particularly salient for many Aboriginal cultures as impacts of climate change pose a direct threat to many indigenous societies due to their reliance on resource-based livelihoods as well as their often inhabiting vulnerable locations such as high-altitude zones (Nakashima et al. 2012).

6.1.1.3.1 Traditional Knowledge Observations

Nisga'a Nation has observed climate change in the region of the Project, for example changes to the biogeography of Nass Valley alpine tundra, including glacial ablation changing the nature of alpine meadows and available food for gathering (Mackin and Nyce 2012). Nisga'a Nation has identified the Nass River as a valued component to them, especially in relation to wild salmon (Nisga'a Tribal Council 1993; Nisga'a Language and Culture Program 2002; Nisga'a Lisims Government n.d.). They are also concerned about the food security in the Nass Valley region, in particular about the sustainability of Nass River fish stocks, for which freshwater habitats have been identified as being vulnerable to climate change (Pacific Fisheries Resource Conservation Council 2012).

Interviews with wilp Skii km Lax Ha cited in the *Northwest Transmission Line Project: Skii km Lax Ha Traditional Knowledge and Use Study* (Rescan 2009) revealed the following traditional knowledge pertaining to some of the general effects of climate change that they have observed in the area of the Project:

> *Skii km Lax Ha knowledge holders have observed changes in the climate over the last 20 years. The changes are evident in the quality of salmon, an increase in water temperature, and weather changes such as increased rain during the winter (K1 interview in Rescan 2009). Smaller streams are now unsafe to cross as they no longer freeze over. The Bell-Irving does not freeze over anymore either, and is not safe to traverse or travel on in winter. Furthermore, the Skii km Lax Ha have noticed less snowfall from Cranberry River north to Meziadin. Snowfall is heavier north of Meziadin…*
>
> *…Skii km Lax Ha knowledge holders have observed an increase of parasites in fish, which they relate to climate change and warmer water temperatures. With colder water, fish are less likely to have parasites. Skii km Lax Ha have noted that salmon now contain more worms and lice, with some worms up to 30 cm long. More fish now also have a jaundice colour (especially spring salmon), and well as a changed taste and texture. Skii km Lax Ha have sped up the timing of processing their catch, due to increased rates of spoilage. Fish are now processed within a few hours of being caught, rather than the next day. Due to its colder temperatures, the Nass River is considered more suitable for fishing than the Skeena.*

Scientific studies in the province confirm the above Nisga'a Nation information and Skii km Lax Ha traditional knowledge observations of linkages among climate change, water temperature of streams and rivers, and fish health and related survival rates. For example, research near Powell River found that chronic impacts to salmon and trout are already occurring in Lang Creek and that "during a warm year in the 2020s, summer water temperatures in upper Lang Creek will cause very high mortalities to any salmon populations present" and "by the 2040s, high mortalities are likely to occur even during cool years" (BC MWLAP 2004). Recent research confirms physiological health linkages between water temperature and fish mortality (Eliason et al. 2011), as well as concerns on adverse effects to BC fish populations from climate change, such as changes to Fraser River temperatures (Hinch and Martins 2011).

6.1.1.3.2 Traditional Use Observations

Although consultations with Tahltan Nation, Gitanyow First Nation, and Gitxsan Nation did not provide specific traditional knowledge information pertaining to climate change observations in the region, they have also indicated interest in the traditional use of ecosystem components, which may be influenced by climate change effects such as those described above by the Skii km Lax Ha. The interests and concerns described below include climate change factors that have been recognized to potentially affect indigenous cultures such as biogeographic plant and animal assemblages, extent and duration of wildfires, extent and duration of invasive species and pests, changes to seasonal harvest timing, and changes to hydrological and snow parameters that affect fishing and navigation (Bennett and Maynard 2013).

Tahltan Nation has indicated that culturally important features include those that may be affected by climate change, such as general ecosystem dynamics, and plant, wildlife, and fish species and abundance (Tahltan Heritage Resources Environmental Assessment Team 2009).

Gitanyow First Nation has recently signed an agreement with the Province of BC that includes items related to climate change such as the maintenance of ecological terrestrial and aquatic systems for traditional use as well as carbon offset and revenue sharing (Gitanyow Hereditary Chiefs Office and the Province of British Columbia 2012). In addition, Gitanyow First Nation has indicated that it relies on subsistence harvesting, economic and cultural uses of fish and wildlife, and that the nearby Hanna and Tintina areas are considered sacred and essential to the survival of Gitanyow society and culture, especially pertaining to keystone salmon species (Gitanyow Hereditary Chiefs Office 2008; Gitanyow Hereditary Chiefs Office, BC Hydro, and Rescan 2010; BC MFLNRO 2012), which are all traditional use features that may be affected by climate change impacts.

Gitxsan Nation also has a long history of resource use in the area of the Project and has indicated concern for the health and maintenance of aquatic resources, particularly salmon, in downstream systems (Bell-Irving and Nass rivers) of the Project (Rescan 2012b), which may also be influenced by climate change impacts on water temperatures.

6.1.1.3.3 Summary of Regional Traditional Knowledge and Understanding Observations of Climate Change

The above traditional knowledge and use observations on climate change and related concerns for the security of continued traditional use of lands and resources as a result of climate change indicates Aboriginal interest and concern regarding the potential effects of climate change in the Project area. These concerns provide further impetus for the proponent to implement mitigation measures to reduce GHG emissions (Section 6.7.1.1) in conjunction with other collective efforts in the province, country, and world—as the potential impacts of climate change in the Project region is part of an aggregate global issue and not something that Project-related GHG emissions mitigation alone could address.

6.1.2 Legislation and Best Practices Context

International agreements and North American national legislation with clear and enforceable GHG mitigation targets at the project level have yet to be determined. However, provincial and national development of such legislation is underway as described in the section below. Legislation, policy, and initiatives to address climate change adaptation are also being developed (CEA Agency 2003; IPCC 2007a; BC MOE 2010b), but there is some regulatory uncertainty as to what legislation will apply during the Project life due to changes in political influences. In BC, carbon management and markets fall under both regulatory and voluntary frameworks, so organizations can implement carbon management strategies under several voluntary third-party programs that additionally promote best practices in the measurement, reduction, and transparent reporting of GHG inventories.

6.1.2.1 Regulatory Context

The primary pieces of legislation pertaining to carbon management for major projects in BC, including taxation and market mechanisms, are listed in Table 6.1-1. In the absence of regulations, many organizations seek to minimize GHG emissions voluntarily to meet corporate sustainability reporting goals, procure financing, address liability, or improve public relations.

Table 6.1-1. GHG Emission Legislation and Initiatives

Name	Year	Type	Level of Government	Description
Copenhagen Accord	2009	Agreement	International	Canada signed to a GHG1 emissions target of 17% reduction from 2005 levels by 2020; national regulations, under the Clean Air Regulatory Agenda (below), are shaped to meet this target.
Canadian Environmental Protection Act	1999	Act	National	Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development that provides authority for the collection of GHG emission data nationally by Statistics Canada and Environment Canada.
Clean Air Regulatory Agenda	2006	Agenda	National	Established in 2006 and administered by Environment Canada, this agenda supports national efforts to reduce GHG and other air pollutant emissions. Transport sector emissions regulations fall under this agenda.
Federal Sustainable Development Act	2008	Act	National	Purpose is to provide legal framework for a Federal Sustainable Development Strategy which has Climate Change as its Goal 1, to make environmental decision making more transparent and accountable.
Federal Sustainable Development Strategy	2008	Strategy	National	Goal 1 of the Federal Sustainable Development Strategy is climate change, to “reduce greenhouse gas emission levels to mitigate the severity and unavoidable impacts of climate change.”

(continued)

Table 6.1-1. GHG Emission Legislation and Initiatives (completed)

Name	Year	Type	Level of Government	Description
On-road Vehicle and Engine Emission Regulations	2002	Regulation	National	This and newer regulations under the authority of the *Canadian Environmental Protection Act* and Clean Air Regulatory Agenda regulate the reduction of vehicle emissions and establish emission standards.
BC *Climate Action Plan*	2007	Plan	Provincial	Action plan under which provincial acts regulating emissions are being created to achieve specific targets, such as 33% GHG[2] reduction by 2020 compared to 2007 levels.
BC Air Action Plan	2008	Plan	Provincial	Comprises 28 actions that promote clean transportation and clean industry, including emissions reductions.
Carbon Tax	2007	Tax	Provincial	Revenue-neutral tax to incentivize emissions reductions.
Greenhouse Gas Reduction (Cap and Trade) Act	2008	Act	Provincial	Legislation to authorize hard caps on GHG emissions. Reporting underway, but caps currently being negotiated.
GHG Reduction (Vehicle Emissions Standards) Act	2008	Act	Provincial	Will increase automobile fuel efficiency thereby reducing transport sector GHG emissions.
Zero Net Deforestation Act	2010	Act	Provincial	Sets reporting on net deforestation to start in 2012 and achieve net zero deforestation by 2015.
Greenhouse Gas Reporting Regulation	2010	Regulation	Provincial	Under the *GHG Reduction Act*, sets out GHG reporting requirements for facilities emitting 10,000 t/yr CO_2e^2 or more.
Part 6 - Clean Air Provisions under *Environmental Management Act*	2004	Provision	Provincial	Provides general authority to make regulations on fuel emissions and motor vehicle/engine and burning emissions.

Notes:
[1] GHG= greenhouse gas
[2] t/yr CO_2e = tonnes per year of carbon dioxide equivalent

Under the Copenhagen Accord in 2009, Canada signed on to reduce its total GHG emissions by 17% from 2005 levels by 2020, mirroring American targets. To meet this national GHG reduction target, Canada has also begun to implement regulations under the *Canadian Environmental Protection Act* (1999) and the Clean Air Regulatory Agenda for energy suppliers (starting with coal) and the transport sector (for heavy- and light-duty vehicle manufacturers). To demonstrate its reductions, Canada reports national GHG emissions annually to the United Nations Framework Convention on Climate Change (UNFCCC), discussed in Section 6.2.2.

Canada has set progressively aggressive fuel efficiency targets for manufacturers through national transport regulations—in line with those in the United States—which will help to provide transport sector GHG emissions reductions in future years, and consequently provide transport related GHG reductions for the Project from upstream sources. For instance, on November 27, 2012, new regulations for automobiles and light trucks manufactured between 2017 and 2025 were announced by the federal government, which mandate improvements to engine fuel efficiency such that by 2025, vehicles in this category will consume 50% less fuel and emit 50% less GHG emissions than similar 2008 models (Environment Canada 2012b). These proposed regulations will build on the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2010-201) for vehicles manufactured between 2011 and 2016, which mandates that 2016 models have about 25% lower GHG emissions compared to similar 2008 models. The proposed Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulation scheduled to come into force in 2014, will mandate manufactured emission reductions for heavy-duty vehicles, and also help to lower transport related emissions of the Project compared to current estimates (Canada Gazette 2012). For instance, heavy-duty vehicle models (i.e., large pick-up trucks, short/long-haul tractors, cement and garbage trucks, and buses) manufactured in 2018 will be required to reduce end-of-pipe GHG emissions up to 23% from those sold in 2010, and by 2020 overall national emissions from this vehicle class are projected to drop by 3 million tonnes per year (Environment Canada 2012c). These types of reductions are why the procurement of new vehicles is listed as a mitigation measure in Section 6.7.1.1.

BC also has several provincial climate change regulations in place, often aligning targets and mechanisms with those in California. Through the BC Climate Action Plan, (Government of British Columbia 2008) the province has set more stringent targets—33% GHG emissions reductions by 2020, and 80% by 2050, compared to 2007 levels—than the national targets described above (Government of British Columbia 2008). BC currently also has a carbon tax, although the general *GHG Reduction (Cap and Trade) Act* (2008a) is currently slated to become the major legislative arm to regulate emissions in BC. The *GHG Reduction (Cap and Trade) Act* also enabled the province to be the first Canadian province to join the regional (US and Canada) Western Climate Initiative in 2007, but BC has not yet implemented regulations through the Western Climate Initiative and still has the option to opt out prior to its slated implementation in 2015 (see next section for details).

The *GHG Reduction (Vehicle Emissions Standards) Act* (2008b) is also slated to roll out in BC in the next few years, putting initial caps on transport emissions, which will likely be raised incrementally in future years to be in line with target reductions in BC: a total of 33% by 2020 compared to 2007, and 80% below 2007 levels by 2050 (Government of British Columbia 2008). In conjunction with national transport regulations, this act will help reduce GHG emissions of contracted (Scope 3) haul truck emissions for the Project.

Regarding land-use change, in support of the Climate Action Plan, BC has enacted the *Zero Net Deforestation Act* (2010), targeting net zero deforestation for BC by December 31, 2015, starting with government reporting on deforestation in 2012. The objectives of this act are to achieve net zero deforestation without "undermining economic development," and to use information and incentives to encourage voluntary action by industry to avoid and reduce deforestation and increase afforestation levels (BC MFML 2010).

6.1.2.2 Greenhouse Gas Emission Reporting and Reduction Requirements

Since 2010, in support of Canada's GHG mitigation targets, facilities emitting over 50,000 t of CO_2e[2] have been required to report emissions to Environment Canada for the *Greenhouse Gas Emissions Reporting Program* (Environment Canada 2010a), under the jurisdiction of Section 46 of the *Canadian Environmental Protection Act* (1999). Data from the Reporting Program is used to supplement that from the annual Report on Energy Supply-Demand in Canada compiled by Statistics Canada in national inventory reports (NIRs) to the UNFCCC (Environment Canada 2012e).

In BC, since January 1, 2010, facilities emitting over 10,000 t of carbon dioxide equivalent (CO_2e) must report to the BC Ministry of Environment, and those emitting over 25,000 t CO_2e must also have emissions verified by an independent and accredited third party under the BC Reporting Regulation (BC Reg 272/2009) of the *Greenhouse Gas Reduction (Cap and Trade) Act* (2008a).

The above provincial and national reporting regulations only pertain to facility-level emissions, and so do not include land-use change. If the KSM Project facility-level GHG emissions surpass 50,000 t CO_2e/yr, to satisfy federal and provincial reporting requirements, Project GHG emissions will need to be assessed, verified, and reported. Project GHG emissions will also be reported through the online one-window reporting (OWR) system, which was introduced in 2010 to align the needs of federal and provincial reporting, prevent duplication, and reduce the reporting burden on industry (BC MOE 2011c).

There is no current cap on industrial GHG emissions mandating emission reductions for the Project; however, BC's carbon tax will also apply to purchases for the Project, and the *Greenhouse Gas Reduction (Cap and Trade) Act* (2008a) is designed to set the groundwork for a regulatory regime that was to be implemented through the tabled Emission Trading Regulation on January 1, 2012. The proposed Emission Trading Regulation is applicable to facility operations that emit over 25,000 t CO_2e/yr from "emissions from general stationary combustion of fuel or waste with the production of useful energy"(BC Climate Action Secretariat 2010), which would be applicable to the Project.

Implementation of the Emission Trading Regulation is designed to be concurrent with that of California's cap and trade system, as BC, California, Quebec, and other regional members have arrangements to be GHG emissions trading partners under a linked system arranged through the regional Western Climate Initiative. The California Air Resources Board (CARB) delayed the implementation of its own cap and trade system (under California's *Global Warming Solutions Act*, AB 32) until 2013, which prompted the delay in BC as well.

California has now taken steps to initiate its cap and trade system. In September 2012 it officially launched the program, followed by the first auctioning of greenhouse gas allowances by the California Air Resources Board on November 14, 2012 (California Air Resources Board 2012b), and its December 14, 2012 announcement of provisions for carbon offset projects (California Air Resources Board 2012a). Quebec has also now become the first Canadian province to join California and the Western Climate Initiative in creating a regional carbon market by adopting

[2] The reporting threshold has decreased from 100,000 t of CO_2e in 2009.

regulations to join their two capped systems (MDDEFP 2012; Segun 2012). There is currently regulatory uncertainty as to whether BC will continue with its original plans under the *Greenhouse Gas Reduction (Cap and Trade) Act* (2008a) to join in a capped and regulated carbon market with California and Quebec or pursue other avenues of carbon management.

6.2 Historical Activities

Due to the additive nature of GHGs in the atmosphere, BC and Canada evaluate and report on aggregated GHG inventories annually per UNFCCC reporting standards, which are then incorporated into global anthropogenic emission inventories by the UNFCCC. These inventories serve as the historic GHG emission setting for the KSM Project GHG assessment, and also serve as a point of comparison for the assessment of significance for the GHG emission effects of Project in Section 6.8. The context of international, national, and provincial emissions is provided below to serve as a historic GHG baseline setting for the KSM Project GHG assessment and point of comparison of Project GHGs.

6.2.1 The International Greenhouse Gas Setting

International anthropogenic GHG emissions can provide an idea of the global context to compare Project GHG emissions to, as will be done further in this assessment in Section 6.8.3. As shown in Table 6.2-1, out of the total global estimate of anthropogenic CO_2 emissions to the atmosphere of 30,086,265 kt (kilotonnes), Canada was the eighth largest GHG emitter in 2009 with 513,937 kt CO_2e (UN Statistics Division 2009). Note that total values reported in Table 6.2-1 are lower than those reported in the Canadian inventory report (Table 6.2-2) for the same year as international data does not account for emissions from other GHGs besides CO_2 due to gaps in obtaining information from developing nations. Canadian self-reported emissions in 2009 were 690,015 kt CO_2e with 542,000 kt from CO_2 (UNFCCC 2012). The GHG emissions listed in Table 6.2-1 also only include facility-level sources, and not land use, land-use change, and forestry (LULUCF) GHG emissions relating to deforestation and afforestation activities.

Table 6.2-1. Global GHG Emissions (2009, not counting LULUCF*)

Rank	Country	Annual CO_2 Emissions (kt)	% of World Emissions
1	China	7,687,114	25.55%
2	United States	5,299,563	17.61%
3	India	1,979,425	6.58%
4	Russian Federation	1,574,386	5.23%
5	Japan	1,101,134	3.66%
6	Germany	734,599	2.44%
7	Iran (Islamic Republic of)	602,055	2.00%
8	Canada	513,937	1.71%
9	Korea, Republic of	509,376	1.69%
10	South Africa	499,016	1.66%
Total	**World**	**30,086,265**	**100%**

Source: UN Statistics Division (2009)
***LULUCF: land use, land-use change and forestry. Data reported in this table does NOT account for LULUCF reporting requirements or GHGs besides CO_2 due to data gaps from developing nations.**

Table 6.2-2. National and Provincial GHG Emissions, Including Mining Sector

Emission Source GHG	GHG Emissions (kt CO_2e) 1990	2000	2005	2006	2007	2008	2009	2010	2010 % Change from 1990	2010 % Change from 2005[†]
United States Total*	6,161,461	7,072,447	7,178,658	7,116,140	7,215,170	7,020,898	6,587,687	6,802,225	10%	-5%
European Union Total*	5,583,135	5,078,135	5,148,712	5,132,293	5,078,976	4,974,387	4,609,880	4,720,878	-15%	-8%
Canada Total*	**589,291**	**717,603**	**739,794**	**725,539**	**751,097**	**730,599**	**690,015**	**691,710**	**17%**	**-6%**
Stationary Combustion Sources Subtotal**	279,000	345,000	343,000	329,000	353,000	335,000	315,000	308,000	10%	-10%
• Electricity and Heat Generation**	92,000	128,000	124,000	117,000	126,000	114,000	98,000	101,000	10%	-19%
• Fossil Fuel Production and Refining**	50,000	67,000	68,000	67,000	66,000	62,000	64,000	53,000	6%	-22%
• *Mining Sector (Including Oil and Gas Extraction)***	*6,700*	*12,200*	*19,700*	*22,000*	*31,100*	*32,300*	*34,600*	*38,200*	*470%*	*94%*
• Manufacturing Industries**	56,100	56,100	50,000	46,300	48,300	45,400	40,100	41,300	-26%	-17%
Agriculture & Forestry**	2,400	2,500	2,000	1,900	2,200	2,200	2,700	3,300	38%	65%
Afforestation/Reforestation**	n/a	n/a	n/a	n/a	n/a	-740	-800	-860	n/a	n/a
Deforestation**	n/a	n/a	n/a	n/a	n/a	14,530	14,700	14,830	n/a	n/a
Canada Metal Mining Total §	***3,934***	***3,265***	***3,327***	***3,445***	***3,532***	***3,890***	***3,130***	***3,525***	***-10%***	***6%***
• *Canada Gold Mining* §	*356*	*340*	*319*	*287*	*309*	*303*	*249*	*274*	*-23%*	*-14%*
British Columbia Total***	**49,372**	**61,894**	**62,223**	**60,338**	**61,389**	**62,342**	**58,542**	**59,089**	**20%**	**-5%**
Stationary Combustion Sources Subtotal***	18,940	22,514	21,676	20,454	20,515	20,460	19,465	19,235	2%	-11%
• Electricity and Heat Generation***	803	1,813	1,552	1,484	1,299	1,665	1,558	1,438	79%	-7%
• Fossil Fuel Industries***	3,555	3,781	5,097	5,084	4,990	4,914	4,901	5,202	46%	2%
• *Mining Sector (Including Oil and Gas Extraction)****	*328*	*730*	*635*	*1,043*	*1,336*	*1,632*	*1,574*	*1,662*	*407%*	*162%*
• Manufacturing Industries***	6,461	7,705	6,138	4,553	4,916	4,250	4,017	4,243	-34%	-31%
Agriculture & Forestry***	321	316	66	66	64	56	46	306	-5%	360%
Afforestation/Reforestation***	0	1	-3	-9	-13	-14	-16	-18	n/a	100%
Deforestation***	6,146	4,636	3,863	3,341	3,520	3,089	2,996	2,922	-52%	-24%

Notes:
Data gathering and processing techniques have improved since 1990, so this table is intended to give general rather than precise indications of aggregate provincial and national GHG emissions
Numbers in bold represent sum totals and values in italics specifically represent the mining sector
n/a: not applicable
Afforestation emissions are negative because they sequestered carbon and a withdrawing from rather than adding to atmospheric GHG pool.
[†] % change provided for 1990 and 2005 to represent reporting under Kyoto Protocol and new national targets respectively.
*** UNFCCC Annex 1 GHG Data Sheet (UNFCCC 2012).**
**** NIR, National GHG Inventory Report (Environment Canada 2012d); note numbers in report were reported in Mt, so have been multiplied by 1,000 to correspond to units.**
***** BC Greenhouse Gas Inventory Report 2010 (BC MOE 2012b); note percent change for Agriculture and Forestry calculated against 2000.**
§ Direct emissions, measured and reported separately by the Canadian Industrial Energy End-use Data and Analysis Centre (Nyboer and Rudd 2011) with slightly different methods than NIR; included to provide disaggregated values of metal mining and gold mining from Mining Sector reported for Canada and BC, the latter which include high oil and gas extraction GHG emissions.

Of total world emissions, the energy sector accounted for 26%, the industrial sector for 17%, LULUCF for 17%, agriculture for 14%, transportation for 13%, commercial and residential buildings for 8%, and waste and wastewater (including landfill methane and incineration sources) at 3% of global emissions in 2004 (IPCC 2007b).

6.2.2 The National and Provincial Greenhouse Gas Setting

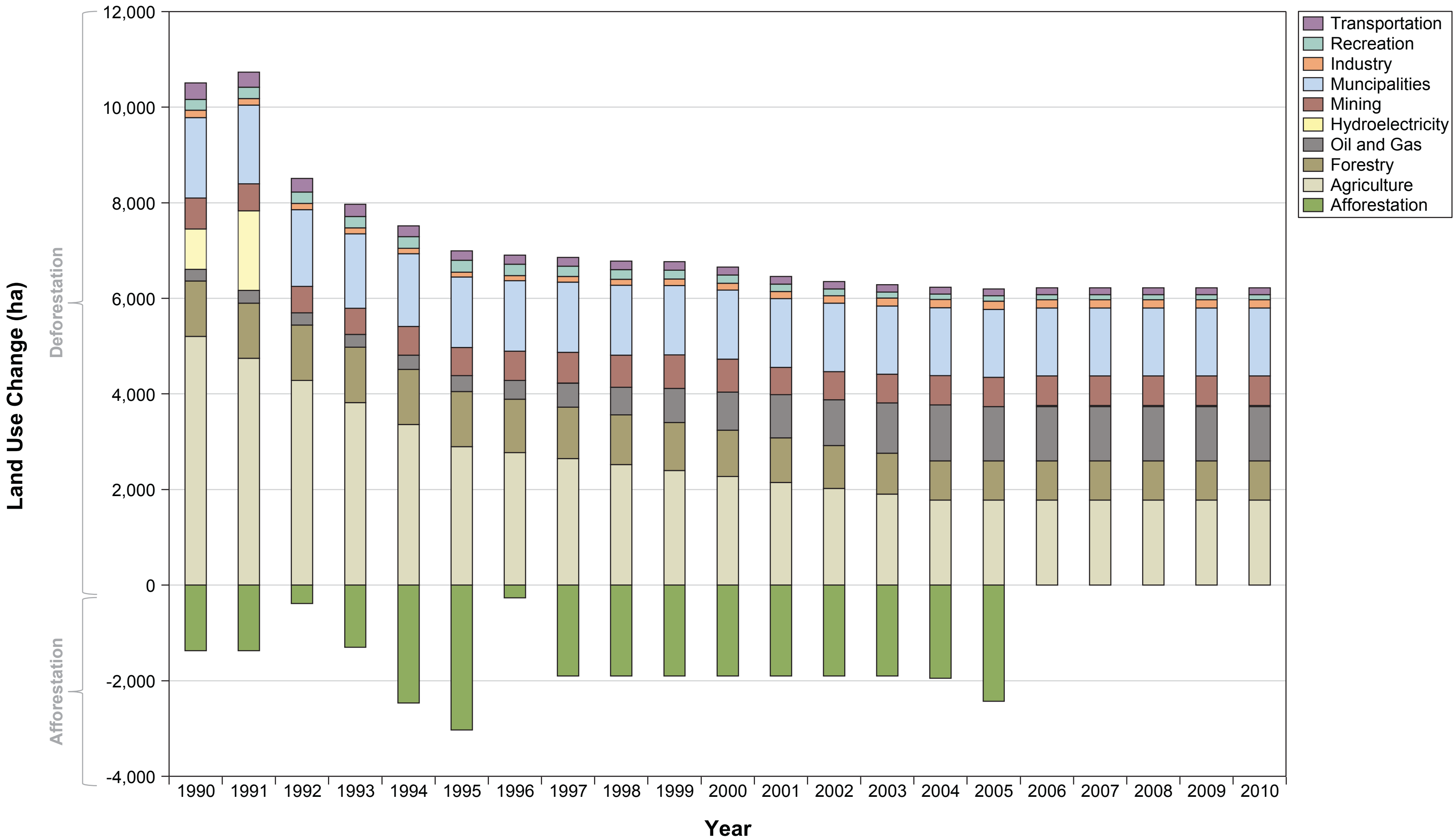
Table 6.2-2 summarizes historic GHG emissions across BC and Canada, reported in inventory reports. Reported GHG inventories give yearly emissions and show trends across years, the latter demonstrating whether emissions reduction targets are been achieved. LULUCF emissions are reported as afforestation and deforestation and are based on land-use change data such as that shown in Figure 6.2-1. As shown in Table 6.2-2, the 2010 total annual reported GHG emissions were 691,710 kt CO_2e nationally[3] and 59,089 kt CO_2e in BC. Note that this inventory is intended to serve as a general rather than exact guide, since at the onset of reporting towards this inventory in 1990, data sources were not as complete as they currently are, and reporting methods and standards have also changed slightly over the years.

Mining sector emissions include data from oil (e.g., crude bitumen), gas, and coal extraction, as well as emissions associated with non-energy mining such as iron ore, gold, diamonds, potash, and aggregates. Per UNFCCC reporting standards, in 2010, the national mining sector accounted for about 38,000 kt CO_2e and provincial mining emissions were 1,662 kt CO_2e, as shown in Table 6.2-2. Since the mining sector values reported provincially and nationally include aggregate metal and non-metal mining alongside oil/gas extraction—and mostly account for oil and gas extraction GHG emissions, supplementary data on gold mining and metal mining are also included in Table 6.2-2. Note that this data was tracked separately by the Simon Fraser University Canadian Industrial Energy End-use Data and Analysis Centre for the Mining Association of Canada (Nyboer and Rudd 2011).

Table 6.2-2 shows that, in terms of relative growth, GHG emissions for the mining sector as a whole have increased more rapidly than any other subsector. For instance, between 1990 and 2010, these emissions rose by about 470% (Environment Canada 2012d). Federal metal and gold mining GHG emissions clearly decrease over the same time period, by 10% for mining, and 23% for gold mining (Nyboer and Rudd 2011). Mining sector emissions for 2010 reported by the Canadian Industrial Energy End-use Data and Analysis Centre as 3,525 kt CO_2e for national metal mining and 274 kt CO_2e for national gold mining also show declines in GHG emissions over the same time (Nyboer and Rudd 2011). Of the facilities that have to report to Environment Canada under the federal reporting system, as the Project will have to, two BC mining facilities reported in 2010, totalling 227 kt CO_2e for BC metal mining. These facilities are included in the sector comparison of Project GHG emissions in Section 6.8.3.1.

[3] The figure reported here is larger than that in Table 6.2-1 as it accounts for deforestation and afforestation emissions.

PROJECT # 0868-016-17 ILLUSTRATION # a38835w November 16, 2012



Note: Afforestation data for years 2006-2010 is incomplete, and data is for anthropogenic causes only, therefore not including forest fires or mountain pine beetle.

Source: "Land Use, Land-use Change and Forestry" data (BC MOE 2010).

Figure 6.2-1

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BC Land Use Change from Deforestation and Afforestation, 1990-2010

Figure 6.2-1

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Table 6.2-2 also indicates provincial and national deforestation and reforestation/afforestation emissions per the IPCC's LULUCF methodology. Reforestation/afforestation emissions are reported as negative values in the table to represent carbon removals from the atmospheric GHG pool through photosynthetic sequestration of CO_2 into biomass pools. In BC, the difference between deforestation (2,922 kt CO_2e) and afforestation (-18 kt kt CO_2e) led to net deforestation emissions of 2,904 kt CO_2e in 2010. Deforestation in this context only counts anthropogenic causes, not natural causes that emit very high levels of GHGs, such as mountain pine beetle or forest fires; the latter alone caused emissions to jump by 43.4 Mt CO_2e in 2009 compared to 2008 (BC MOE 2010a). BC land-use change GHG emissions are correlated to the deforestation data shown in Figure 6.2-1, reported in hectares. Most of this deforestation in BC resulted from agriculture and municipal settlement. Comparatively, the mining sector deforestation rate has been 615 ha/yr on average, accounting for about 9% of the total deforestation in the province from 1990 to 2010.

6.3 Land Use Planning Objectives

The Project lies within the boundaries of the Cassiar Iskut-Stikine Land and Resource Management Plan. The Land and Resource Management Plan makes no mention of climate change nor GHGs (BC MFLNRO 2000). The Nass South Sustainable Resource Management Plan for land near the Project does mention addressing climate change risks to forests, but not preventative GHG mitigation (BC MFLNRO 2012). Hence, there are no regional or local GHG emissions targets applicable to the Project.

6.4 Spatial and Temporal Boundaries

6.4.1 Spatial Boundaries

The spatial boundary for GHG effects assessments is defined as the area subject to potential effects from Project emissions. As mentioned, GHGs emitted by the Project will enter an open atmospheric pool that is globally unbounded, therefore, as is standard for environmental assessments for mining projects (Rescan 2006; Teck Coal Limited 2011), the assessment of potential climatic effects (e.g., of the Project on temperature) will not be included in this assessment. Spatial boundaries are delineated by Project GHG sources for facility and land-use change emissions. For facility-level GHG emissions, the spatial boundaries correspond to Project activities that emit GHGs, broken down by scope as follows:

- **Scope 1**: GHG emissions from on-site, Proponent owned/operated facility and equipment/truck GHG sources on all Project footprint land (e.g., the Mine Site, Processing and Tailing Management Area [PTMA], access roads [during construction], and the connecting Mitchell-Treaty Twinned Tunnels);
- **Scope 2**: GHG emissions from imported electricity from the NTL;
- **Scope 3**: GHG emissions both on- and off-site of the main Project footprint (including access roads) that are from sources (i.e., equipment and haul trucks), owned/operated by third parties contracted by the Proponent.

The GHG emissions assessment for land-use change is based on data from clearing and replanting (i.e., of forest and grassland) for all phases under the direct Project footprint.

6.4.2 Temporal Boundaries

Temporal boundaries are defined as the period of time that Project GHG emissions will have an effect on the environment. Once released into the atmosphere, it is assumed that the potential effect on atmospheric GHG levels from Project GHG emissions will be 50 to 200 years, corresponding to the maximum lifetime of CO_2 in the atmosphere (IPCC 2001). This timeframe is about the same as the post-closure phase of the Project; the temporal boundaries for the Project include the following four phases:

- **construction:** 5 years;
- **operation:** 51.5 years;
- **closure:** three years, including decommissioning and reclamation; and
- **post-closure:** 250 years, including ongoing reclamation and post-closure maintenance monitoring.

The KSM Project GHG assessment will focus on the construction and operation phases as the majority of Project emissions will occur during this time. GHG emissions during closure and post-closure will be negligible in comparison. Deforestation and reclamation planting activities will be ongoing as shown in the scoping table in Appendix 6-A, so the land-use change GHG assessment will be based on the total Project deforestation and reclamation footprints across all Project phases.

6.5 Valued Components

6.5.1 Valued Components Included in Assessment

Studying the effects of the Project on the valued component (VC) of GHGs will provide an indication of how the KSM Project will incrementally affect atmospheric levels of GHGs, which is used as a proxy for determining the relative level of potential effects of the Project on climate change. Table 6.5-1 identifies the parties who have identified GHGs as a VC either directly or through their expressed concern regarding the Project's effects on climate change.

Table 6.5-1. Identification and Rationale for Atmospheric Climate (Greenhouse Gases) Valued Component Selection

		Identified by*				
Subgroup	VC	F	G	P/S	O	Rationale for Inclusion
Climate Change	GHG Emissions	X	X	X		Net GHG emissions by the Project will incrementally add to atmospheric GHG levels

*** F = First Nation and/or Nisga'a Nation; G = Government; P/S = Public/Stakeholder; O = Other.**

GHGs were identified in the AIR (Section 11.1.5) as a VC related to climate change, indicating government interest. The public, Nisga'a Nation, and First Nations, including the Gitanyow and Tahltan, have also indicated that potential effects of the Project on climate change is a concern (CEA Agency 2003; Rescan 2012a, 2013a, 2013c).

6.5.2 Valued Components Excluded from Assessment

No VCs related to climate/GHGs-that were presented in the AIR are excluded from assessment.

6.6 Scoping of Potential Effects for Greenhouse Gases

As illustrated in Figure 6.6-1, a pathway approach has been taken to scope the effects on atmospheric GHG levels as a result of the Project. There are two primary pathways through which activities taking place across Project areas/components are anticipated to lead to incremental increases in atmospheric GHG emissions:

1. **Facility-level GHG sources** (Scope 1, 2, and 3) from activities such as fuel burning by mobile and stationary equipment/generators/trucks, electricity use by facilities/equipment, incineration at camps, and blasting.
2. **Land-use change GHG sources and sinks** (LULUCF) from GHG emitting (source) activities such as clearing and burning of vegetation on Project land components, and restoration through replanting which will contribute to GHG sequestration (sink) over time.

The activities at the KSM Project will produce CO_2, N_2O, and CH_4 emissions, so these gases will be included in the assessment. GHG emissions from all gases will be aggregated and reported in tonnes of carbon dioxide equivalent (t CO_2e), and GHG emission intensities will also be reported. As shown in Table 6.6-1, the GHG assessment endpoint is to estimate and compare Project GHG emissions to provincial, national, and international totals as well as the industry profile for the mining and metal mining sectors.

Table 6.6-1. KSM GHG Calculation and Assessment Endpoints

Calculation Endpoint	Assessment Endpoint	Related VCs
Average annual GHG emissions (t CO_2e)	Compare estimated Project GHGs to provincial, national, and international totals, as well as industry profile.	GHG emissions

The following sections will first describe the facility level (Scope 1, 2 and 3) and land-use change scoping methodologies that will be used in the GHG assessment, followed by a discussion of GHG emission scoping by Project phase.

6.6.1 Facility Level and Land-use Change Scoping Methodology

6.6.1.1 Facility Level Atmospheric GHG Emission Effects Scoping Summary

The KSM Project will involve activities at the facility level (e.g., blasting and fuel burning from incinerators, equipment/truck engines, and generators) that will contribute to Scope 1, 2, and 3 GHG emissions. The table in Appendix 6-A describes how the different Project components (e.g., pits, roads, rock storage facilities, camps, processing areas) will contribute to facility-level GHG emission sources for different phases of the Project as a result of the activities happening in those areas.

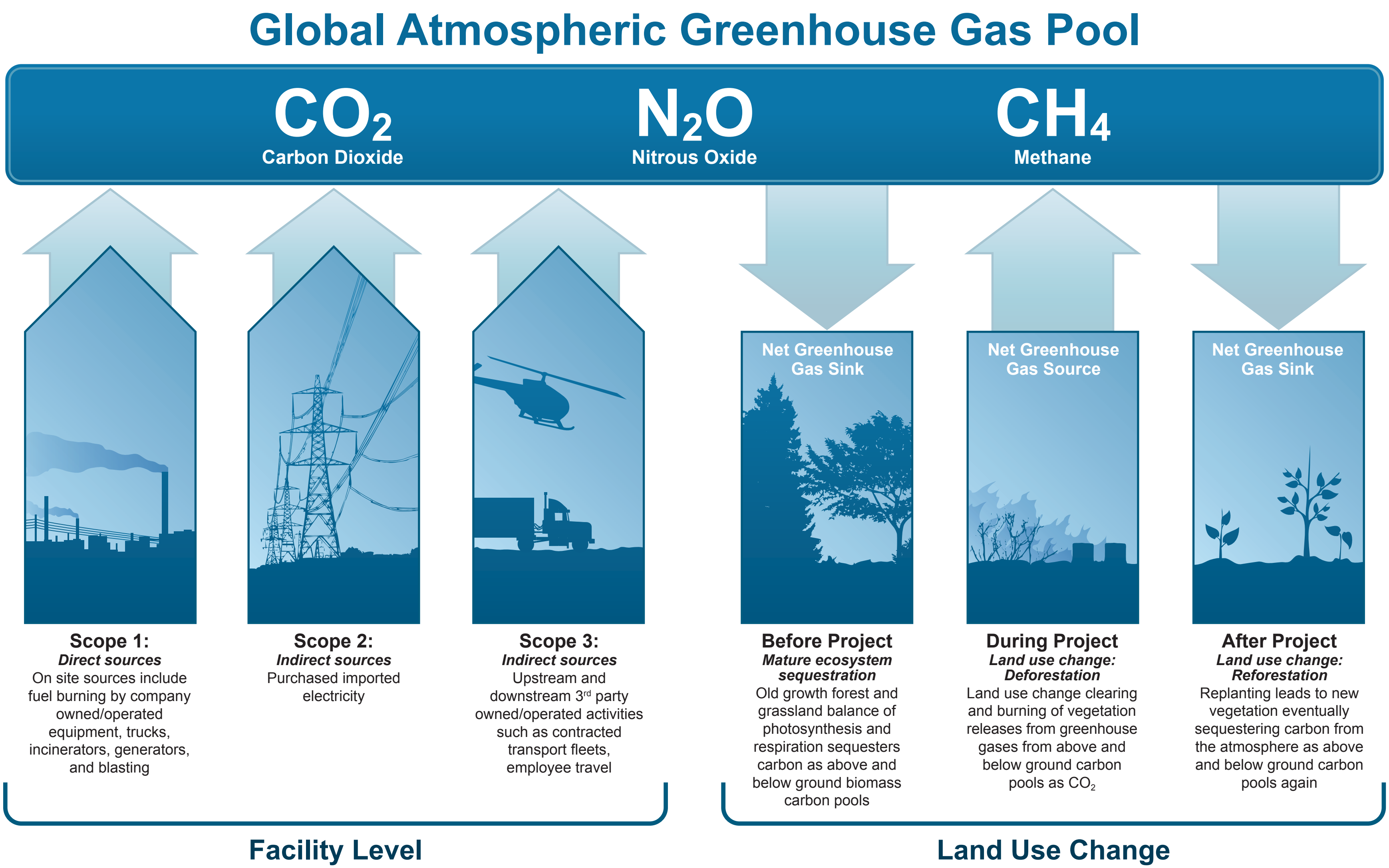

Figure 6.6-1

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KSM Project Greenhouse Gas Assessment: Scoping Framework

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In general, as shown in the Appendix 6-A scoping table, all active components of the Project are considered to increase facility-level GHG emissions as it is assumed that these components will involve Scope 1, 2, or 3 facility-level GHG-emitting activities. As the Project components shown in the Appendix 6-A scoping table do not exactly delineate GHG-emitting activities, the Scope 1 through 3 GHG accounting classification system is used for the Project facility-level GHG assessment instead of classifying GHG emissions by component. Breaking down emissions by Scope 1 through 3 allows for GHG accounting that takes into consideration upstream and downstream indirect emissions, and prevents double counting when aggregating emissions from many sources. This method follows that developed for organizational reporting by the *Greenhouse Gas Protocol for the Corporate Accounting and Reporting Standard* (World Resources Institute and World Business Council for Sustainable Development 2004), also adopted by the International Standards Organization for its ISO 14064-1 standard on organizational GHG quantification and reporting (International Standards Organization 2006). This approach is also consistent with methods used to report to the IPCC for government GHG emission reporting (Environment Canada 2010b).

6.6.1.1.1 Scope 1 Emissions

Scope 1, or direct GHG emissions, sources will arise from the Project from direct, on-site fuel burning, incinerating, and blasting. Most of the Project's GHG emissions will result from fossil fuel burning required for activities involving on-site mobile or stationary vehicle/equipment engines or generators. Diesel is assumed to be the fuel that will be required to power equipment for all constructed components, drilling, loading, hauling, pit maintenance, crushing, and other comminution and processing engines.

Engine sources contributing to Scope 1 emissions will include heavy-duty trucks (i.e., haul trucks, tool trucks, water trucks, and fire trucks), hydraulic shovels, excavators, forklifts, backhoes, cranes, loaders, snow ploughs, tractors, pumps, pipe layers, drills, graders, and lifts. Scope 1 emissions from construction equipment GHG emissions are attributable to all Project component areas during construction. This includes the two main access roads to the Mine Site and the PTMA, which will contribute to Scope 1 construction activity emissions as well as Scope 3 haul vehicles operated by third-party contractors. During operation though, these two main access roads will be used only for Scope 3 hauling activities.

Waste treatment may also contribute to GHG emissions and require inclusion in future Project GHG reporting, but these emissions are anticipated to be negligible so are not included in the GHG assessment at this time. For instance, of the 43,323 t CO_2e reported by the Mount Polley metal ore mine for 2010, under the BC Reporting Regulation (BC Reg 272/2009), emissions from waste contributed only 70 t CO_2e to this amount (BC MOE 2011b). In addition, hydroelectric generation by the Project may also lead to fugitive emissions of sulphur hexafluoride (SF_6), which is used for insulation and current interruption in electric transmission and distribution equipment such as circuit breakers, gas-insulated substations, and switchgear. The GWP of SF_6 is 23,900 times greater than that of CO_2 and its lifetime in the atmosphere is 3,200 years, so these GHG emissions also must be included in GHG accounting reports to provincial and national authorities. However, SF_6 emissions are determined *ex poste*, based on a mass balance approach or directly measured leakage (Environment Canada and Canadian

Electricity Association 2008; BC Reg 272/2009), and the IPCC does not provide emission factors for fugitive emissions of SF_6 estimation either (Olivier and Bakker 2001), so it is not possible to include a calculation of these emissions at this time. It is also anticipated that the GHG emissions from SF_6 for the Project will be a negligible contribution to the carbon footprint of the Project as the hydro plants are anticipated to lead to net GHG reductions for the Project. For instance, the Mica Generating Station of the BC Hydro and Power Authority emitted 15,521 t CO_2e from SF_6 in 2010 (BC MOE 2011a), which represents SF_6 GHG emissions for a 7,202 gigawatt hour (GWh) plant. In comparison, the mini hydroelectric generating stations for the Project will generate about 48.7 GWh (Tetra Tech Wardrop 2012), which, using a rough linear comparison, corresponds to SF_6 emissions of only about 100 t CO_2e per annum.

6.6.1.1.2 Scope 2 Emissions

Scope 2 emissions are called indirect emissions as they arise from electric energy for the Project, imported from the BC Hydro main grid electricity via the NTL. It is assumed that these emissions will only commence during the operation phase of the Project, after the power line connection to the NTL is built. In general, Scope 2 emissions are less than those from Scope 1 per unit power as they stem largely from cleaner hydroelectric power rather than fossil fuel burning.

6.6.1.1.3 Scope 3 Emissions

Scope 3 emissions are another indirect GHG emission source arising from the activities of third parties contracted by the Project, such as for on- or off-site equipment use and hauling activities.

During the construction phase, third parties will include primary contractors for on-site equipment and truck operation at both the Mine Site and the PTMA. Scope 3 GHG emissions during construction also include vehicle emissions to off-site locations via access roads and local highways from third-party controlled fleets operating vehicles such as 48-foot flat-decks, vans, and bulk tankers to haul infrastructure, camp and support facility cargo/supplies, crew, equipment, materials, flocculants, lime, fuel, and explosives.

During the operation phase, Scope 3 emissions will largely arise from third-party-operated fleets travelling to and from off-site locations to haul items such as copper and molybdenum concentrates, lime and other reagents, grinding media, fuel and lubricants, personnel/visitors/ maintenance, camp supplies, explosives, lime for water treatment, parts and machinery, and major mine equipment. Vehicles included in the Scope 3 assessment are Bulk B-trains and Super B-train trucks, vans, buses, tankers, and 48-foot flat decks. Details on off-site hauling activities of the KSM Project on local highways are provided in the *Highways 37 and 37A Traffic Effects Assessment* (Rescan 2013b), provided in Appendix 22-C.

6.6.1.1.4 Summary of Facility-level Emissions Scoped into Project GHG Assessment

In order to best adhere to the provincial and national GHG reporting standards as well as fulfill the requirements of the AIR and the Comprehensive Study Scope of Assessment, the GHG assessment at the facility level for the KSM Project includes the phases, scopes, and emission sources listed in Table 6.6-2.

Table 6.6-2. Summary of KSM Scope 1 to 3 Greenhouse Gas Emissions Considered

Phase	GHG Emission Source	Emission Source Description
Construction	Scope 1 - Direct	Fuel burning by on-site mobile and stationary equipment and generators, blasting, and incineration—activities owned and controlled by the KSM Project.
	Scope 2 - Indirect	Imported hydroelectricity* from BC Hydro provincial grid
	Scope 3 - Indirect	Fuel burning activities owned and operated by third-party contractors (i.e., on-site equipment/trucks or transport)
Operation	Scope 1 - Direct	Fuel burning by on-site mobile and stationary equipment and generators, blasting, and incineration—activities owned and controlled by the KSM Project.
	Scope 2 - Indirect	Imported hydroelectricity from BC Hydro provincial grid, reduced/mitigated by on-site hydro projects
	Scope 3 - Indirect	Fuel burning activities owned and operated by third parties contracted by the KSM Project (i.e., on- or off-site equipment or hauling such as concentrate transport)

***Estimated to be zero as the connection to the NTL will be under construction during this phase.**

The assessment method is done to be as similar as possible to those that will be required for the Project after start-up to comply with provincial and national reporting requirements. The BC Reporting Regulation (BC Reg 272/2009) requires reporting only of *direct* emissions (Scope 1); however, in order to fulfill AIR requirements, this GHG assessment not only estimates direct on-site sources (stationary and mobile sources such as equipment and generator fuel burning), but also reports on *indirect* emissions, including Scope 2 emissions estimates from imported electricity, and Scope 3 emissions estimates for third-party transport fleet activities on- and off-site. The BC Reporting Regulation (BC Reg 272/2009) indicates that facilities do not generally need to include and report on emissions from "mobile equipment"; however, mine ore hauling vehicles are an exception to this rule as they are not considered "mobile equipment" under the regulation, so mobile equipment have been included in this assessment to be consistent with this approach.

6.6.1.2 Land-use Change Atmospheric GHG Emission Effects Scoping Summary

Land-use change GHG emissions are included in the Project GHG assessment per the AIR requirement to "describe and quantify the direct effects on potential large scale carbon sinks" (BC EAO 2011). Large-scale carbon sinks that will be affected by the Project are those that sequester carbon through photosynthesis into above- and below-ground biomass sinks.

The scoping table in Appendix 6-A provides a detailed list of how the different Project components will contribute to facility-level GHG emissions for different phases of the Project, and similarly, how biomass sinks will be affected by vegetation clearing and restoration activities for the various components within the main Project footprint areas.

Best practices in estimating GHG emissions from land-use change have been developed by the IPCC in their *Good Practice Guidance for Land Use and Land-use Change and Forestry* guidance document (IPCC 2003). LULUCF methodologies, involving complex carbon budget modeling, are used for Canadian national and provincial land-use change GHG assessments and reporting (BC MOE 2012b; Environment Canada 2012d), but are not typically used for GHG assessments that are reported as part of environmental assessments. One of the reasons for this is that national and provincial inventories are done *ex poste* involving data on land-use change that has actually taken place, with sources such as the Canadian Forest Inventory and other harvested wood forestry sources collected via remote sensing or field based studies[4], while environmental assessments use *ex ante* data estimates, and are therefore simplified assessments. The land-use change GHG assessment for the KSM Project uses a modified method, using LULUCF terminology and approach and applying emissions factors to ex ante land-use change data.

Under the IPCC LULUCF method, there are several defined land use categories to use in GHG reporting that apply to the Project—forest, grassland, wetland, and settlement. These categories are listed in Table 6.6-3, along with the land-use change data pertaining to them for all phases of the KSM Project.

Table 6.6-3. Land Use Categories

Categories	Definition Used in BC GHG Inventory Report 2010
Forest	Forest land includes all land with woody vegetation consistent with the following thresholds used to define forest land in the NIR*: (i) 1 ha minimum land area; (ii) 25% minimum tree crown cover (at maturity); (iii) 5 metre minimum tree height (at maturity); (iv) 20 metre minimum width (distance between trunks). Forest land also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
Grassland	Grassland includes unimproved pasture or rangeland that is only used for grazing domestic livestock and occurs only in geographical areas where the grassland would not naturally re-grow to forest if unused. In addition, vegetated areas that do not and will not meet the definition of forest land or cropland are generally included in this category. Note that this categorization of grassland differs from other definitions and uses of the term. Some studies classify grassland by vegetation while others characterize them by climate, soils, and human use of the ecosystem.
Wetland	Wetlands are areas where permanent or recurrent saturated conditions allow the establishment of vegetation and soil development typical of these conditions and that are not already in forest land, cropland, or agricultural grassland.
Settlement	Settlements include all built-up land: urban, rural residential, land devoted to industrial and recreational use; roads, rights-of-way and other transportation infrastructure; and resource exploration, extraction, and distribution (mining, oil, and gas).

Source: IPCC (2003), BC MOE (2012b); *NIR=National Inventory Report for Canadian GHG emissions

It is assumed that the clearing of forest, grassland, and wetland (as defined in Table 6.6-3) for the Project will result in GHG emissions from the removal of biomass, the decay of dead organic

4 These studies collect a variety of data on modelling stand biomass volume and carbon that is unavailable for the Project, such as tree diameters at breast height for assessed stands.

matter, and soil composition changes (BC MOE 2012b). Activities to clear, grub, and burn land to convert any vegetated land to settlement is referred to as deforestation in the assessment, and restoration activities to replant vegetation, converting land back from settlement to forest, grassland, or wetland is referred to as reforestation[5]. Deforestation and reforestation activities for the KSM Project will occur at different times over the four phases of the Project, as shown in the Appendix 6-A scoping table for land-use change. Any clearing/burning activities in a Project component will result in GHG emissions being generated by that component (marked by a "+" in the table), while replanting/restoration activities will lead to GHG sequestration, a beneficial effect (marked by a "-" in table). In this way, land-use change emissions differ from facility-level emissions, which are all net positive to the atmosphere.

Deforestation usually leads to GHG emissions that are emitted relatively quickly to the atmosphere from vegetation burning, and then more slowly from decomposition in remnant soil and other remaining biomass, while reforestation typically takes many years to restore original carbon pools to biomass. It is assumed that reforestation activities will cancel out deforestation over the long term, and net deforestation will be used to estimate the land-use change GHG footprint of the Project.

6.6.2 KSM Project Greenhouse Gas Scoping across Project Phases

As shown in Scoping Table 6.6-4, all components of the KSM Project will contribute to net changes in GHG emissions mostly from Project activities such as clearing land, construction, excavation, crushing, comminution, and hauling will require energy from fuel burning primarily and secondarily from electricity from the grid.

Table 6.6-4. Component Scoping Table of Potential Effects from Project on Atmospheric GHG Levels

Project Region	Project Area	Change in Atmospheric GHG Levels
Mine Site	Camp 3: Eskay Staging Camp	X
	Camp 7: Unuk North Camp	X
	Camp 8: Unuk South Camp	X
	Coulter Creek Access Corridor	X
	Mitchell Operating Camp	X
	McTagg Rock Storage Facility	X
	McTagg Twinned Diversion Tunnels	X
	McTagg Power Plant	X
	Mitchell Rock Storage Facility	X
	Camp 4: Mitchell North Camp (for MTT Construction)	X
	Mitchell Ore Preparation Complex	X

(continued)

5 Note that the term afforestation is used when planted land has not been forested in recent history, while reforestation applies to land that was recently vegetated.

Table 6.6-4. Component Scoping Table of Potential Effects from Project on Atmospheric GHG Levels (completed)

Project Region	Project Area	Change in Atmospheric GHG Levels
Mine Site *(cont'd)*	Mine Site Avalanche Control	X
	Iron Cap Block Cave Mine	X
	Mitchell Pit	X
	Mitchell Block Cave Mine	X
	Mitchell Diversion Tunnels	X
	Upper Sulphurets Power Plant	X
	Mitchell Truck Shop	X
	Water Storage Facility	X
	Camp 9: Mitchell Initial Camp	X
	Camp 10: Mitchell Secondary Camp	X
	Water Treatment and Energy Recovery Area	X
	Sludge Management Facilities	X
	Sulphurets Laydown Area	X
	Sulphurets-Mitchell Conveyor Tunnel	X
	Sulphurets Pit	X
	Kerr Rope Conveyor	X
	Kerr Pit	X
	Camp 2: Ted Morris Camp	X
	Explosives Manufacturing Facility	X
	Temporary Frank Mackie Glacier Access Route	X
	Camp 1: Granduc Staging Camp	X
Processing and Tailing Management Area	Mitchell-Treaty Twinned Tunnels	X
	Construction Access Adit	X
	Mitchell-Treaty Saddle Area	X
	Camp 6: Treaty Saddle Camp	X
	Camp 5: Treaty Plant Camp	X
	Treaty Operating Camp	X
	Treaty Ore Preparation Complex	X
	Concentrate Storage and Loadout	X
	North Cell Tailing Management Facility	X
	East Catchment Diversion	X
	Centre Cell Tailing Management Facility	X
	South Cell Tailing Management Facility	X
	Treaty Creek Access Corridor	X
	Camp 11: Treaty Marshalling Yard Camp	X
	Camp 12: Highway 37 Construction Camp	X
Off-site Transportation	Highway 37 and 37A	X

X = interaction between component and GHG emissions effect

As an alternative to the above scoping table, which breaks down emissions by Project components (as in Appendix 6-A scoping tables), Table 6.6-5 provides scoping of GHG emissions by Project activities instead. Table 6.6-5 represents how scoping is typically done by activities rather than components, and lists which scope activities fall under (facility-level scope 1 to 3 or land-use change), and during which phase these activities will be present.

Table 6.6-5. Scoping Table of Potential Effects of KSM Project on Atmospheric GHG Levels

Project Region	Project Activities	Emission Category	Project GHG Sources/Sinks Resulting in Net Change in Atmospheric GHG Levels			
			Construction	Operation	Closure	Post-closure
Mine Site*	Incinerating (Camps)	Scope 1	X	X	X	
	Fuel Burning: On-site Stationary and Mobile Equipment/Truck	Scope 1,3	X	X	X	X
	Blasting	Scope 1	X	X		
	Electricity Use (Imported)	Scope 2		X	X	X
	Energy Generation (Power Plants)**	Scope 1, 2	X	X	X	X
	Clearing and Debris Burning	Land-use Change	X	X		
	Restoration Replanting	Land-use Change		X	X	X
PTMA*	Incineration (Camps)	Scope 1	X	X	X	
	Fuel Burning: On-site Stationary and Mobile Equipment/Truck	Scope 1,3	X	X	X	X
	Electricity Use (Imported)	Scope 2		X	X	X
	Energy Generation (Power Plants)**	Scope 1,2	X	X	X	X
	Clearing and Debris Burning	Land-use Change	X	X		
	Restoration Replanting	Land-use Change		X	X	X
Main Access Roads (to Mine Site and PTMA)	Fuel Burning: On-site Stationary and Mobile Construction Equipment	Scope 1	X			
	Fuel Burning: Third Party Haul Vehicles	Scope 3	X	X	X	
	Clearing and Debris Burning	Land-use Change	X			
	Restoration Replanting	Land-use Change			X	X

Notes: Empty cells have no effect and cells with X's have an effect; cyan coloured cells indicate GHG sinks or reductions.
***The Mitchell-Treaty Twinned Tunnels components are considered split halfway between the Mine Site and PTMA.**
**** Hydroelectric stations are anticipated to be a net source of GHGs during construction from construction equipment; after this phase, they will provide GHG reductions as they will lower the energy drawn from the grid.**

6.6.2.1 Construction

As shown in Table 6.6-5, GHG emissions sources from the Project during construction will include Scope 1 and 3 activities involving fuel burning by stationary and mobile on-site equipment, generators, and transport vehicles, camp incineration and blasting for facility-level GHG emissions, and land-use change clearing/burning. Scope 2 GHG emissions will not be included, as the power line connector to access the provincial electric power grid from the NTL will not be connected yet. Land-use change will be substantial during the construction phase and is also included in the GHG assessment. The Appendix 6-A scoping table provides a further breakdown of facility level and land-use change GHG emissions across the various Project components during the construction phase.

In summary, both facility level and land-use change construction phase GHG emissions will be included in the Project climate (GHGs) effects assessment, as GHG emissions from both pathways are anticipated to be material during this phase.

6.6.2.2 Operation

As shown in Table 6.6-5, GHG emissions sources will include the activities listed in construction for Scope 1 and 3, as well as Scope 2 emissions from imported electricity from the BC Hydro grid. Land-use change will continue to be material in this phase. The scoping table in Appendix 6-A provides a further breakdown of facility level and land-use change GHG emissions across the various Project components during the operation phase.

It is anticipated that the highest levels of average annual GHG emissions will be emitted during the operation phase from both facility level and land-use change activities, as this is the case for most metal mines, so the operation phase will be included in the Project GHG assessment.

6.6.2.3 Closure

Decommissioning and closure activities that take place in the closure phase of the Project will contribute to some facility-level emissions, as shown in Table 6.6-5. The scoping table in Appendix 6-A provides a further breakdown of facility level and land-use change GHG emissions across the various Project components during the closure phase. Facility-level GHG emission levels during closure are anticipated to be small in comparison to those during construction and operation, and so have been scoped out of the Project GHG assessment.

Land-use change activities during closure will be material, mostly involving replanting of terrestrial systems, resulting in net sequestration for this Project phase. In order to best incorporate the closure phase, as well as other Project phases, the land-use change GHG assessment is based on the "all phases" net land-use change measured across the entire Project footprint. This net land-use change data set incorporates the net difference between maximum extent of deforestation and afforestation across all phases.

6.6.2.4 Post-closure

Scope 1 to 3 Project activities will be greatly diminished during the post-closure phase, and facility-level GHG emissions are anticipated to be negligible for this phase compared to construction and operation, and so are not included in the GHG assessment. The Appendix 6-A scoping table provides a further breakdown of facility level and land-use change GHG emissions across the various Project components during the closure phase.

It is anticipated that during post-closure, land-use change emissions will transition from the Project being a net GHG emission source to a net sink due to biological sequestration of replanted terrestrial systems. As mentioned in the previous section, the post-closure phase will also be incorporated into the "all phases" net land-use change Project footprint.

6.7 Potential for Residual Effects for Greenhouse Gases

The following sections contain the KSM Project GHG Emissions Assessment for both facility level and land-use change GHG emission sources. This assessment is considered to include design-phase mitigation, but other mitigation measures listed in Section 6.7.2 may lead to GHG reductions beyond those represented in this assessment.

6.7.1 Potential Effects of Project on Greenhouse Gas Emissions

6.7.1.1 Facility-level Greenhouse Gas Emissions Assessment

Facility-level Greenhouse Gas Emissions Calculation Methodology

The GHG assessment for the KSM Project uses facility-level activity data—including fuel consumption, equipment used, blasting levels, transport vehicles and routes, and energy use—obtained from the PFS (Tetra Tech Wardrop 2012), with some information provided by other consultants such as Moose Mountain Technical Services on blasting, and land-use change estimates made based on the Project footprint by Rescan. Table 6.7-1 provides the projected fuel use (Scope 1) for the Project for the construction and operation phases. As shown in Table 6.7-1, hauling and then loading account for most of the fuel consumption for the Project during the operation phase. More detailed information on data sources of Project activities such as blasting and equipment can be found in Tables 3-1, 3-2, 7-1, and 7-2 of Appendix 7-A.

Emissions factors (EFs) are typically used in GHG accounting to calculate facility GHG emissions from Scope 1, 2, and 3 fuel- and electricity-use activity data. For example, diesel was considered to be the primary fuel used by the Project, and the EFs used for diesel fuel GHG calculations are taken from the BC GHG inventory report and are: 2,663 g of CO_2 per litre of diesel (g/L), 0.133 g/L for CH_4, and 0.4 g/L for N_2O (BC MOE 2012b). The EF for blasting used is 0.189 t of CO_2 per t of explosive used.

The EF used for imported electricity (Scope 2) for the Project is 25 t CO_2e per GWh, corresponding to a rolling three-year average of BC Hydro's domestic supply GHG intensities from 2008 to 2010, recommended for use in BC for public reporting (BC MOE 2012a). For this assessment, GHG emissions from on-site hydroelectric power are assumed to be zero, while BC Hydro derives some of its electricity generation from fossil fuel sources.

For Scope 3 transport GHG emissions, EFs were derived from the US Environmental Protection Agency's Motor Vehicle Emission Simulator for the highway transport vehicles anticipated to be used for the Project such as 48-foot flat-decks, enclosed vans, bulk tankers, and B-train trucks (US Environmental Protection Agency 2012).

Global warming potential (GWP) factors—defined as 1 for CO_2, 21 for CH_4, and 310 for N_2O, respectfully—are used to convert all GHGs to CO_2e.

Table 6.7-1. Projected Diesel Fuel Consumption for the KSM Project

Phase	Fuel Consumed	Unit	Year -6*	Year -5	Year -4	Year -3	Year -2	Year -1
Construction	Drilling	m^3	93	208	357	486	1,058	1,239
	Loading	m^3	900	985	1,783	4,601	6,385	6,739
	Hauling	m^3	1,485	1,814	2,883	8,049	19,388	18,784
	Pit Maintenance	m^3	3,369	4,077	4,396	4,432	4,498	4,505
	Total	**m^3**	**5,935**	**7,210**	**9,615**	**17,962**	**32,169**	**32,283**

Phase	Fuel Consumed	Unit					
Operation	**Fuel Consumed**	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
	Drilling	m^3	1,759	1,561	1,838	1,867	1,241
	Loading	m^3	9,984	9,238	9,184	9,523	9,511
	Hauling	m^3	56,413	54,624	56,013	55,818	42,008
	Pit Maintenance	m^3	6,360	6,348	6,334	6,325	6,343
	Total	**m^3**	**77,295**	**74,394**	**76,279**	**76,593**	**61,449**
	Fuel Consumed	**Unit**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
	Drilling	m^3	1,649	1,357	1,137	1,648	401
	Loading	m^3	9,493	9,586	9,555	9,667	7,734
	Hauling	m^3	42,048	42,177	41,109	35,954	28,038
	Pit Maintenance	m^3	6,209	6,716	6,732	6,736	6,736
	Total	**m^3**	**62,061**	**62,288**	**60,819**	**56,671**	**44,610**
	Fuel Consumed	**Unit**	**Year 11 to 20**	**Year 21 to 30**	**Year 31 to 40**	**Year 41 to 50**	**To Year 51.5**
	Drilling	m^3	2,776	4,630	15	15	-
	Loading	m^3	53,514	48,691	9,213	7,070	4,652
	Hauling	m^3	291,188	419,071	97,704	191,647	27,728
	Pit Maintenance	m^3	67,052	57,229	52,438	35,732	21,982
	Total	**m^3**	**430,535**	**547,028**	**166,527**	**239,826**	**54,363**

Source: Moose Mountain Technical Services (2012); *Data represents up to year -5.5 to be conservative

<u>Facility-level Greenhouse Gas Emissions</u>

The breakdown of Scope 1, 2, and 3 GHG emissions for the KSM Project for construction and operation is listed in Table 6.7-2. This table does not include LULUCF GHG emissions.

As shown in Table 6.7-2, most of the estimated Project facility-level emissions are from direct Scope 1 activities including the burning of diesel fuel. The assessment is congruent with other reports that indicate that over 95% of GHG emissions in the mining sector result from energy use, whether from fuel or electricity (Stratos 2009a). Scope 1 to 3 KSM Project activities are anticipated to release an average estimated 113 kt of CO_2e to the atmosphere annually during the construction phase and an average 170 kt of CO_2e annually during the operation phase, making operation the most GHG intensive phase of the Project. Averaged over these two phases, the facility-level annual GHG emissions for the Project are anticipated to be about 165 kt CO_2e. At a production level of 130,000 tonnes of ore milled per day, the facility-level emission rate corresponds to a GHG intensity of about 3.5 t CO_2e/kt ore to mill.

Table 6.7-2. KSM Project Facility-level GHG Assessment

Phase	GHG Emissions Source	CO_2 (t)	CH_4 (t)	CH_4 (t CO_2e)	N_2O (t)	N_2O (t CO_2e)	Average GHG Emissions (t CO_2e/yr)
Construction[1]	Scope 1	97,492	3	65	9	2,878	103,583
	Scope 2	n/a	n/a	n/a	n/a	n/a	n/a
	Scope 3	8,600	0	9	1	325	9,080
	Total	**106,092**	**4**	**74**	**10**	**3,203**	**112,664**
Operation[2]	Scope 1	127,938	6	126	18	5,601	133,665
	Scope 2	-	-	-	-	-	31,407
	Scope 3	5,207	0	3	0	2	5,212
	Total	**133,145**	**6**	**129**	**18**	**5,603**	**170,285**
Total[3] Average Annual KSM Project Facility-level GHG Emissions							**164,725**

Notes:
[1]Averaged over 5.5 years to be conservative;
[2]Averaged over 51.5 years;
[3]Averaged over 57 years.
GHG=Greenhouse gas; CO_2=carbon dioxide, N_2O=nitrous oxide, CH_4=methane; CO_2e=carbon dioxide equivalent

Scope 2 emissions from imported electricity will only commence during the operation phase, once the NTL is built. During the construction phase the mini hydro power plants will contribute to minor emissions from land clearing and activities involved in their construction, but in the operation phase, these hydroelectric stations are anticipated to generate 48.7 GWh (over 3%) of the annual 1,305 GWh electric power requirements of the Project (Tetra Tech Wardrop 2012), providing energy reductions from the NTL.

6.7.1.2 Land-use Change Greenhouse Gas Emissions Assessment

<u>Land-use Change Greenhouse Gas Emissions Calculation Methodology</u>

Per LULUCF guidelines, the flux of CO_2 to or from the atmosphere from land-use change is assumed to be equal to changes in carbon stocks in existing biomass and soils. Calculations were performed for the net difference in land cleared versus replanted. For the purposes of this assessment, "deforestation" refers to conversion of forest, grassland, and wetland to settlement for the Project footprint, and "reforestation" is used for the conversion back to a naturally vegetated state. Biogeoclimatic ecosystem classification (BEC) units identified through baseline studies for the Project are listed in Table 6.7-3.

The BC GHG Inventory Report estimated an average EF of 500 t/ha of GHG emissions (CO_2e) released from conversion of forest to settlement for vegetation zones across BC (BC MOE 2012b). This EF is derived primarily from zones of converted forest in the lower mainland, east Vancouver Island, and north central and northeastern BC, which are typically more biomass-rich—with correspondingly larger GHG emissions from the conversion of above- and below-ground biomass—than the predominantly alpine and subalpine zones of the Project. In spite of this EF likely overestimating emissions for the Project, it has still been used in order to provide a conservative conversion factor for land-use change per GHG accounting best practices. In order to represent the variety of terrestrial zones in the Project, EFs of 300 t/ha CO_2e for conversion of sparse forest to settlement, and 12 t/ha CO_2e for conversion of grassland zones were used, which were extrapolated from similar zone calculations as per IPCC and other research methodologies (Skrivanos 2002; IPCC 2003; Hatano et al. 2006; Boudewyn et al. 2007; Ravin and Raine 2007; Greig and Bull 2009; Houghton et al. 2012).

Table 6.7-3. BEC Units in the KSM Area

BEC Unit Label	BEC Unit Name	Description	Dominant Species
BAFAunp	Boreal Altai Fescue Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	Spruce and subalpine fir, dwarf willows, sedges, lichens, and grasses
CMAunp	Coastal Mountain-heather Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	Mountain heathers, mountain hemlock, yellow-cedar, and subalpine fir in krummoholz form
CWHwm	Coastal Western Hemlock - Wet Maritime Subzone	Low elevation forest (coastal)	Western hemlock and Sitka spruce. Understory with blueberry variants, false azalea, bunchberry, bramble, and fern
ESSFwv	Engelmann Spruce – Subalpine Fir Wet Very Cold Subzone	Subalpine forest (interior)	Subalpine fir, with understory of huckleberry, blueberry, false azalea, five-leaved bramble, bunchberry, feather moss, and liverworts
ICHvc	Interior Cedar Hemlock - Very Wet Cold Subzone	Low elevation forest (interior)	Highest productivity of all zones with cedar, hemlock, devil's club, and oak fern
MHmm[2]	Mountain Hemlock - Leeward Moist Maritime Variant	Subalpine forest (coastal)	Mountain hemlock, western hemlock at lower elevations and subalpine fir

Source: Rescan (2010)

<u>Land-use Change Greenhouse Gas Emissions</u>

Terrestrial baseline studies for the Project have led to BEC zones in the area being further subdivided into Terrestrial Ecosystem Mapping (TEM) zones (Rescan 2010). Figure 6.7-1 illustrates BEC units and major TEM vegetation zones (green/blue coloured zone mapped around the Project footprint), and the maximum extent of the Project footprint across all phases (indicated in orange), which corresponds to an associated loss of vegetated land for underlying BEC and TEM zones. In addition to the GHG assessment in this Application/EIS, further information on vegetation zones and their loss as a result of the Project is described in Chapter 17, Terrestrial Ecosystems.

Table 6.7-4 presents the Project TEM zones re-classified as LULUCF zones for the purpose of this assessment, along with their predicted areas of land lost through conversion to industrial settlement, and then reclaimed back from settlement again over all phases of the Project and for the whole Project footprint. Structural stage for all TEM forest units (except avalanche tracts) is assumed to be either mature or old forest (not new growth) based on terrestrial baseline studies conducted in the area (Rescan 2010).

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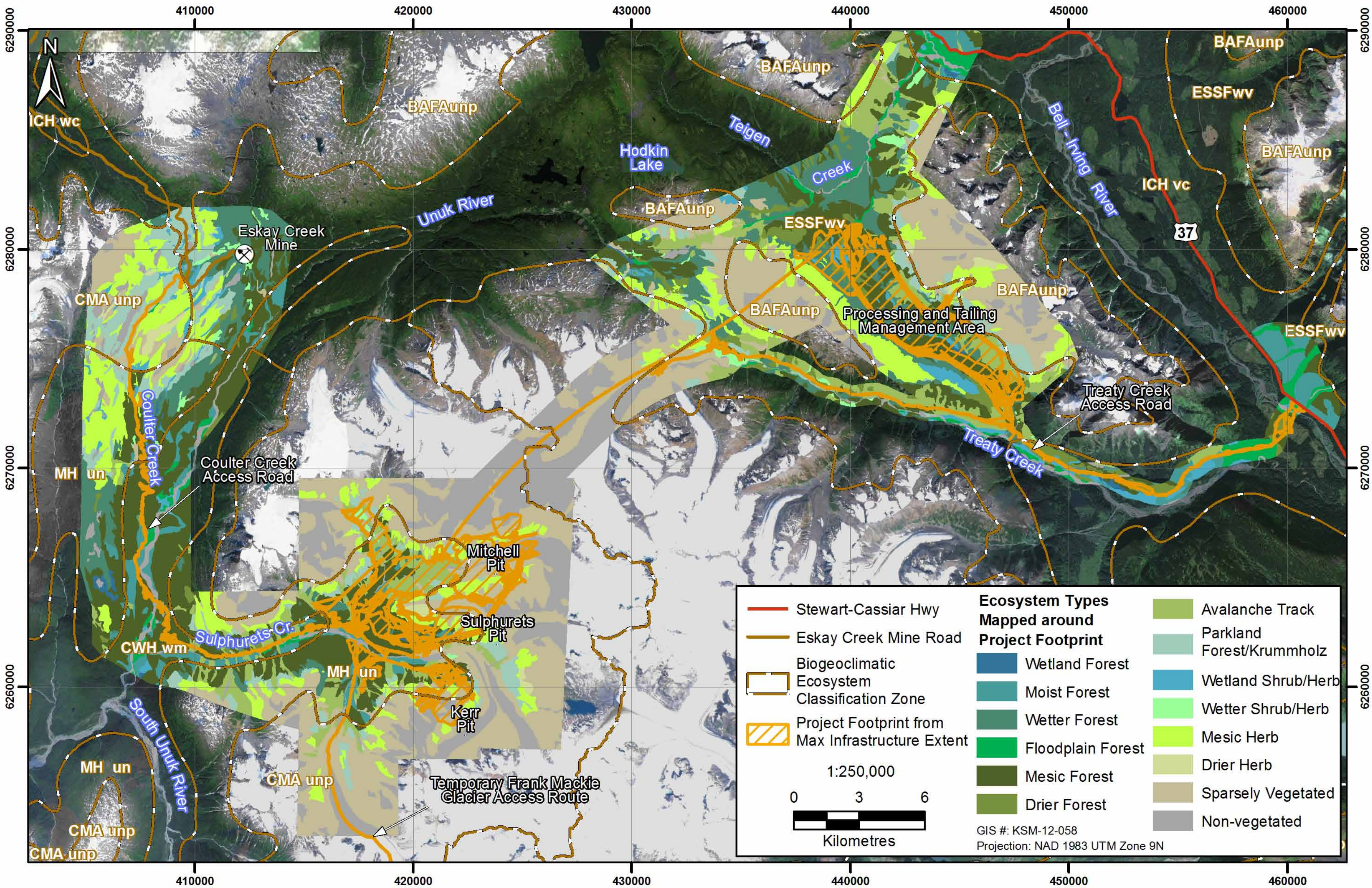

Figure 6.7-1

Maximum Extent (All Phases) of KSM Project Footprint and Resulting BEC/TEM Vegetation Area Loss

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Figure 6.7-1

Table 6.7-4. All Phases Land-use Change - Summary across KSM Project Footprint

TEM Vegetation Type	LULUCF Classification	All Phases Area Lost (ha)			All Phases Area Reclaimed (ha)			Net Loss
		Mine Site	PTMA	Total Mine Footprint	Mine Site	PTMA	Total Mine Footprint	Total Mine Footprint
Wetland Forest	Forest	0	17	17	0	-1	-1	17
Moist Forest	Forest	108	33	141	-27	-4	-31	110
Wetter Forest	Forest	23	475	498	-15	-179	-193	305
Floodplain Forest	Forest	4	49	53	-1	-14	-16	37
Mesic Forest	Forest	763	1,037	1,800	-640	-1,126	-1,766	34
Drier Forest	Forest	1	201	202	0	-99	-99	103
Forest Subtotal		898	1,812	**2,710**	-683	-1,422	**-2,105**	**606**
Avalanche Track	Sparse Forest[1]	528	375	903	-65	-79	-144	759
Parkland Forest/ Krummholz	Sparse Forest	72	10	82	-9	-4	-13	69
Wetland Shrub	Sparse Forest	0	47	47	0	-19	-19	27
Wetter Shrub/Herb	Sparse Forest	33	17	50	-31	-11	-42	8
Sparsely Vegetated[2]	Sparse Forest	75	2	77	-30	-5	-35	42
Sparse Forest Subtotal		709	451	**1,159**	-135	-118	**-253**	**906**
Drier Herb	Grassland	8	6	15	0	0	0	15
Mesic Herb	Grassland	313	26	339	-84	-152	-236	103
Grassland Total		321	32	**354**	-84	-152	**-236**	**117**
Wetland Herb	Wetland	0	59	59	-0	-275	-275	-216
Total Area		1,928	2,354	**4,283**	-902	-1,967	**-2,869**	**1,414**

Source: Estimates based on Project footprint estimated by Rescan GIS 2012
Notes:
LULUCF=land use, land-use change, and forestry; ha=hectare
Numbers may not balance exactly due to rounding and 0 values represent areas less than 1 ha; numbers may differ from other chapter values calculated per phase.
[1]Sparse forest is still considered as forest under the LULUCF categories, but will have a lower emission factor applied to it due to lower biomass than regular forest.
[2]Sparsely vegetated land contains only about 10% vegetation.

Land-use change data is provided in Table 6.7-4 for forest, sparse forest, wetland, and grassland converted to settlement, and then back again. As reported in the table, the total net land-use change for the Project is 1,414 ha. Net land lost per LULUCF land category will be used to estimate the net land-use change GHG emissions from the Project resulting from a loss of biomass from vegetation. Although land-use change involving wetland is reported in Table 6.7-4, this data is not included in the GHG assessment because wetland carbon budgets are not usually included in environmental assessments as they are complex (some types act as carbon sources and others as net sinks), and further data would be required to do so.

Based on the land-use change net loss data presented for all phases of the Project footprint in Table 6.7-4, average annual GHG emissions over the combined construction and operation phases are presented in Table 6.7-5. Averaged over this period, land-use change emissions are estimated to be about 10 kt CO_2e per annum.

Table 6.7-5. KSM Project Land-use Change GHG Emissions

Land Classification	Net LOM Land Converted to Settlement (ha)	EF* (t CO_2e/ha)	Average Annual GHG Emissions (t CO_2e/yr)**
Forest	606	530	5,630
Sparse Forest	906	300	4,770
Grassland	117	12	25
Total	**1,629**	**-**	**10,425**

Notes:
LOM=life of mine
***EF=emission factor**
****Averaged over 57 years (5.5 construction to be conservative + 51.5 operation)**
Note that numbers may not add up exactly due to rounding from source data (sources in methodology section).

6.7.1.3 KSM Project Greenhouse Gas Assessment Summary

Based on the results of GHG assessments for the KSM Project over the construction and operation phases, the total average annual facility-only Project GHG emissions is estimated at 164,725 t CO_2e/yr; with LULUCF (10,425 t CO_2e/yr) the GHG emissions increase to 175,150 t CO_2e/yr.

6.7.2 Mitigation for Greenhouse Gas Emissions

GHG mitigation for the Project consists of ways to reduce the facility-level and land-use change carbon footprints through minimizing facility-level and land-use change GHG emissions. Mitigation activities at the design phase are already incorporated into the Project GHG assessment; the mitigation measures outlined below to control, reduce, and offset GHG emissions will result in further reductions in the Project GHG footprint.

6.7.2.1 Objective

The primary objective of the Greenhouse Gas Management Plan (see Chapter 26.12) is to mitigate net GHGs emitted to the atmosphere by Project activities.

6.7.2.2 Targets

The Greenhouse Gas Management Plan targets are to:

- ensure reporting is carried out to meet the requirements discussed in Section 6.12 ;
- identify and implement measures to progressively minimize GHG emissions and maximize fuel and energy efficiency;
- maintain a plan to monitor on-site GHG emission data, the cumulative results of which will be reviewed annually to determine if any trends are evident and if target criteria are being met;
- maintain a plan to monitor GHG emissions associated with land-use change GHG sources and sinks; and
- increase the carbon fixed as biomass by minimizing clearing and maximizing vegetation reclamation where possible.

6.7.2.3 Actions to Avoid, Control, and Minimize Effects

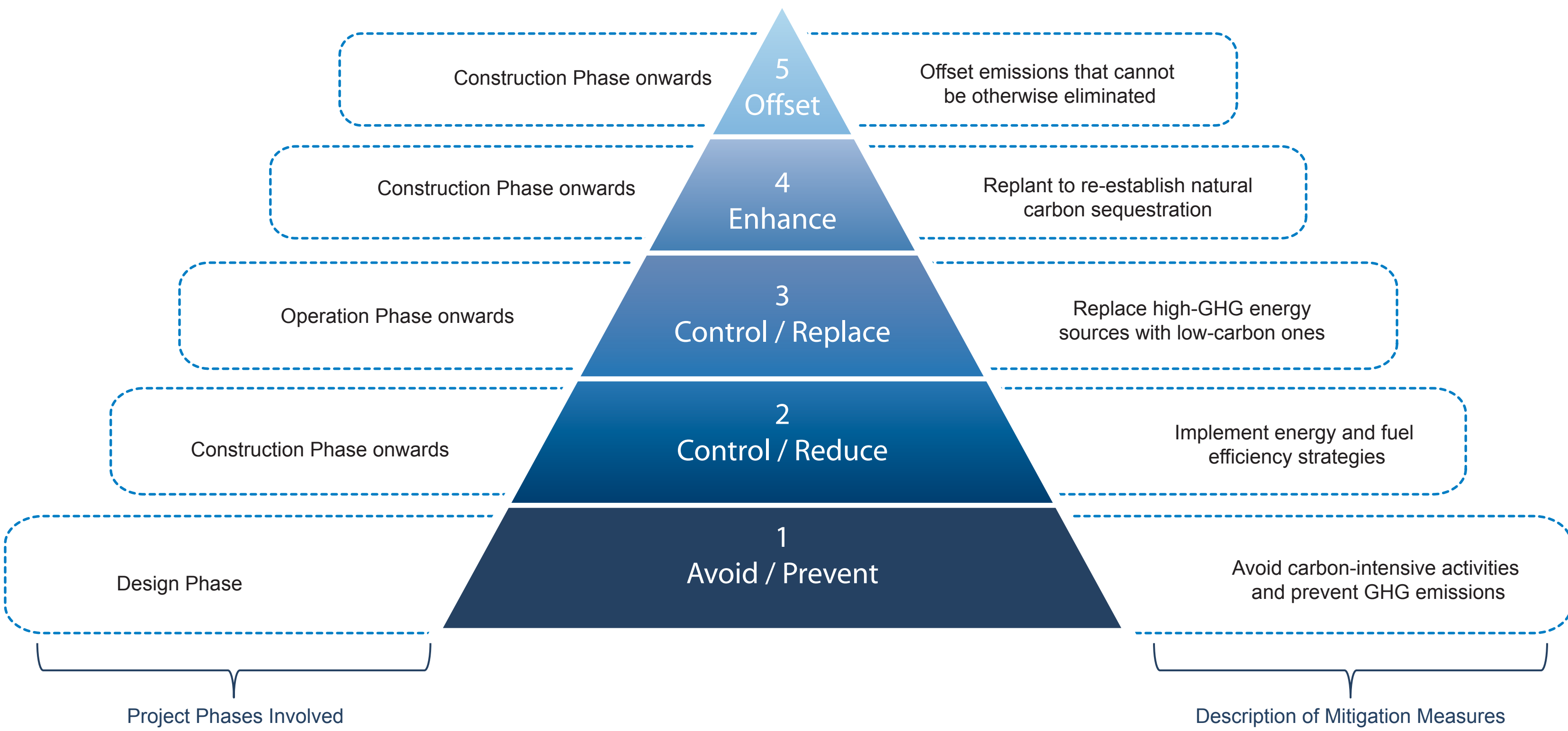
6.7.2.3.1 Greenhouse Gas Mitigation Hierarchy: Introduction

There are several ways to mitigate the GHG emissions of a project. The GHG management hierarchy in Figure 6.7-2 illustrates the ideal line of mitigation strategy for GHG emissions, starting with avoidance, then reduction, replacement, enhancement, and finally offsetting of GHG emissions. Carbon offsetting for projects in this hierarchy only takes place after other reasonable mitigation measures have been implemented.

The actions at the base of the hierarchy are the most transformative and effective at reducing a company's GHG emissions profile. Avoidance, reduction, and replacement activities to mitigate GHG emissions involve reducing fuel use or energy consumption, and so are also typically cost saving as well. Enhancement includes actions that are committed to for the Project regarding replanting activities, which will re-establish vegetation and natural carbon sequestration from the atmosphere via photosynthesis. Offsetting remaining GHG emissions that cannot otherwise be mitigated can involve either purchasing offsets, or creating them by developing additional offset projects.

6.7.2.3.2 Description of Project Greenhouse Gas Emissions Sources

The major source of GHG emissions associated with the Project will be from facility-level emissions from the fuel/energy needs of the Project. This includes direct, on-site (Scope 1) sources, such as from diesel engines and blasting, and indirect sources such as imported electricity consumption (Scope 2) and activities by third parties such as on-site equipment operation and transport activities to off-site locations (Scope 3). The Mining Association of Canada (Stratos 2009b), states that over 95% of the GHG emissions generated directly by the mining industry are a result of fossil fuel use. Therefore, controlling fuel use will result in the most significant GHG emissions reductions, as well as reduced expenses. In addition, decreasing the variability of energy use and improving operating and maintenance practices can reduce energy costs by 5 to 10% and in most cases do not require a capital expenditure.



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The GHG Mitigation Hierarchy

Figure 6.7-2

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There will also be net emissions associated with land-use change GHG sources and sinks from activities such as clearing and burning of biomass on land (e.g., deforestation) to convert it for the Project, emitting GHGs, and restoration through replanting (e.g., reforestation) to convert land back to forested land, which will contribute to GHG sequestration over time. The timing of deforestation and reforestation activities for various components across the Project footprint is shown in the scoping table in Appendix 6-A.

6.7.2.3.3 Greenhouse Gas Mitigation Hierarchy: Implementation

In an effort to mitigate GHG emissions during the various phases of the KSM Project, the proponent has already incorporated design measures that will reduce GHG emissions and plans to implement a variety of other measures throughout the Project life. Applying the mitigation measures outlined below will enable the proponent to work with its upstream and downstream partners towards reducing the atmospheric GHG emissions for the Project across its value chain. This partnership strategy will enable a cost-efficient method of GHG emissions mitigation for the Project as well as provide a means of reducing associated fuel/energy costs and other co-benefits.

Design Phase (Avoid/Prevent)

During the design phase, alternatives assessments were carried out by Seabridge to assess different options for carrying out the Project. As reported in Chapter 33 (Alternative Means of Undertaking the Proposed Project) of the Application/EIS, one of the major Project changes was the switch from open pit to underground mining for the Iron Cap and part of the Mitchell deposits. Using underground mining will result in significant reductions in GHGs emitted by the Project, such as (1) reduced waste rock volume leading to corresponding reductions in fuel burned for excavating, loading, and hauling, and (2) prevention of clearing and burning of vegetation in the reduced mine footprint (Figure 33.3-3 in Chapter 33).

Regarding the placement of the Tailing Management Facility (TMF) and Treaty Process Plant, GHG emissions are anticipated to be similar for each facility regardless of location; however, mobile GHG emissions will be higher for sites with longer access routes. As reported in Chapter 33, minimizing road length was one of the criteria used in selecting the TMF and Treaty Process Plant locations, and shorter Project routes in general have been chosen for the Project, such as in the placement of rock storage facilities, and the choice to truck copper-gold concentrate to the proximate Port of Stewart, rather than to Prince Rupert. Shorter new road construction also has the benefit of reducing effects on other VCs[6], and minimizing route lengths also reduces haul costs. Similarly, minimizing route length was also a criterion in selecting ore, tailing, and other transport systems for the Project.

GHG management for the Project is also closely tied with energy management, for which, under its Power Smart program, BC Hydro has a tiered pricing system to incentivize energy conservation measures. Seabridge has included mini hydroelectric plants in the Project design that will effectively reduce the energy requirements from the NTL to the Project by about 3%

[6] Valued components: as defined in the Application for Information Requirements (AIR) for the Project.

(Tetra Tech Wardrop 2012). Seabridge also has included gravity-assisted water management diversion structures in the design to reduce energy use, and considered energy conservation features in equipment procuring and selection of processing types, including choosing high-pressure grinding rolls in lieu of semi-autogenous grinding milling to reduce the energy requirements of the Project. These and other energy conservation measures will reduce GHG emissions compared to earlier Project designs as well as provide the additional benefit of potentially reducing higher tier pricing for the Project.

<u>Construction Phase (Control/Reduce)</u>

Starting from construction, and onward through subsequent phases, controlling GHG emissions will consist primarily of reducing emissions through implementing energy and fuel efficiency measures and choosing lower GHG emission models when replacing equipment, vehicles, and technology for the Project. Reducing energy/fuel consumption not only reduces GHG emissions, but also has corresponding co-benefits of lowering costs and minimizing the risks of being subject to energy and fuel cost spikes (Stratos 2009b), as well as improving Project optics and public relations.

The following measures will be put in place for the Project during construction to reduce GHG emissions from buildings, equipment, generators, and incinerators:

- Building design/type:
  - selecting well-insulated and high-performance building envelopes with properly sized heating equipment where possible; and
  - designing buildings according to energy efficiency and heat conservation principles where possible, as improvements in the thermal envelope of buildings can reduce heating requirements by a factor of two to four compared to standard practice at little to no net incremental cost for commercial buildings if downsizing of heating and cooling systems is accounted for (Hastings 2004; Levine and Urge-Vorsatz 2007).
- Equipment design/type:
  - procuring recent models, and those with run-time indicators where possible, to assist in monitoring and lowering fuel use/cost;
  - reducing idle-time running using add-ons where possible, such as automatic off mechanisms; and
  - procuring more fuel-efficient and/or hybrid/electric engines where feasible (e.g., the Caterpillar 336E-H cuts fuel consumption by 25 to 50% over non-hybrid models [Caterpillar 2012]).
- Equipment maintenance:
  - regularly maintaining equipment to ensure efficient operation; for instance, a European Union study found that implementing, maintaining, and improving high-efficiency motors could save about 30% in energy consumption (De Keulenaer et al. 2004); and
  - downloading information on use from engines to assist in reporting.

- Staff/operator training to reduce run-time GHG emissions, such as:
  - reducing downtime operation of equipment/generator; and
  - improving fuel efficiency of equipment used, in order to reduce GHGs and fuel costs.

The following fuel efficiency measures will be implemented during Project construction to reduce vehicular fuel use:

- Procuring fuel-efficient vehicle designs/types, which may include but not be limited to:
  - retrofitting older engines (now required in BC for 1989 to 1993 models weighing more than 8,200 kg) with emission reduction devices;
  - procuring fleets with engines three years or newer, if feasible;
  - improving vehicle aerodynamics (can improve efficiency by up to 10%);
  - installing fuel performance displays in vehicles;
  - using add-ons such as cabin heaters to reduce idling;
  - switching to alternative fuels such as biodiesel or natural gas if feasible, as fuel switching within fossil fuel groups can lead to 10% fuel-related GHG emissions (Berstein and Roy 2007), and switching to biomass, a renewable and carbon-neutral fuel source; and
  - implementing hybrid or electric engines if and when feasible, e.g., pilot field tests on Class 8 tractor trailers by the US Department of Energy National Renewable Energy Laboratory found that, over 13 months, the hybrid group demonstrated 13.7% higher fuel economy than the diesel group, resulting in 12% fuel savings (Walkowicz, Lammert, and Curran 2012).
- Vehicle maintenance:
  - regularly checking tire pressure (for every 10 PSI reduction in tire inflation, about a 1% improvement in mileage ensues);
  - regularly maintaining fleets; and
  - downloading information on use from engines to assist in monitoring/reporting.
- Driver training—studies in Europe and the United States have found that eco-driving training can lead to 5 to 20% improvements in fuel economy (International Energy Agency 2005)—which may include but not be limited to:
  - reducing vehicle idling;
  - minimizing rapid starts and stops;
  - optimizing haul efficiency (such as carrying full loads);
  - optimizing driving speeds to conserve fuel; and
  - implementing driver incentive programs.

The proponent will use the list of mitigation measures above as a guide to develop a checklist for use in screening and selecting third-party equipment and fleet providers/owners/operators for the Project. The Proponent will work with its upstream and downstream partners to reduce GHG emissions throughout the KSM Project lifecycle by including procurement criteria that third-party contractors monitor and report on fuel use and related emissions, as well as follow GHG emission mitigation targets mandated under provincial and federal legislation.

Operation Phase (Control/Reduce/Replace, Enhance, Offset)

In addition to the measures outlined for the construction phase, all of which are relevant to the operation phase, the following control measures will be put in place during operation:

- implementing design features such as hydro plants to reduce and replace energy imported from the grid with cleaner (i.e., lower GHG) forms of energy;
- implementing regular energy system audits to identify opportunities to reduce energy use, which have led to 10 to 26% energy use reductions in other industrial applications such as oil and gas refining and steel manufacturing (Berstein and Roy 2007);
- implementing energy/fuel efficiency measures as recommended by energy system audits to directly reduce the Project GHG footprint;
- installing building energy and management systems where possible, which can monitor and prevent energy waste, and improve energy savings by 20% for space heating, 10% for lighting and ventilation, and 5 to 20% overall (Roth et al. 2005);
- monitoring energy use and related GHG emissions where possible, especially for high energy/fuel use facilities/equipment (e.g., by using automated systems, emissions factors, etc.) and taking reasonable steps to minimize GHG emissions from these sources;
- completing preventative maintenance according to manufacturer specifications to ensure optimum performance of diesel mining equipment, thereby reducing GHG emissions;
- considering, when replacing any energy/fuel-using equipment, upgrading to more energy/fuel efficient models;
- optimizing ore, product, and waste transport systems to minimize the extent of double handling;
- using and maintaining HVAC systems to maximize efficiency; and
- making efforts to minimize waste/incineration and reduce downtime running of generators at Project camps.

To achieve mitigation through enhancement, soil salvage, storage, and reapplication will be carried out as described in the Terrain, Surficial Geology, and Soil Management and Monitoring Plan (Chapter 26.13) to ensure successful reclamation of designated areas, and encourage carbon sequestration. Appropriate trees and other plants will be selected for site and climatic conditions to maximize the success of re-vegetation and the ultimate return of the site to its productive land use.

Continuous/progressive reclamation will be conducted across all Project phases. While there will be some reclamation of land affected by some Project components during construction (e.g., early construction camps), reclamation activities will largely start in the operation phase, be most predominant during closure, and may continue to post-closure. The scoping table in Appendix 6-A provides a detailed outline of the current Project plan for clearing and burning activities and restoration/compensation activities to forest, grassland, or wetland for different components of the Project. This table also describes how Project components will contribute to net GHG emissions ("+" for net source, and "–" for net sink) as a result of these land-use change activities. Where possible during Project implementation, land clearing will be minimized and land reclamation will be maximized to conserve and maximize the carbon sequestration capacity of the ecosystems affected by the Project compared to the estimates during this prefeasibility stage.

Closure Phase (Control/Reduce/Replace, Enhance)

Activities during the closure phase will be similar to the activities during the prior phases; therefore, many of the vehicle- and equipment-related actions identified above will also be implemented for the Project, as applicable, during the closure phase.

Post-closure Phase

Project activities will be very minimal in the post-closure phase, as outlined in Chapter 27, and will mostly be limited to transport and water treatment-related activities. The Coulter Creek Access Road to the Mine Site will be decommissioned and restored so that it can revert back to a vegetated habitat. This will reduce vehicle emissions from the use of the access road and enhance natural carbon sequestration. Only the Treaty Creek Access Road and the Mitchell-Treaty Twinned Tunnels will be used post-closure to access the site. The proponent will also maximize the closure of other non-essential Project roads to reduce GHG emissions and continue to implement GHG reduction strategies for the limited activities still in effect for the Project. It is assumed that planted areas, particularly forests, will continue to sequester carbon long after Project closure.

6.7.2.4 Summary

Aside from this chapter, GHG mitigation measures across the Project lifecycle are also provided in the Greenhouse Gas Management Plan (Chapter 26.12) and in Table 6.7-6. The primary GHG mitigation measures for the Project can be categorized as:

- minimizing Project fuel use (e.g., by equipment, vehicles, and generators) through implementing fuel efficiency/conservation measures;
- minimizing Project energy use (e.g., by facility and electrical equipment) through implementing energy efficiency/conservation measures; and
- minimizing planned land-use change clearing/burning and maximizing replanting/ sequestration where possible.

Table 6.7-6. GHG Mitigation Strategies Used at KSM Project

Type of Mitigation	Level of Mitigation	Definition	Strategy Used
Alternative	Avoid or reduce	*Preventing or reducing adverse environmental effects through selecting alternative Project options (e.g., choosing an alternative site or process).*	As described in Chapter 33 (Alternative Means of Undertaking the Proposed Project), GHG emissions were avoided through choosing underground mining, choosing shorter new road options, minimizing distance between PTMA and Mine Site, and minimizing transport distances both on- and off-site. Land-based GHG emissions were avoided by switching to underground mining, which reduced the surface footprint of the Project from pits and waste rock storage.
Design Change*	Avoid or reduce	*Preventing or reducing adverse environmental effects at the source by implementing design changes at the early stages of Project planning (i.e., changing route alignment based on public consultation)*.*	Seabridge has implemented mini hydro plants, lowering electricity use by 48,706 MWh/a, 3% from the original project plan, as well as incorporated energy efficiency measures such as implementing an HPGR option instead of SAG mill and implementing gravity-assisted water diversion structures into Project design.**
Management Practices	Avoid or reduce	*Eliminating or minimizing adverse effects through management practices that reduce or eliminate the cause of the effect at the source, and/or the receptor (e.g., watering unpaved roads to reduce dust).*	Management practices that promote fuel and energy efficiency will be implemented for the Project such as procuring newer engine models where possible, implementing driver training, reducing downtime power use where feasible and other measures described in the GHG Management Plan.
Monitoring and Adaptive Management	Monitor and reduce	*Minimizing and controlling adverse effects through regular analysis and reporting where the potential for adverse effects is unclear (possibly caused by scientific uncertainties, insufficient data, or unknown environmental and/or social interactions). When monitoring identifies adverse effects, mitigation/management practices are implemented at an appropriate level.*	Monitoring will consist of conducting fuel and energy audits and implementing audit recommendations as well as conducting GHG assessments per provincial and federal reporting and verification requirements. Reporting will be done at the provincial and national level per relevant reporting standards.

(continued)

Table 6.7-6. GHG Mitigation Strategies Used at KSM Project (completed)

Type of Mitigation	Level of Mitigation	Definition	Strategy Used
Compensation	Offset	*Offsetting remaining effects that cannot be prevented or reduced through remedial or compensatory actions, so that the net effect on the community or ecosystem is neutral or beneficial (e.g., enhancement of similar habitat in another area, enhancement of other social/economic/cultural benefits).*	If a GHG cap and trade system is legislated during the life of the Project, and the Project does not meet the cap it may: (1) meet caps directly through implementing GHG emissions reductions, (2) generate offsets to apply to its carbon footprint through implementing on-site carbon offset projects, or (3) purchase approved amounts of carbon offsets.
Enhancement	Enhance benefits	*Provide measures to enhance a beneficial effect. Enhancement generally applies to socio-community and socio-economic effects.*	The Project proponent will lower land-use change GHG emissions by minimizing land clearing emissions and maximizing those from replanting.

Notes:
SAG = semi-autogenous grinding
HPGR = high pressure grinding rolls
*** Design change is mitigation at the Project design and alternative assessment phase of the Project, not in the effects assessment phase of the Project.**
**** Wardrop (2012)**

There is the potential that the net GHG emissions for the Project could be mitigated significantly compared to those reported in the GHG assessment, depending on technological advances in fuel and energy efficiency measures over the life of the Project, as well as potential carbon offsetting schemes under a potentially regulated regime.

In addition to obligatory reporting (Section 6.1.2.2), in anticipation of a potential cap, early adoption of mitigation methods involving enhancing or offsetting can help large projects to directly reduce their carbon footprints (such as through efficiency programs or fuel switching), or indirectly (such as through carbon offset programs that have been developed to reduce the costs of GHG mitigation). Many cap and trade systems offer early adopters incentives, such as allowing them to bank early reductions, and apply them to their GHG profile later, allowing for cost savings compared to having to purchase allowances or offsets at a later date. An offset[7] is a specific reduction in GHG emissions or increase in sequestration of carbon from the atmosphere, made in order to compensate for GHG emissions where 1 offset = 1 tonne of CO_2e. In most Canadian provinces, offsets are traded under a voluntary context. Corporations facing challenges to reduce their carbon footprint may use offsets to reduce costs of meeting regulated carbon reductions, or to help achieve reduction targets that correspond to lowering costs and minimizing risks of being subject to energy and fuel cost spikes (Stratos 2009a). Organizations that can achieve direct GHG reductions that are beyond normal business practice may also qualify to

[7] Offsets are discussed further in mitigation strategies (Section 6.7.2.2 and Chapter 26).

create offset projects themselves, and may use those offsets themselves or sell them on voluntary markets such as the Verified Carbon Standard (Verified Carbon Standard 2012) in order to recoup costs for implementing reduction technologies.

6.7.2.4.1 Other Project/Activity Mitigations to Address Greenhouse Gas Emissions

It is anticipated that GHG mitigation and management will become a greater priority federally and provincially, leading to increased mitigation of GHGs from other projects and activities in the province and country over the Project life. New projects will likely have access to improved technology to minimize Scope 1 to 3 GHG emissions, and an emphasis on no net loss for land-use change may also take place. The Project and other projects that are currently in existence will also have access to improved GHG management toolkits to reduce GHG emissions, and will also be able to reduce emissions when replacing equipment/trucks through the purchase of more fuel-efficient or electric models.

6.7.3 Potential for Residual Effects

Table 6.7-7 shows that there will be net GHG emissions after mitigation for the Project from facility level and land-use change sources, indicating that there will be residual effects of the Project on atmospheric GHG levels.

6.7.3.1 Residual Effects due to Increased Atmospheric Greenhouse Gas Levels from the Project

The residual effect on atmospheric GHG levels, after mitigation, is anticipated to be a net incremental increase of about 165 kt CO_2e/yr from facility-level GHG emissions alone, rising to 175 kt CO_2e/yr when land-use change is added, as reported in the GHG assessment in Section 6.7.1.

6.7.4 Comparison of Project Greenhouse Gas Emission Levels

The following section compares the estimated Project GHG emissions to provincial, national, and international GHG emissions totals, as well as mining sector industry norms, as a proxy for assessing the level of effect of the Project GHG emissions on the atmosphere. This is commonly done against provincial, national, and sector profiles in environmental assessments as recommended by the guidance documentation (CEA Agency 2003); however, this assessment also includes an international inventory comparison, as this is considered to be more representative of the actual global GHG atmospheric scale involved.

6.7.4.1 Provincial, National, and International Comparison of Project Greenhouse Gas Emissions

The international, provincial, and national inventories—which serve as historic GHG emissions baselines and a comparison point to the Project emissions—are listed in Section 6.2.1 and 6.2.2. Table 6.7-8 provides a comparison of Project emissions to the total provincial, national, and international emissions for the nearest reported year.

Table 6.7-7. Potential Residual Effects on Atmospheric Greenhouse Gas Levels

VC	Project Area(s)	Timing Start	Components/ Activities	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Residual Effect	Description of Residuals
GHG Emissions	Mine Area	Construction	Camp Incinerators and generators	GHG emissions from each component/activity incrementally increases atmospheric GHG levels.	Mitigation outlined in GHG Mangement Plan (Ch 26)	Generators and incinerators will be selected with lower emission rates	Yes	Net increase in atmospheric GHG levels
			On-site Stationary & Mobile Equipment/Vehicles			Procure new equipment/vehicles with monitoring capabilities when possible, regular maintainance, use GHG mitigation as contractor hiring criteria, train operators		
			Blasting			Minimize blasting where possible		
			Net land use change after clearing and debris burning and replanting restoration			Usable wood and debris will be taken offsite or go to other usage to prevent biomass conversion to GHGs; Maximize restoration replanting		
	PTMA		Camp Incinerators and generators			Generators and incinerators will be selected with lower emission rates		
			On-site Stationary & Mobile Equipment/Vehicles			Procure new equipment/vehicles with monitoring capabilities when possible, regular maintainance, use GHG mitigation as contractor hiring criteria, train operators		
			Electricity			Procure efficient equipment; Employ individual site facility level management practices to minimize use and maximize efficiency		
			Net land use change after clearing and debris burning and replanting restoration			Usable wood and debris will be taken offsite orgo to other usage to prevent biomass conversion to GHGs; Maximize restoration replanting		
	General Area		Mobile Transport to/from Off-Site			Have GHG management as selection criteria to hire fleet contractors; Driver training to minimize emissions		
	Mine Area	Operation	Camp Incinerators and generators			Generators and incinerators will be selected with lower emission rates		
			On-site Stationary & Mobile Equipment/Vehicles			Procure new equipment/vehicles with monitoring capabilities when possible, regular maintainance, use GHG mitigation as contractor hiring criteria, train operators		
			Blasting			Minimize blasting where possible		

(continued)

Table 6.7-7. Potential Residual Effects on Atmospheric Greenhouse Gas Levels (completed)

VC	Project Area(s)	Timing Start	Components/ Activities	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Residual Effect	Description of Residuals
GHG Emissions (*con'd*)	Mine Area (*cont'd*)	Operation (*cont'd*)	Electricity	GHG emissions from each component/activity incrementally increases atmospheric GHG levels (*cont'd*).	Mitigation outlined in GHG Mangement Plan (Ch 26; *cont'd*)	Procure efficient equipment; Employ individual site facility level management practices to minimize use and maximize efficiency	Yes	Net increase in atmospheric GHG levels (*cont'd*)
			Net land use change after clearing and debris burning and replanting restoration			Usable wood and debris will be taken offsite orgo to other usage to prevent biomass conversion to GHGs; Maximize restoration replanting		
	PTMA		Camp Incinerators and generators			Generators and incinerators will be selected with lower emission rates		
			On-site Stationary & Mobile Equipment/Vehicles			Procure new equipment/vehicles with monitoring capabilities when possible, regular maintainance, use GHG mitigation as contractor hiring criteria, train operators		
			Electricity			Procure efficient equipment; Management practices to minimize use and maximize efficiency		
			Net land use change after clearing and debris burning and replanting restoration			Usable wood and debris will be taken offsite orgo to other usage to prevent biomass conversion to GHGs; Maximize restoration replanting		
	General Area		Mobile Transport to/from Off-Site			Have GHG management as selection criteria to hire fleet contractors; Driver training to minimize emissions		

Notes:

PTM = Processing and Tailing Management

GHG = greenhouse gas

Table 6.7-8. Comparison of KSM Project to Provincial and National Facility-level GHG Emissions

Comparison Source of GHG Emissions	Facility (Scope 1-3) GHG Emissions		KSM Project Emission Comparison (%)
	Comparison (t CO_2e)	KSM Project (t CO_2e)	
International Total (2009)	30,086,265,000	164,725,	0.0005%
Canadian Total (2010)	677,740,000	164,725	0.02%
British Columbia Total (2010)	56,185,000	164,725	0.29%

Project GHG emissions are considered to be negligible due to dilution factors in the atmosphere as a whole, and are also negligible compared to global GHG emissions as confirmed in Table 6.7-8, where the Project's estimated average annual emissions of 164,725 t CO_2e are roughly about 0.0005% compared to the most recent global total estimate of anthropogenic GHG emissions for 2009. The international total is considered a conservative estimate, as it is only for CO_2, while the Project total includes accounting for methane and nitrous oxide emissions as well.

Also shown in Table 6.7-8, the anticipated average annual GHG emissions of the KSM Project are about 0.3% of the total provincial emissions and about 0.02% of the total national emissions, as reported in 2010. Land-use change Project emissions (10,425 t CO_2e) are about 0.42% of provincial LULUCF[8] emissions (BC MOE 2012b) and about 0.09% of national LULUCF emissions (Environment Canada 2012d).

6.7.4.2 Sector Comparison

GHG emission intensities measured against production provide a relatively standardized way to compare GHG emissions from projects with different production rates. The total average annual facility-level GHG emissions from the Project over the combined construction and operation phases, determined in Section 6.7.2.1, is anticipated to be about 165 kt CO_2e/yr, corresponding to an emissions intensity of 3.5 t CO_2e/kt ore to mill. Table 6.7-9 provides an industry norm comparison of the KSM Project facility emissions against those reported by similar BC mines.

As reported in Table 6.7-9, the estimated GHG emission intensity of the KSM Project is below all but one of the other provincial mining projects. In comparison to the emission intensities reported for metal mines in the table, an emission intensity range of 39 to 242 kg CO_2e/t raw coal was recently reported for the coal mining sector, which is considerably higher than that for metal mining (Teck Coal Limited 2011). Hence, the Project's GHG emissions are considered to be less than the industry norm for the mining sector indicating that the magnitude of Project emissions is relatively low.

8 Land use, land-use change, and forestry; net of deforestation and reforestation/afforestation activities.

Table 6.7-9. KSM Project and other BC Mining Project GHGs

Project Name	Project Type	Timeframe	Production Rate (t/day)	Reported Facility Emissions (t CO_2e/yr)	Emission Intensity (t CO_2e/ kt Ore to Mill)
KSM Project	***Copper/Gold/ Molybdenum Silver***	***Future Proposed***	***130,000***	***164,725***	***3.5***
Teck Highland Valley Copper Partnership	Copper/Molybdenum	Reporting to Environment Canada	129,600	181,953[1]	3.8
Mount Polley Mine	Copper/Gold	Reporting to Environment Canada	20,000	45,291[1]	6.2
Galore Creek	Copper/Gold/Silver	Certified in 2007	65,000	121,300[2]	5.6
		Redrafting PD	95,000	-	-
Kitsault	Molybdenum	Under review	45,000	35,845[3]	2.2
Mt. Milligan	Copper/Gold	In construction	60,000	85,556[4]	3.9
Red Chris	Copper/Gold/Silver	In construction	27,500	297,172[5]	29.6

Sources:[1] Environment Canada (2010a); [2] Rescan (2006); [3]Amec (2012); [4] Amec (2008); [5] Red Chris Development Company Ltd. (2004)
Notes: - = not available; PD=project description.

There are two main mines in BC that reported GHG emissions in 2010 to Environment Canada under federal reporting standards for facilities emitting over 50,000 t CO_2e annually: the Highland Valley Partnership copper mine and the Mount Polley copper/gold mine. These two mines are represented in Table 6.7-9, with the Highland Valley mine being the most analogous to the Project in terms of production and GHG emissions levels. The Project estimated carbon footprint falls below that measured for Highland Valley, and the KSM Project GHG emission intensity is also below both Highland Valley and Mount Polley mines. Regarding land-use change, the Highland Valley mine reported net deforestation of 3,889 ha (6,181 ha deforestation and 2,292 reforestation), which is approximately 53% greater than the net deforestation of 1,414 ha currently estimated for the KSM Project.

6.8 Significance of Residual Effects for Greenhouse Gases

6.8.1 Residual Effect Descriptors for Effects for Greenhouse Gases

As shown in Table 6.7-7, there will be residual GHG emissions to the atmosphere from the KSM Project, even after mitigation. These residual GHG emissions are currently estimated at the facility level at 164,725 t CO_2e/yr, and with LULUCF (10,425 t CO_2e/yr), the GHG emissions increase to 175,150 t CO_2e/yr. These GHGs are anticipated to remain in the atmosphere for up to 50 to 200 years, and fully mix into the global atmospheric GHG pool (Section 6.1.1.1).

The Project GHG emissions will go into the global atmospheric pool where, after mixing, there will be no measurable difference to global GHGs as a result of the Project. This means that GHG levels measured in the global atmosphere will not be able to detect the increase in GHGs as a result of the Project due to the size of the pool and dilution factors. As such, the measurable effect on the global atmosphere is considered negligible.

Due to the global scale involved, in order to determine a more useful proxy to assign significance to the residual effects of net GHGs emitted by the KSM Project on the atmosphere, Table 6.8-1 defines various descriptors used to rank the level of effect of the Project on atmospheric GHGs. Note that these descriptors specifically pertain to the direct, measurable effect on atmospheric GHG levels by comparing to international, national, provincial, and sector norms as a proxy for assessing atmospheric effects, including climate change[9].

Table 6.8-1. Definitions of Significance Criteria for GHGs Residual Effects

Descriptor	Definitions of Descriptor Classifications Used
Timing (What phase of the Project is the effect associated with?)	**Construction** **Operations** **Closure** **Post-closure**
Magnitude (negligible, low, medium, high)	**Negligible.** There is no detectable change from baseline conditions: GHG emissions increase by < 0.001% of international totals, and/or by < 0.01% compared to national totals, and/or < 0.1% compared to provincial totals, and are less than the industry profile. **Low.** The magnitude of effect differs from baseline conditions such that GHG emissions increase by > 0.01% but < 0.5% of international totals, and/or by > 0.01% but < 0.1% compared to national totals, and/or > 0.1% but < 1% compared to provincial totals, and are within the range of the industry profile. **Medium.** The magnitude of effect differs from baseline conditions such that GHG emissions increase by > 0.5% but < 1% of international totals, and/or by > 0.1% compared to national totals, and/or by > 1% compared to provincial totals, and are within the range of the industry profile. **High.** The magnitude of effect differs from baseline conditions such that GHG emissions increase by > 1% but < 10% of international totals, and/or by > 0.1% compared to national totals, and/or by > 1% compared to provincial totals, and are greater than the range of the industry profile.
Geographic Extent	**Local.** The effect is limited to the immediate air column directly above the Project footprint (i.e., within about a 100 m buffer). **Landscape.** The effect extends beyond the Project footprint to within an area about 5 to 50 km beyond the Project footprint. **Regional.** The effect extends across the Project region (i.e., 51 to 100 km beyond the Project footprint). **Beyond Regional**: The effect extends possibly across or beyond the province.

(continued)

[9] As mentioned previously in this Application/EIS, it is not possible to assess the individual effect or cumulative effect of the Project on atmospheric systems due to the global scale involved, including the uncertainty in apportioning the effects of the Project from other sources as causal factor contributing to global climate change. Therefore, a proxy for relative effect is used in comparing Project GHG emissions levels to other anthropogenic sources in order to ascertain degree of magnitude and whether it is within sector norms.

Table 6.8-1. Definitions of Significance Criteria for GHGs Residual Effects (continued)

Descriptor	Definitions of Descriptor Classifications Used
Duration	**Short-term**. The effect lasts approximately 1 year or less. **Medium-term.** The effect lasts from 1 to 10 years. **Long-term.** The effect lasts between 11 and 100 years. **Far Future:** The effect lasts more than 100 years.
Frequency	**Once.** The effect occurs during a discrete period of time that is less than 1% of the time during the Project phase considered. **Intermittent.** The effect occurs at sporadic, intermittent intervals during the Project phase considered (i.e., 2 to10% of the time). **Regular.** The effect occurs on a regular basis (i.e., between 11 and 80% of the time) during the Project phase considered. **Continuous.** An effect occurring constantly (i.e., more than 81% of the time) during the Project phase considered.
Reversibility	**Reversible Short-term:** The effect can be reversed relatively quickly. **Reversible Long-term:** The effect can be reversed after many years after activities cease. **Irreversible.** The effect cannot be reversed (i.e., it is permanent).
Context (ecological resilience and/or unique attributes: low/neutral/high)	**Low**. Receiving environment (atmosphere) environment has a high natural resilience to imposed stresses, and will easily adapt to the effect. **Medium.** The receiving environment (atmosphere) has a neutral resilience to imposed stresses and may be able to respond and adapt to the effect. **High.** Receiving environment (atmosphere) has a low natural resilience to imposed stresses, and can't easily respond/adapt to the effect.
Probability	**Low.** The effect is unlikely but could occur. **Medium.** The effect is likely but may not occur. **High**. The effect is highly likely to occur.
Confidence	**Low** (< 50% confidence). The cause-effect relationship between the Project and its interaction with the environment is poorly understood; data for the project area may be incomplete; uncertainty associated with synergistic and/or additive interactions between environmental effects may exist. High degree of uncertainty. **Medium. (**50 to 80% confidence): The cause-effect relationship between the Project and its interaction with the environment is not fully understood, or data for the Project area is incomplete: moderate degree of uncertainty. **High**. There is greater than 80% confidence in understanding the cause-effect relationship between the Project and its interaction with the environment, and all necessary data is available for the Project area. There is a low degree of uncertainty.

(continued)

Table 6.8-1. Definitions of Significance Criteria for GHGs Residual Effects (completed)

Descriptor	Definitions of Descriptor Classifications Used
Significance	**Not Significant (Minor).** Residual effects have no or low magnitude, local geographical extent, short- or medium-term duration, and occur intermittently, if at all. There is a high level of confidence in the conclusions. The effects on the VC (at a population or species level) are indistinguishable from background conditions (i.e., occur within the range of natural variation as influenced by physical, chemical, and biological processes). Land use management objectives will be met. Follow-up monitoring is not required. **Not Significant (Moderate).** Residual effects have medium magnitude, local, landscape or regional geographic extent, are short-term to chronic (i.e., may persist into the far future), and occur at all frequencies. Residual effects on VCs are distinguishable at the population, community, and/or ecosystem level. Ability of meeting land use management objectives may be impaired. Confidence in the conclusions is medium or low. The probability of the effect occurring is low or medium. Follow-up monitoring of these effects may be required. **Significant (Major).** Residual effects have high magnitude, regional or beyond regional geographic extent, are chronic (i.e., persist into the far future), and occur at all frequencies. Residual effects on VCs are consequential (i.e., structural and functional changes in populations, communities and ecosystems are predicted). Ability to meet land use management objectives is impaired. Probability of the effect occurring is medium or high. Confidence in the conclusions can be high, medium, or low. Follow-up monitoring is required.
Follow-up Monitoring	**Required.** Follow-up monitoring of GHG parameters is required for the project beyond that prescribed in Chapter 26.11 in the GHG Management Plan. **Not Required.** Follow-up monitoring of GHG parameters is not required for the project beyond that prescribed in Chapter 26.12 in the GHG Management Plan.

One of the most important descriptors for the determination of significance of Project GHG emissions in Table 6.8-1 is that of magnitude. There is some flexibility in the determination of magnitude in comparing Project GHG emissions against international and/or national and/or provincial totals to assign negligible, low, medium, or high magnitude. Regarding sector norms, if the Project is above sector norms, it is considered high, whereas if it is below, it can be ranked as negligible, low, or medium depending on how it compares to provincial, national, and/or international inventories.

6.8.2 Residual Effects Assessment on Atmospheric Greenhouse Gases

The summary of residual effects of GHG emissions from the Project on the atmosphere is shown in Table 6.8-2. This table incorporates the descriptors in Table 6.8-1 to determine the significance of residual GHG effects of the Project on the atmosphere from all the facility-level and land-use change components and activities during the construction and operation phases. As indicated in Table 6.7-9, the KSM Project GHG emission intensity is below most other comparable mining sector projects in BC, indicating that it is below the mining sector norm. In addition, as shown in Table 6.7-8 the Project GHG emissions are assessed at about 0.0005% of the most recent comparable international GHG emission inventory, which ranks the project as negligible based on the magnitude descriptor definition provided in Table 6.8-1. The Project comparison against provincial and national totals places the Project at low magnitude compared to those inventories. Although the Project could be ranked as negligible from an international perspective, a more conservative approach is applied with a focus on a Canadian comparison, and therefore the magnitude is considered low.

The extent of effects of GHGs emitted to the atmosphere by the Project in Table 6.8-2 was rated as “beyond regional” because it is assumed that GHGs will mix well and join the global atmospheric pool, and the duration was selected as “far future” because of the long life of GHGs in the atmosphere. Although some GHG emissions will be sporadic or relatively instantaneous from some Project activities, the frequency of effects has been selected as “continuous” during the operation phase as GHGs will be emitted from the Project relatively constantly during this phase from energy and fuel burning components, while during construction “regular” was chosen, as factors of production will not be as continuous in this phase. “Reversible long-term” was chosen with regard to the reversibility of elevated atmospheric GHGs in the atmosphere being removed by natural sinks. Note that elevated GHG emissions are actually reversible shorter term through the implementation of carbon offset projects involving sequestration.

The resiliency for the receiving environment – the atmosphere – was chosen as “neutral” in Table 6.8-2 as it will not be substantially affected and can accommodate the elevated levels of GHGs from the Project. The probability and confidence levels for the atmospheric rise in GHGs are rated as “high” for both the construction and operation, as the science is clear (as described in Section 6.1.2) that (1) GHGs will be emitted through fuel burning and land-use change activities of the Project, and (2) these GHGs will add to atmospheric GHG levels, thereby incrementally raising atmospheric GHG levels.

6.8.2.1 Significance of Residual Effect of Project Emissions on Atmospheric Greenhouse Gas Levels

As shown in Table 6.8-2, the determination of significance for the residual effect of the rise in atmospheric GHGs as a result of the KSM Project is assessed to be “Not Significant (Minor)” for the construction and operation phases. The rationale for this significance determination is primarily due to the negligible to low magnitude of Project GHG emissions in isolation, in that once emitted, GHGs from the Project will mix fully into the global atmospheric pool, which will not be a detectable change to global atmospheric GHG levels. Even combining the total GHG emissions from all phases of the Project, the detectable level of GHGs in the global atmospheric pool would still not show a measurable change due to factors and the variability in background levels of GHGs in the atmosphere. These GHG emissions will also not result in any local to regional effects on the environmental or human systems surrounding the Project.

As the Project will emit over 100,000 t CO_2e per annum on average, although its GHG emissions in isolation are negligible, it is still considered a large emitter contributing to global anthropogenic GHG emissions. The Project will therefore be subject to provincial and federal reporting regulations, mitigation, and potentially a GHG emissions cap, as described in Section 6.1.2. For this reason, although follow-up monitoring has been deemed as “not required” in Table 6.8-2 regarding the “Not Significant (Minor)” GHG emission residual effects rating, Chapter 26 delineates the GHG emissions monitoring and reporting plan that the Project will have to follow according to provincial and federal government regulations (Section 6.1.2).

Table 6.8-2. Summary of Residual Effects of KSM Project on Atmospheric GHG Levels

Description of Residual Effect	Project Components	Timing of Effect	Magnitude of Effect	Extent of Effect	Duration of Effect	Frequency	Reversibility	Context	Initial Significance Determination	Follow-up Monitoring
Rise in atmospheric GHG levels	All	Construction	Low	Beyond Regional	Far Future	Regular	Reversible Long-term	Neutral	Not Significant (Minor)	Not Required†
Rise in atmospheric GHG levels	All	Operation	Low	Beyond Regional	Far Future	Continuous	Reversible Long-term	Neutral	Not Significant (Minor)	Not Required†
Confidence in the Probability and Likelihood of Residual Effect										
High*										

Notes:
Section 6.8.2 describes how residual effect descriptors in the table were chosen.
GHG=greenhouse gas
*** Confidence and probability levels are both rated high for residual effect descriptors**
† Follow-up monitoring is ranked as "not required" per "not significant" rating; however, measuring/monitoring and reporting Project GHG emissions will still be required per BC and Canadian GHG reporting regulations as stated in Section 6.1.2 and the GHG Management Plan (26.12) in Chapter 26.

6.8.2.2 Overall Effect on Atmospheric Greenhouse Gas Levels by the Project

As summarized in Table 6.8-3 Project GHG emissions are considered not significant against the global atmospheric GHG pool.

Table 6.8-3. Executive Summary: Overall Significance of Residual Effects on Atmospheric GHG Levels as a Result of the KSM Project

Factor	Rationale
Residual Effects	***Residual effect*** *for this assessment is interpreted to be the net increase to atmospheric GHG levels as a result of the Project*
Magnitude	***Negligible to Low****: There will be no detectable change to global atmospheric GHG levels as a result of the Project, but the Project has a Low magnitude compared to provincial and national GHG inventories, as well as mining sector industry norms.*
Geographic Extent	***Beyond Regional*** *as GHGs emitted by Project will enter global pool.*
Duration	***Far Future****: 200+ years based on average life of GHGs in the atmosphere.*
Frequency	***Continuous****: GHGs will be emitted continuously during the construction and operation phases of the Project, though not always at consistent levels.*
Context	***Neutral****: Atmosphere is considered to have neutral resiliency, in that it can accommodate elevated GHG levels.*
Probability	***High****: The effect is highly likely to occur.*
Confidence Level	***High****: A good understanding of the cause-effect relationships of facility level and land-use change emissions substantiates the assessment.*
Residual Effects Significance	***Not Significant****: Due to dilution factors involved at the global scale involved with climate change, atmospheric GHG levels—and hence secondary effects on climate—will not be significantly affected by GHG emissions from the Project.*
Summary of Cumulative Effects	***Cumulative Effects Not Assessed:*** *A cumulative effects assessment is not possible for project level GHG emissions (CEA Agency 2003). To serve as a proxy for comparison at different scales, the estimated average Project facility level GHG emissions (about 165 kt CO_2e per year) were compared to recent provincial (about 0.28%), national (about 0.02%), and international (about 0.0005%) GHG emissions inventories.*

6.9 Summary of Assessment of Potential Environmental Effects of Project Greenhouse Gas Emissions

As determined by the assessment for both facility and land-use change GHG emissions, the total average annual GHG emissions from the Project over the combined construction and operation phases is rated as *not significant* (Tables 6.8-2 and 6.9-1). This is due primarily to the Project's *negligible* contribution to the total global anthropogenic GHG emissions to the atmospheric pool, as the Project's anticipated GHG emissions are 0.0005% of the most recent world GHG emissions assessment, which is less than the 0.001% magnitude descriptor ranking provided in Table 6.8-1. The Project facility emissions are ranked as *low* (> 0.1% but < 1% compared to provincial totals, or > 0.01% but < 0.1% compared to national totals) compared to both the total provincial and national GHG 2010 facility level inventories, leading them to being ranked conservatively as low overall in Table 6.8-2.

Table 6.9-1. Summary of Assessment of Residual Effects: Greenhouse Gas

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects
GHG emissions	Construction	Increase in atmospheric GHGs	Fuel efficiency and minimizing vegetation land clearing	Not significant
GHG emissions	Operation	Increase in atmospheric GHGs	Fuel/energy efficiency and maximizing land reclamation	Not significant

Project GHG emissions will be additive with those across the province, Canada, and globally, incrementally contributing to elevated GHG levels in the atmosphere and consequent amplification of the greenhouse effect.

6.10 Greenhouse Gas (Climate Change) Conclusions

The KSM Project will emit GHG emissions throughout its life primarily from fossil fuel and energy requirements, which will be higher during the operation than construction phases. Project GHG emissions have been compared against provincial, national, and international emission inventories and mining sector norms to achieve a determination of the significance of the effects of the Project on the global atmospheric pool.

The result of the KSM Project GHG assessment is that the Project will emit an estimated 165 kt CO_2e/yr (emissions intensity of 3.5 t CO_2e/kt ore to mill) at the facility level, increasing to about 175 kt CO_2e/yr incorporating land-use change. These projected Project GHG emissions are considered residual after mitigation is applied. The estimated facility-level residual GHG emissions are considered to be *negligible* as they are *below industry norms* for metal mining, and well below total world anthropogenic GHG emissions, and therefore *not a significant* effect to the atmosphere with secondary effects on climate change.

Although Project GHG emissions have been assessed as negligible on the atmosphere directly, emissions levels are ranked as *low* compared to BC and Canadian inventories, and the Project will be a large final emitter that will have to satisfy legislated reporting and mitigation requirements. Provincial and federal reporting requirements will include assessing Project GHG emissions *ex poste* on an annual basis, verification of the assessment under the BC Reporting Regulation (BC Reg 272/2009; required for facilities emitting over 25k t CO2e/yr), and transparent reporting of assessed GHG emissions provincially and nationally through the joint one-window reporting system from its first year of operation. The Project Proponent will also continue to monitor and mitigate the KSM Project GHG footprint over the Project life such as through implementing fuel and energy efficiency improvements and other measures as outlined in the GHG Management Plan in Chapter 26 of the Application/EIS.

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