26 Environmental Management and Monitoring Plans

26.1 Introduction

26.1.1 Environmental Management System

This chapter discusses the conceptual Environmental Management System (EMS) and associated Environmental Management Plans (EMPs) for the KSM Project. As stated in the KSM Project Application Information Requirements (AIR) document approved by the British Columbia Environmental Assessment Office (BC EAO; 2011), EMPs are essential for the EMS for any major development.

An EMS is a requirement of a *Mines Act* Permit for mines in BC and is the high level framework supporting each EMP. EMPs are the specific and detailed goals, objectives, and procedures for the protection of worker health and safety, environmental monitoring, and operating procedures that show the regulatory agencies how legislation and regulations will be met at the Mine Site and the Processing and Tailing Management Area (PTMA). EMPs are managed collectively under the umbrella of the EMS.

EMPs are to be applied during the planning, construction, operation, closure, and post-closure phases of the KSM Project (the Project).

The EMS will identify the approach to the KSM Project planning and to the development of the Project with respect to the Proponent's legislative and corporate environmental obligations. The fundamental component of the EMS is the EMPs, which detail environmental protection measures to mitigate potential environmental effects. The EMPs describe the environmental practices and procedures to be applied during the planning, construction, and operation phases of the Project.

It is necessary and prudent planning for projects to have an EMS in place to guide project performance from construction through to closure. An integrated system is required because there are inherent overlaps in activities, e.g., actions taken to protect workers' safety and health often protects the environment. For example, emergency response plans will address spills to the environment that can also have worker and public safety risks. Similarly, traffic safety and driver training programs can significantly reduce risks to workers and to the public, as well as spills to the environment. Appropriate training and other resources will be available to ensure that workers at the KSM Project are properly equipped to perform their work. The KSM Project operating company will develop an overall management system for the Project that includes:

- an organizational structure and reporting structure;
- the assignment of responsibilities;
- communication protocols;

- company policies;
- methods to evaluate environmental practices, procedure, and processes; and
- resource allocation.

The EMS will define the Proponent's environmental approach through all phases of the Project. The EMS is based on prevention, mitigation, and management of effects identified by the company Environment and Safety Superintendents with input from the Table of Commitments in the Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS).

The purpose of the EMS is to organize and guide all activities during all phases of the Project to ensure orderly, safe, compliant, and environmentally and socially responsible operations at the mine. The EMS aims to coordinate human aspects of the Project to control or reduce the Project's effect on the environment (biophysical and human).

The EMS is the framework within which EMPs will be developed, implemented, maintained, and updated. The following three-step process has been used for the development of EMPs.

- **Step One:** High-level Framework: To be included in the Application/EIS, the high-level framework will commit the Proponent to specific and detailed goals, objectives, and procedures for producing EMPs. Included in this step is a procedure to re-evaluate monitoring plans, methods, and objectives for adaptive management goals.
- **Step Two:** Production of the formal EMPs: May be initiated after the issuance of the Environmental Assessment Certificate, but before construction begins. This step will follow the procedures and commitments developed in Step One.
- **Step Three:** Development of Standard Operating Procedures: Development of the Standard Operating Procedures will fulfill obligations as defined in Step Two.

This three-step process will be used to develop EMPs for each phase of the Project.

26.1.2 Construction Management Plan

The Construction Management Plan is an EMP specific to the construction phase of the Project. The purpose of the Construction Management Plan is to integrate the EMS and EMPs into contractual obligations for the many and varied construction sub-projects that will be occurring at the KSM Project.

Figure 26.1-1 shows the relationship between the EMS; the Construction Management Plan, which is a phase-specific management plan; and the EMPs that will be developed for the construction phase. The EMPs presented in Sections 26.3 to 26.26 would provide the basis for the development of future phase-specific EMPs.

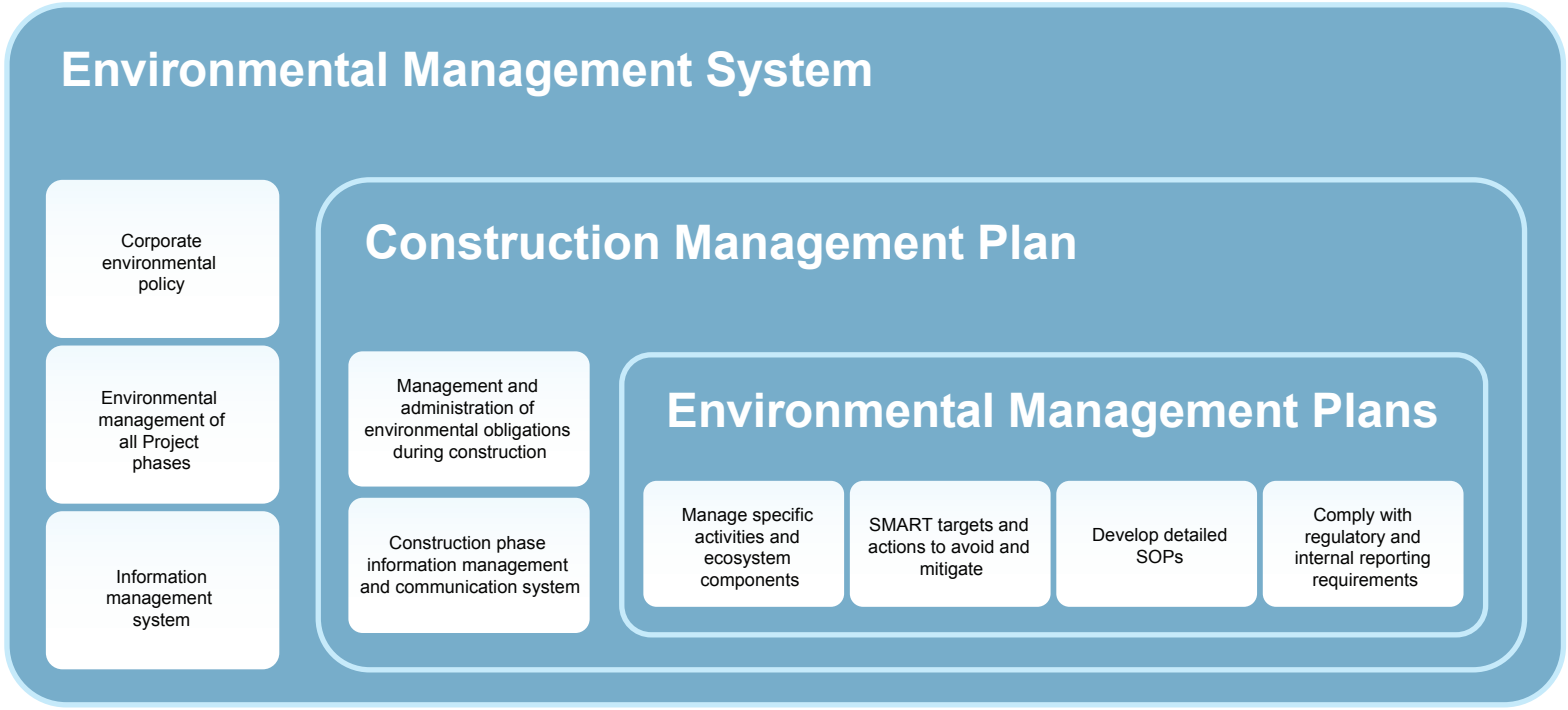


Figure 26.1-1

SEABRIDGE GOLD
KSM PROJECT

Conceptual Environmental Management System Framework

Figure 26.1-1

Rescan
Engineers & Scientists

26.1.3 Corporate Policies Supporting the Environmental Management System

26.1.3.1 Environmental Policy

The Proponent strives to be an exemplary leader in environmental management. The Proponent seeks to meet or surpass existing regulatory standards and to minimize undesirable effects on the environment to the extent possible.

To meet this objective, the Proponent will:

- recognize environmental management as an important corporate priority, and integrate environmental considerations into all mine exploration, development, operation, and closure planning;
- use best management practices and technologies that minimize environmental effects and that enhance the quality of water, air, vegetation, and wildlife;
- assess the potential environmental risks of Project design so that effective preventative measures can be established;
- at a minimum, meet all regulatory requirements;
- continuously improve the efficient use of resources, processes, and materials;
- participate in recycling programs to the extent possible and commercially feasible;
- optimize the use of resources to ensure the conservation of natural resources and consumer goods such as energy;
- require contractors and supplies to provide operational guidelines and procedures that meet their environmental responsibilities, as part of the bid and procurement process;
- consider environmental guidelines when purchasing equipment and materials;
- communicate environmental information to employees, including changes and potential changes to environmental regulations as well as technology developments that may mitigate effects;
- develop guidelines for training and education of employees;
- work with government agencies, the public, Treaty Nations, and First Nations to develop open communications for a shared understanding of the Proponent's environmental protection programs and responsibilities;

It is the responsibility of every employee of the Proponent to carry out their daily activities in accordance with this Environmental Policy.

26.1.3.2 Health and Safety Policy

The Proponent is responsible for providing and maintaining a safe and healthy work environment for all persons engaged in the Proponent's work sites. The management team is required to provide active leadership and support for occupational health, safety, fire protection, and loss

control. The Proponent and its employees and subcontractors are responsible for complying fully with all health and safety standards and regulations, including work site inspections and accident/incident investigations.

This policy's objectives will be achieved by:

- the meaningful involvement and participation of all employees;
- the provision of safe and appropriate equipment and conditions at the forefront of daily operations;
- the right for an employee to refuse to perform dangerous or unsafe work;
- training employees to carry out their jobs safely and productively. No employee will be permitted to commence a job without the requisite training;
- investigating the causes of accidents and incidents, and developing effective and immediate preventative and remedial action;
- the development, maintenance and review of practices and procedures;
- emergency preparedness to minimize losses or injury arising from an incident or unforeseen event;
- the monitoring, reporting, and evaluation of employee health and safety performance; and
- promoting the Health and Safety Policy as a way of life in all aspects of the Project work sites and in families and local communities.

All personnel are also responsible for their own safety by complying with legislative and industry standards, as well as the Proponent's safety standards The Proponent's commitment is to safety first.

26.1.4 Environmental Management Plans

The information contained in this chapter includes conceptual level EMPs; Detailed EMPs will be developed prior to the start of each phase of the Project, beginning with construction. The following EMPs are provided in this chapter

- Construction Management Plan;
- Rock Storage Facility Management and Monitoring Plan;
- Tailing Management Facility Management and Monitoring Plan;
- Water Storage Facility Management and Monitoring Plan;
- Domestic and Industrial Waste Management Plan;
- Dangerous Goods and Hazardous Materials Management Plan;
- Explosives Management Plan;
- Emergency Response Plan;

- Spill Prevention and Emergency Response Plan;
- Air Quality Management Plan;
- Greenhouse Gas Management Plan;
- Terrain, Surficial Geology and Soil Management and Monitoring Plan;
- Metal Leaching and Acid Rock Drainage Management Plan;
- Groundwater Management Plan;
- Glacier Monitoring Plan;
- Water Management Plan;
- Fish and Aquatic Habitat Management Plan;
- Wetlands Management Plan;
- Terrestrial Ecosystems Management and Monitoring Plan;
- Wildlife Management Plan;
- Noise Management Plan;
- Heritage Management and Monitoring Plan;
- Visual Quality Management Plan; and
- Traffic and Access Management Plan.

26.1.5 KSM Project Reporting Structure

The following section discusses the reporting structure to be used for the Project by the Proponent or its successor organization (Figure 26.1-2). This reporting structure will ensure a flawless and consistent implementation of the above listed EMPs.

26.1.5.1 Purpose

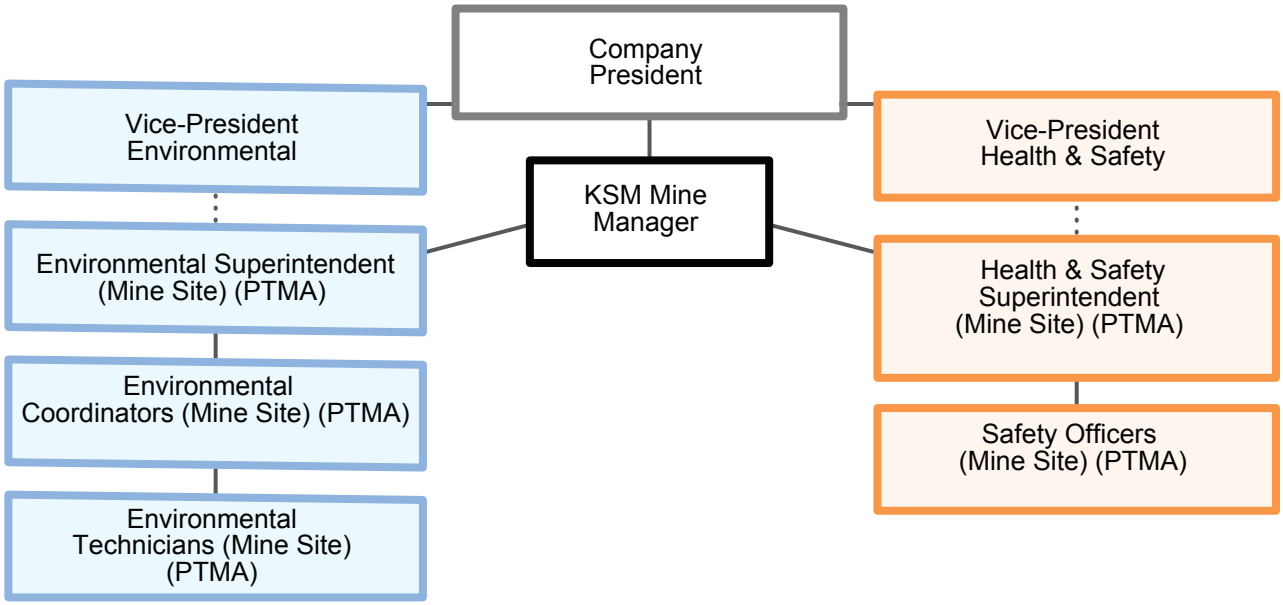
The focus of the environmental reporting structure is to achieve a seamless and consistent means for reporting to senior management, government agencies, and communities/stakeholders in an efficient and timely manner.

26.1.5.2 Responsibilities

The KSM Project must operate in compliance with all applicable regulations, permit conditions, and health, safety, and environmental statutes. Paramount among these responsibilities is the protection of worker safety. Meeting these responsibilities also addresses concerns such as the potential release of contaminants and waste products to the air, water, and soil; fish, wildlife, and habitat; threatened and endangered species; and the protection of cultural sites.

A list of key management personnel and their health and safety and general construction phase environmental responsibilities is provided below. This reporting structure may be adapted or superseded for the Project's operation and closure phases.

	KSM Project Environmental Reporting Structure
Purpose	***To facilitate successful environmental implementation, this Guideline sets out descriptions of positions, reporting structure (internal/external) and conditions for stopping work during construction.***
Scope	This Guideline applies to all KSM Project activities.



The KSM Project operating company must consider effective health, safety, and environmental management as a shared responsibility; safety and environmental management responsibilities must be fully integrated into the duties of all personnel.

Company President

The Company President bears overall responsibility for engineering, environmental, and governmental relations pertaining to the KSM Project, and coordinates with the Mine Manager to ensure that overall Project objectives are being managed.

Mine Manager

The Mine Manager bears overall responsibility for the construction of the KSM Project, and responsibility for on-site environmental monitoring and compliance relating to construction activities. The Mine Manager reports to the Company President and coordinates with the Vice-President of Environment and the Vice-President of Health and Safety to ensure that construction objectives are being met.

Vice President of Environment

The Vice President of Environment is responsible for the overall management of KSM Project environmental programs and permits, and reports to the Company President.

Due to the distance between the Mine Site and the PTMA it is assumed that senior management positions below the Mine Manager will be duplicated for the PTMA and Mine Site.

Environmental Superintendent

The Environmental Superintendents are responsible for the day-to-day management of KSM Project environmental programs and permits. The Environmental Superintendents report to the Vice-President of Environment.

The Environmental Superintendents will:

- act as resources to the construction teams by providing guidance relating to permit conditions, commitments, regulations, acts, and interpretation of legislation;
- be responsible for obtaining the required environmental permits for construction and operation;
- be responsible for the completion of the EMS and EMPs;
- be the liaisons for government agencies for permitting and non-compliance incidents; and
- be the liaisons for Treaty Nations and First Nations, through their designated representatives, for permitting as well as non-compliance issues.

Environmental Coordinators

Environmental Coordinators are responsible for tracking and reporting on the environmental permit obligations and environmental assessment (EA) commitments for the KSM Project. Environmental Coordinators report to the Environmental Superintendents.

The Environmental Coordinators will:

- have the authority to shut down specific activities if there is non-compliance and/or an infraction, until that non-compliance and/or infraction is rectified;
- report incidents to the Environmental Superintendents, including all non-compliances and/or infractions;
- liaise with the Project Manager to ensure that permit requirements, commitments, regulations, and acts are understood at the field level, and that they are managed appropriately for the construction of the KSM Project;
  - ensure that wildlife and wildlife habitat permit conditions, commitments, and regulations are being undertaken ahead of construction disturbance to meet regulatory compliance;
  - ensure that blasted rocks samples along the Coulter Creek and Treaty Creek Access corridors are collected for on-site laboratory analysis. Maintain a database of rock disposal locations, analytical results, and mitigation strategies for metal leaching/acid rock drainage for non-deposit rock;
  - advise workers in the use of best management practices, Fisheries and Oceans Canada (DFO) Operational Statements, and Erosion and Sediment Control Plans as training and on-site reference tools;
- act as resources to the construction teams by providing guidance relating to permit conditions, commitments, regulations, acts, and interpretation of legislation; and
- provide advice to contractors on stream-crossing techniques to avoid adverse effects and to employ Erosion and Sediment Control Plan practices at all work sites.

Environmental Technicians

The Environmental Technicians report to the Environmental Coordinators. They are responsible for implementing and managing monitoring programs for sewage, water, refuse, and air emissions the construction camps.

The Environmental Technicians will:

- have the authority to shut down specific activities if there is non-compliance and/or an infraction, until that non-compliance and/or infraction is rectified (stop work procedures);
- ensure that stop work procedures are adhered to in accordance with government requirements, and prepare non-compliance/incident reports in a timely manner (distribute as necessary) and ensure that remedial action is being undertaken;
- liaise with the Environmental Coordinator to ensure that permit monitoring, environmental assessment commitments, and EMPs are being followed at construction sites, and report incidents to the Environmental Coordinator, including all non-compliances and/or infractions; and

- ensure that compliance monitoring is being undertaken and that monitoring reports are being prepared and submitted in a timely manner.

Vice President of Health and Safety

The Vice President of Health and Safety is responsible for supervising the safety of workers at the KSM Project, and reports to the Company President.

Health and Safety Superintendent

The Health and Safety Superintendents are responsible for supervising workers' safety. The Health and Safety Superintendents guide management on regulatory compliance and program development, investigate health and safety complaints and problems, provide expertise on health- and safety-related questions, and may administer some of the Proponent's health and safety programs. The Health and Safety Superintendents supervise Safety Officers and report to the Vice President of Health and Safety.

Safety Officers

Safety Officers are responsible for implementing, monitoring, and enforcing health and safety practices. The Safety Officers are responsible for designing and maintaining all of the Proponent's safety and health regulations. This can include the safe operation of heavy equipment, chemical handling guidelines, and proper fire drill procedures. The Safety Officers' primary duties include designing safety programs, creating and maintaining safety forms, conducting program monitoring and training, and delivering safety reports. The Safety Officers report to the Health and Safety Superintendents.

The Safety Officers will:

- ensure that safety and environmental induction programs for consultants, contractors, etc. are undertaken as required;
- maintain training records for all employees, and maintain a training records inventory for all contractors and personnel on site;
- conduct safety practice drills, mock emergency response training, and audits of training records and employees;
- coordinate daily field activities with workers including safety reporting, avalanche hazard and risk assessment;
- advise and train workers in operational policies under the EMS framework, and in procedures for specific EMPs. Record and report incidents, accidents, and near misses for annual updates of EMPs; and
- maintain equipment and equipment inventories for emergency spill response caches.

26.1.5.3 Stop Work Authority

Every member of the Environmental Department will have the authority to issue stop work orders to anyone on site for reasons that include, but may not be limited to:

- a construction activity that is causing a substantial adverse effect to the environment (e.g., soil mobilization due to heavy rain events);
- an accidental spill or release of harmful material; and
- the discovery of an archeological artifact.

Construction activities will be allowed to continue at the discretion of the person ordering the work stoppage once the heavy rains stop or the spill has been cleaned up, appropriate remediation measures have been implemented, and there is no further risk of environmental damage. In the event of an archeological artifact discovery, a licenced archaeologist must attend the site to assess the significance of the discovery and determine an appropriate course of action.

26.2 Construction Management Plan

26.2.1 Legislation and Standards

A Construction Management Plan (CMP) is not specifically described in provincial or federal legislation; however, the requirement for a CMP was identified in the AIR (BC EAO 2011). The CMP will be developed to comply with all applicable legislation, regulations, guidelines, corporate policies, and permit obligations. Central to the development of the CMP will be the Table of Commitments in the Application/EIS.

Legislation and standards that may apply to the CMP include:

- *Environmental Assessment Act* (2002b)
- *Mines Act* (1996j) and Health, Safety, and Reclamation Code for Mines in British Columbia (BC MEMPR 2008)
- *Mineral Tenures Act* (1996i)
- *Environmental Management Act* (2003)
- Municipal Wastewater Regulations (BC Reg. 27/2012)
- *Land Act* (1996h)
- *Water Act* (1996n) and Water Regulation (BC Reg. 204/88)
- *Wildlife Act* (1996q)
- Groundwater Protection Regulation (BC Reg. 299/2004)
- *Forest and Range Practices Act* (2002c)
- *Canadian Environmental Assessment Act, 2012* (2012)
- *Fisheries Act* (1985c) and Metal Mining Effluent Regulations (SOR/2002-222)
- *Navigable Waters Protection Act* (1985g)
- *Explosives Act* (1985b)
  - Ammonium Nitrate Storage Facilities Regulations (CRC, c 1145)
  - NRCan *Guidelines for Bulk Explosives Facilities* (NRCan 2010)
- *Forest and Range Practices Act* (2002c)
- Spill Reporting Regulation (BC Reg. 263/90)
- Hazardous Waste Regulation (BC Reg. 63/88)

- *Forest Act* (1996d)
- British Columbia Fire Code Regulation (BC Reg. 175/2006)
- *British Columbia Transportation of Dangerous Goods Act* (1996m)
- *Agricultural Land Commission Act* (2002a)
- *Weed Control Act* (1996p)
- *Drinking Water Protection Act* (2001)
- *Heritage Conservation Act* (1996g)
- *National Energy Board Act* (1985f; oil or gas pipeline)
- *Canada Transportation Act* (1996a)
- *Transportation of Dangerous Goods Act* (1992b)
- *International River Improvements Act* (1985e; KSM Project involves a hydroelectric development aspect on an international river)
- *Species at Risk Act* (2002d)
- *Migratory Birds Convention Act* (1994)
- WorkSafeBC Occupational Health and Safety Regulation (BC Reg. 296/97)

26.2.2 Objectives

The objectives of the CMP are:

- to describe the administration and management of all construction phase environmental commitments and responsibilities in a manner that is compliant with regulatory and permit obligations, corporate policies, contractual obligations, and the Project EMS;
- to provide a framework for the development of detailed site- and activity-specific plans and procedures; and
- to define the information management system to be used to track and report environmental compliance data.

This section provides a high-level overview of the CMP that is required for the construction phase of the Project and that is a component of the larger EMS. This CMP will form the framework that will be used to establish a construction phase system that ensures the effective implementation of all component EMPs as well as regulatory requirements and commitments. The CMP will form the basis of a more detailed and comprehensive CMP to be developed prior to the commencement of construction activities.

The CMP will link the communication and coordination of all environmental responsibilities for the Project. Policies and procedures will be developed to guide communications between the Proponent, regulators, construction contractors, First Nations, Treaty Nations, and other stakeholders. These procedures will assist the Proponent in building a shared understanding of the environmental monitoring requirements of the Project and will show others how the Proponent will meet their obligations to execute the legislated requirements of the EMPs and their associated protection and mitigation measures.

An integrated information management system will be developed as part of the CMP and will be used to track, analyze, and report on monitoring requirements of EMPs and the Table of Commitments in the Application/EIS.

The CMP will be updated regularly to accommodate a dynamic construction project. A philosophy of adaptive management and continual improvement will guide the evolution of the CMP and will allow its key parts to help inform environmental management in subsequent Project phases.

26.2.3 Construction Management Plan

The CMP guides the planning, coordination, and execution of a project with respect to its health, safety, and environmental obligations during its construction phase. This CMP constitutes a high-level description of what will eventually develop into the construction phase component of the EMS. The CMP requires the Proponent to consider all aspects of monitoring required for each construction activity and to communicate these requirements to construction contractors and service providers. The CMP must be structured to enable the development of successively more detailed component plans and standard operating procedures as necessary.

Major projects typically require that each party, including the proponent and construction contractors, have dedicated personnel to ensure the execution of CMP requirements and to communicate these requirements to their staff.

Components of a CMP can include:

- scheduling and forecasting of construction activities and associated permitting;
- data collection standard operating procedures;
- employee roles, responsibilities, and training requirements;
- environmental monitoring and inspections;
- reporting requirements, frequency, and distribution;
- reporting structure and incident reporting procedure;
- activity-specific management plans (e.g., fish salvage); and
- site-specific management plans (e.g., at a particular road chainage).

26.2.4 Activity-specific and Site-specific Plans

Activity-specific management plans should be developed for environmental components identified through the environmental assessment and permitting process. Plans may also be developed by specific construction contractors in conjunction with their corporate environmental policies and in relation to specialty activities that they may undertake such as pile driving or blasting.

Site-specific plans are developed on an as-needed basis as determined by the on-site environmental personnel and within the framework of the CMP and the EMS. Where the CMP is a high-level overview of construction environmental management, a site-specific plan incorporates all detailed information available on a given site and its environmental sensitivities,

and provides prescriptive and detailed management and mitigation measures to be implemented prior to, during, and after construction.

Each group including the Proponent, the general construction contractor, and construction sub-contractors and their environmental representatives may be required to produce activity or site-specific plans. These plans will build on the applicable framework provided in the CMP or component EMP but will incorporate current site information and prescriptive detail beyond the level present in any pre-existing plans.

26.2.5 Environmental Compliance

The CMP will provide specific targets for environmental compliance based primarily on *Mines Act* (1996j) and *Environmental Management Act* (2003) permit requirements and the Table of Commitments in the Application/EIS. Additional targets will be developed from other authorizations, licences, and approvals as well as from the component EMPs in which targets that are Specific, Measurable, Achievable, Realistic, and Time-bound (SMART) will be identified. The general approach to environmental compliance within the CMP and component EMPs will be for all personnel on site to observe, record, and report potential concerns and then the Proponent will avoid, control, and mitigate any environmental non-compliance.

The CMP will include an information management system that the Proponent can use to regularly monitor compliance targets, track compliance, and generate internal reports. Internal reporting may be shared with construction contractors to provide clear expectations and to celebrate successes. The information management system will be designed to integrate new information and quality of past performance to support the goal of adaptive management and continual improvement.

External reporting to regulatory agencies will be as required by regulation.

26.2.6 Valued Component Environmental Management Plans

The CMP provides a framework for the management and administration of a number of valued component EMPs. The following sections form a list of EMPs that will be developed into more detailed plans for the construction, operation, and closure phases of the Project.

26.2.6.1 Rock Storage Facility Management and Monitoring Plan

Details of the Rock Storage Facility Management and Monitoring Plan for the construction phase can be found in Section 26.3.2.3.2.

26.2.6.2 Tailing Management Facility Management and Monitoring Plan

Details of the Tailing Management Facility Management and Monitoring Plan for the construction phase can be found in Section 26.4.2.3.2.

26.2.6.3 Water Storage Facility Management and Monitoring Plan

Details of the Water Storage Facility Management and Monitoring Plan for the construction phase can be found in Section 26.5.2.3.2.

26.2.6.4 Domestic and Industrial Waste Management Plan

Details of the Domestic and Industrial Waste Management Plan for the construction phase can be found in Section 26.6.14.1.

26.2.6.5 Dangerous Goods and Hazardous Materials Management Plan

Details of the Dangerous Goods and Hazardous Materials Management Plan for the construction phase can be found in Section 26.7.4.

26.2.6.6 Explosives Management Plan

Details of the Explosives Management Plan for the construction phase can be found in Section 26.8.4.

26.2.6.7 Emergency Response Plan

Details of the Emergency Response Plan for the construction phase can be found throughout the plan (Section 26.9). Emergency response requirements will be developed and scaled relative to the size of the workforce on site and the scope of the planned activities.

26.2.6.8 Spill Prevention and Emergency Response Plan

Details of the Spill Prevention and Emergency Response Plan for the construction phase can be found throughout the plan (Section 26.10). Spill prevention and emergency response requirements will be developed and scaled relative to planned activities and to the type and volume of products stored on site.

26.2.6.9 Air Quality Management Plan

The Air Quality Management Plan consists of three separate plans that address different aspects of air quality. These plans are listed below.

26.2.6.9.1 Emissions Management Plan

Details of the Emissions Management Plan for the construction phase can be found in Section 26.11.1.4.

26.2.6.9.2 Fugitive Dust Emissions Management Plan

Details of the Fugitive Dust Emissions Management Plan for the construction phase can be found in Section 26.11.2.4.

26.2.6.9.3 Meteorological Monitoring Plan

Details of the Meteorological Monitoring Plan for the construction phase can be found in Section 26.11.3.

26.2.6.10 Greenhouse Gas Management Plan

Details of the Greenhouse Gas Management Plan for the construction phase can be found in Section 26.12.1.4.3.

26.2.6.11 Terrain, Surficial Geology and Soil Management and Monitoring Plan

The Terrain, Surficial Geology and Soil Management and Monitoring Plan consists of three separate plans that address specific aspects of soil handling and management. These plans are listed below.

26.2.6.11.1 Soil Salvage and Handling Plan

Details of the Soil Salvage and Handling Plan for the construction phase can be found in Section 26.13.1.3.2.

26.2.6.11.2 Erosion Control Plan

Details of the Erosion Control Plan for the construction phase can be found in Section 26.13.2.3.1

26.2.6.11.3 Soil Contamination Prevention Plan

Details of the Soil Contamination Prevention Plan for the construction phase can be found in Section 26.13.3.3.

26.2.6.12 Metal Leaching and Acid Rock Drainage Management Plan

Details of the Metal Leaching and Acid Rock Drainage Management Plan for the construction phase can be found throughout the plan (Section 26.14). Specific management standard operating procedures will be developed based on specific construction activities.

26.2.6.13 Groundwater Management Plan

Details of the Groundwater Management Plan for the construction phase can be found throughout the plan (Section 26.15).

26.2.6.14 Glacier Monitoring Plan

Details of the Glacier Management Plan for the construction phase can be found throughout the plan (Section 26.16).

26.2.6.15 Water Management Plan

Details of the Water Management Plan for the construction phase can be found in Section 26.17.4.1.

26.2.6.16 Fish and Aquatic Habitat Management Plan

The Fish and Aquatic Habitat Management Plan consists of three separate plans that deal with specific aspects of the management of fish and aquatic habitat. These plans are listed below, and can be found in Section 26.18.

26.2.6.16.1 Fish and Aquatic Habitat Effects Protection and Mitigation Plan

Details of the Fish and Aquatic Habitat Effects Protection and Mitigation Plan for the construction phase can be found in Section 26.18.1.

26.2.6.16.2 Aquatic Effects Monitoring Plan

Details of the Aquatic Effects Monitoring Plan for the construction phase are included throughout the plan.

26.2.6.16.3 Fish Salvage Plan

The general procedures within the Fish Salvage Plan apply to the activity of fish salvage regardless of Project phase; however, the majority of fish salvage can be expected to occur during construction and possibly during early operation.

26.2.6.17 Wetlands Management Plan

The Wetlands Management Plan can be found in Section 26.19 and contains details applicable to the construction phase throughout the plan. Wetlands management is most critical during the construction phase because this is the phase in which most ground disturbance and disruption of hydrologic function is expected.

26.2.6.18 Terrestrial Ecosystems Management and Monitoring Plans

The Terrestrial Ecosystems Management and Monitoring Plan consists of four individual plans intended to address specific aspects of the management of terrestrial ecosystems. These plans are listed below, and can be found in Section 26.20.

26.2.6.18.1 Vegetation Clearing Management Plan

The Vegetation Clearing Management Plan can be found in Section 26.20.1. Vegetation clearing will be most significant during the construction phase of the Project and so construction-related details can be found throughout the plan.

26.2.6.18.2 Invasive Plant Management Plan

The Invasive Plant Management Plan can be found in Section 26.20.2. The management of invasive plants during the construction phase will be critical due to the exposure of soil and the introduction of heavy equipment and trucks from different regions.

26.2.6.18.3 Transmission Line Management Plan

The management of terrestrial ecosystems during the construction of linear infrastructure such as a transmission line require specific management actions. The Transmission Line Management Plan can be found in Section 26.20.3.

26.2.6.18.4 Terrestrial Plant Tissue Metal Concentrations Monitoring Plan

The Terrestrial Plant Tissue Metal Concentrations Monitoring Plan is described in Section 26.20.4. Plant tissue monitoring is more likely to occur in the operations and closure phases of the Project; however, some activities may be recommended for the construction phase.

26.2.6.19 Wildlife Management Plan

The Wildlife Management Plan consists of three separate plans that address specific aspects of wildlife management during the phases of the Project. These plans are listed below, and can be found in Section 26.21.

26.2.6.19.1 Wildlife and Wildlife Habitat Management Plan

Details of the Wildlife Habitat Management Plan that are specific to construction phase activities can be found in Section 26.21.1.4.

26.2.6.19.2 Ungulate Winter Range Management Plan

Ungulate Winter Range management will occur throughout all phases of the Project. Specific construction-related details are included throughout the plan and can be found in Section 26.21.2.

26.2.6.19.3 Wildlife Effects Monitoring Plan

Wildlife Effects monitoring will occur throughout all phases of the Project. Specific construction-related details are included throughout the plan and can be found in Section 26.21.3.

26.2.6.20 Noise Management Plan

Details relevant to construction phase activities are included throughout the Noise Management Plan and can be found in Section 26.22.

26.2.6.21 Heritage Management and Monitoring Plan

Details of the Heritage Management and Monitoring Plan for the construction phase can be found in Section 26.23.2.3.

26.2.6.22 Visual Quality Management Plan

Details of the Visual Quality Management Plan for the construction phase can be found in Section 26.24.

26.2.6.23 Traffic and Access Management Plan

The Traffic and Access Management Plan will be particularly important during the construction phase during the development of new access roads and the initial introduction of additional traffic to existing access roads. Details of the plan related to the construction phase can be found throughout Section 26.25.

26.2.7 Construction Schedule

Detailed construction scheduling and forecasting of requirements to meet environmental responsibilities is fundamental to the success of the CMP and its associated EMPs. A detailed schedule of environmental obligations, milestones, review periods, and timing windows must be maintained in conjunction with a construction schedule. This will allow construction activities to progress on schedule while actively managing environmental responsibilities. The following is a brief overview of major activities planned during the Project's five-year construction phase.

The Project's construction phase is scheduled to be complete in five years with some procurement and logistics activities beginning prior to the breaking of new ground. Activities will commence in Year -6 (relative to the start of production) with detailed design engineering, long-lead procurement, updating existing access, and the development of construction laydowns, new access, and camps.

In Year -5, development of access roads and construction camps would continue as well as the development of tunnel portals and initial tunnelling operations. The primary activities associated with these early works will be clearing and grubbing, excavation and soil handling, and earthworks and grading. Establishment of construction support services such as power and water treatment plants will be ongoing.

In Year -4, construction camps will be fully operational. Access road construction will expand to reach all major Project areas and tunnelling will expand to include additional tunnels. Mobilization of larger earthworks equipment will increase as access is completed.

In Year -3, access construction will be completed as well as some early infrastructure. Dam fills will incorporate mining equipment and pre-stripping of the Mitchell Pit will begin. The Mine Site permanent camp will be complete, and foundations will be underway site wide.

In Year -2, tunnel construction, dam construction, and pre-stripping will continue, with pre-stripping expanding to include the Mitchell Pit. The Water Storage dam (WSD) will be operational, and Mine Site foundations will be complete, as will the primary crusher building. The Treaty operating camp will be complete, along with the diversion and seepage collection ponds and all site preparation activities.

In Year -1, tunnelling and dam raising will be complete. Pre-stripping will continue at the Sulphurets and Mitchell pits. Most Mine Site and PTMA buildings will be complete with commissioning underway. The Tailing Management Facility (TMF) will be completed, and mining will be underway.

26.2.8 Targets, Monitoring, and Reporting

The CMP is itself a management system and as such, there will be specific targets, monitoring, and reporting requirements developed during the production of the detailed CMP prior to the start of construction. Some examples of CMP targets may include:

- reporting detail and report submission deadlines;
- completion of corrective actions following an environmental inspection;
- participation and presentation of materials for regulatory meetings; and
- monitoring improvement in environmental performance as measured by compiling valued component EMP targets results.

In general, the CMP can be considered to be compliant if the environmental obligations of the Project are met and if the targets, monitoring, and reporting requirements of its component EMPs are met.

26.3 Rock Storage Facilities Management and Monitoring Plan

Waste rock from open pit and underground mining operations that is not used for construction purposes will be consigned to the Mitchell Rock Storage Facility (RSF) located in the Mitchell Creek Valley and to the McTagg RSF located in the McTagg Creek Valley. Waste rock from the Kerr Pit will be backfilled into the mined-out Sulphurets Pit. All waste rock placed in the RFSs is assumed to be potentially acid generating. The locations of the RSFs are shown in Figure 26.3-1.

The total amount of mine waste rock to be removed during open pit excavations at the Mitchell Pit, Sulphurets Pit, and Kerr Pit is approximately 3.03 Bt over the mine life. Mine waste rock removed from the Mitchell and Sulphurets pits will be placed in the Mitchell RSF and McTagg RSF. Mine waste rock from the Kerr Pit will be placed in the Sulphurets Pit.

Not potentially acid-generating mine waste rock removed from the Sulphurets Pit during pre-production will be used to construct the basal drain beneath the Mitchell RSF, and it will be used as rockfill material in the construction of the WSD. A rock drain will also be constructed under the McTagg RSF.

Requirements for design, operation, and closure of RSFs on a mine site are legislated under the *Mines Act* (1996j) and are covered by sections of the Health, Safety and Reclamation Code for Mines in British Columbia (the Health, Safety and Reclamation Code; BC MEMPR 2008). The Health, Safety and Reclamation Code (BC MEMPR 2008) applies to "major dumps." A dump is defined as an accumulation of rock fragments or other unconsolidated material formed by pushing or dropping loose material over a crest and allowing it to come to rest without further handling. A major dump is defined as a dump that has one or more of the following characteristics:

- contains a volume of material that exceeds 1 million m^3;
- has a dump height greater than 50 m;
- has an area that is covered by a dump that exceeds 1 ha;
- is founded upon natural or trimmed slopes that are sometimes steeper than 20° from a horizontal plane;
- contains material dumped or placed in a water course having a potential peak flow greater than 1 m^3/s, once in every 200 years; or
- any other mine dump so declared by the Chief Inspector.

The RSFs proposed for the KSM Project fall into the category of a major dump (BC MEMPR 2008).

26.3.1 Legislation and Standards

BC's *Mines Act* (1996j) provides guidance and approvals for all activities on a mine site, from exploration to development, production, closure, and reclamation. It also requires project proponents to obtain a permit approving the work system and reclamation program. To obtain this permit a detailed Mine Development Plan and Reclamation Program has to be submitted to the Chief Inspector of the British Columbia Ministry of Energy, Mines and Natural Gas (BC MEMNG) for approval.

414 000 m E
418 000 m E
422 000 m E
426 000 m E
6 266 000 m N
6 262 000 m N

PHASE 3 McTAGG INLETS (YEAR 20+)
PHASE 2 McTAGG INLET (YEAR 10 TO 15)
PHASE 1 McTAGG INLET (YEAR −2 TO 10)
MITCHELL−TREATY TUNNELS
IRON CAP U/G WORKS FOOTPRINT (YEAR 30+)
NORTH PIT WALL DEWATERING ADIT (YEAR 5)
UNDERGROUND PHASE OUT−OF−PIT DIVERSIONS (YEAR 30+)
NORTH MITCHELL SLOPE COLLECTION DITCH
McTAGG RSF
WEST McTAGG CLOSURE/OPS CHANNELS
MAIN McTAGG TWINNED DIVERSION TUNNELS STAGE 2
NORTH SLOPE DIVERSION DITCH AND PIPELINE
MITCHELL CLOSURE CHANNELS
MITCHELL U/G WORKS FOOTPRINT (YEAR 30+)
ORE PREPARATION COMPLEX
MITCHELL GLACIER
MAIN McTAGG TWINNED DIVERSION TUNNELS STAGE 1 (YEAR −2)
WSF BYPASS BURIED PIPELINE
WATER STORAGE DAM (YEAR −2)
CONSTRUCTION PERIOD TUNNEL MUCK AND WATER TREATMENT
MITCHELL RSF
MITCHELL SURFACE DIVERSION INLETS
CLOSURE DAM
MITCHELL PIT (YEAR −2 TO 23)
MITCHELL VALLEY DRAINAGE TUNNEL (YEAR 5)
MITCHELL U/G DRAINAGE TUNNELS YEAR 30
GINGRASS CREEK
WSF CONSTRUCTION DIVERSION TUNNEL
WSF SPILLWAY
WSF SEEPAGE DAM
HIGH POND
LOW POND
CAMP 9/10
TRUCK SHOP
PENSTOCK TUNNEL
SURFACE PENSTOCK
SELENIUM TREATMENT PLANT
McTAGG POWER PLANT (YEAR 10)
SULPHURETS CREEK
CAMP
SLUDGE STORAGE FACILITY
WATER SLUDGE STORAGE BUILDING (CONSTRUCTION PERIOD)
WATER TREATMENT PLANT AND ENERGY RECOVERY POWER PLANT (YEAR −2)
DIVERSION DITCH
SULPHURETS LAYDOWN AREA
SULPHURETS−MITCHELL TUNNEL
SULPHURETS PIT (YEAR −2 TO 27)
KERR BACKFILL PLACED IN SULPHURETS PIT (YEAR 30)
TWINNED MITCHELL U/G PHASE DIVERSION TUNNELS (YEAR 30)
FLOW
TWINNED MITCHELL O/P PHASE DIVERSION TUNNELS (YEAR −2)
COLLECTION DITCH
SULPHURETS PIT SE PIPELINE
SULPHURETS LAKE
FLIP BUCKET OUTLET (U/G PHASE)
CONSTRUCTION BORROW AND SOIL STORAGE AREA 2
SULPHURETS HYDRO PLANT
STEPPED ROCKCUT FLOOD SPILLWAY (O/P PHASE)
PORTAL TRANSFER CONVEYOR
AN PRILL STORAGE
EXPLOSIVES MAGAZINE
SURFACE PENSTOCK
KERR PIT DEWATERING PIPELINE
EXPLOSIVES MANUFACTURING FACILITY
TEMPORARY FRANK MACKIE GLACIER ACCESS ROAD
TED MORRIS CREEK
KERR PIT (YEAR 27 TO 51)
SULPHURETS GLACIER

LEGEND

- TUNNEL/PORTAL
- CONTACT WATER DITCH
- OPERATION CLEAN WATER DIVERSION DITCH
- CLOSURE CLEAN WATER DIVERSION DITCH
- PIPELINE
- CONTACT WATER TUNNEL
- ROCK STORAGE FACILITY (RSF)
- OPEN PIT
- CULVERT, OR PIPE BRIDGE
- MINE ROADS
- TEMPORARY CONSTRUCTION PERIOD LINED TUNNEL MUCK PADS AND TREATMENT PONDS
- TEMPORARY CONSTRUCTION PERIOD PADS SEDIMENT PONDS

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA (1995). McTAGG GLACIER AND MITCHELL GLACIER CONTOURS RECEIVED FROM McELHANNEY LTD. AUG. 24, 2010 AND SEPT 28, 2010.
2. DATUM: NAD83 UTM ZONE 9.
3. −MINE AREA:

   FROM BOSCHE VENTURES: ORE PROCESS COMPLEX RECEIVED ON APR 3, 2012, SULPHURETES MITCHELL TUNNEL CONVEYOR AND PORTAL TRANSFER CONVEYOR RECEIVED ON APRIL 9, 2012. ACCESS ROAD NEAR TED MORRIS CREEKS RECEIVED ON MAR 23, 2011.

   FROM MOOSE MOUNTAIN: MCTAGG RSF & MITCHELL ROCK STORAGE FACILITY RECEIVED NOV 5, 2012. PITS RECEIVED APR 19, 2012, AND MITCHELL NORTH PIONEERING ROAD ON MAR 2, 2012. MINE AREA ROADS, TRUCK SHOP, BORROW AREAS, AND SPILLWAY NEAR WSF RECEIVED MAR. 30, 2012, SLUDGE STORAGE FACILITIES RECEIVED ON APR 3, 2012. CAMP RECEIVED APRIL 24, 2012. SULPHURETS BACKFILL RECEIVED OCT 3, 2012.

   FROM GOLDER: UNDERGROUND−IRONCAP/MITCHELL RECEIVED ON FEB 01, 2012.
3. STRUCTURES ON GENERAL ARRANGEMENT SHOWN REGARDLESS OF MINE PHASE.

NOT FOR CONSTRUCTION

SCALE: 0 1000m

Source: Klohn Crippen Berger (2012).

SEABRIDGE GOLD KSM PROJECT
Rescan Engineers & Scientists

Figure 26.3-1

Location of Rock Storage Facilities

26.3.2 Legislation and Standards

BC's *Mines Act* (1996j) provides guidance and approvals for all activities on a mine site, from exploration to development, production, closure, and reclamation. It also requires project proponents to obtain a permit approving the work system and reclamation program. To obtain this permit a detailed Mine Development Plan and Reclamation Program has to be submitted to the Chief Inspector of the British Columbia Ministry of Energy, Mines and Natural Gas (BC MEMNG) for approval.

Under the *Mines Act* (1996j), the Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide:

- a mine plan showing the locations of waste disposal areas;
- designs for major dumps developed in accordance with the Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee;
- designs for major dumps that allow for re-contouring and reclamation consistent with the end land use;
- plans to operate and monitor major dumps in accordance with the Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee;
- an annual report on the performance of high risk dumps;
- a design for major dump slopes that meet long-term stability criteria in accordance with the criteria provided in the Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee;
- a reclamation plan that ensures long-term stability and long-term erosion control; and
- a waste dump stability monitoring program.

The Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide plans for the prediction, and if necessary, prevention, mitigation, and management of metal leaching and acid rock drainage (ML/ARD). Details for ML/ARD management and monitoring are included in the Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14).

The Health, Safety and Reclamation Code (BC MEMPR 2008) also requires proponents to provide plans for soil salvage and handling, erosion control, and soil contamination prevention. Details for soil management and monitoring are included in the Terrain, Surficial Geology, and Soil Management and Monitoring Plan (Section 26.13).

Plans for the control and diversion of water on the Mine Site, including of the management of water around the RSFs, are provided in the Water Management Plan (Section 26.17).

A set of detailed mine development and reclamation plans will be submitted at a later date as part of the Mine Plan and Reclamation Program Permit application. The following sections outline the general provisions included in these documents in terms of RSF operation and monitoring.

26.3.3 Rock Storage Stability Plan

26.3.3.1 Objective

The objective of the Rock Storage Stability Plan is to construct and operate the RSFs to provide safe and stable storage of waste rock generated from open pit and underground mining operations. The management and monitoring plan is intended to provide a basis for confirming design assumptions and for tracking performance during construction and after the mine closes.

26.3.3.2 Targets

Targets of the Rock Storage Stability Plan include the following:

- prepare the foundations of rock storage sites;
- construct RSFs to meet short-term (during construction) and long-term stability criteria; and
- control surface and subsurface water.

26.3.3.3 Actions to Avoid, Control, and Mitigate

26.3.3.3.1 Design Criteria

The RSFs have been classified based on the dump stability rating outlined in the *Mine Rock and Overburden Piles Investigation and Design Manual: Interim Guidelines* prepared for the British Columbia Mine Waste Rock Pile Research Committee (Piteau Associates 1991). The stability rating considers the probable failure hazard of the RSF based on key factors affecting stability including RSF size and geometry, foundation conditions, characteristics of the waste rock material, method of construction, climate and expected piezometric conditions, and rate of RSF construction and seismicity.

The dump stability ratings are summarized in *Appendix IV - Design Basis Memorandum* of the *2012 Geotechnical Design of Rock Storage Facilities and Design of Associated Water Management Facilities* report (KCB 2012b; Appendix 4-J) and the Rock Storage Facilities Design Report (KCB 2013; Appendix 4-M). The Mitchell RSF is classified as low-moderate failure hazard, the McTagg RSF is classified as low-moderate failure hazard, and the Sulphurets Pit Backfill is classified as low failure hazard.

Detailed phased site investigations will be undertaken during the operation phase and the following tasks will be performed:

- detailed laboratory index testing, shear strength, and durability testing;
- update stability analyses based on test data;
- moderate restrictions on construction (e.g., limiting loading rate, lift thickness, and material quality); and
- instrumentation monitoring to confirm design, document behaviour, and establish loading limits.

The RSFs will be designed and constructed with slopes that meet or exceed the minimum factor of safety specified in the *Mine Rock and Overburden Piles Investigation and Design Manual: Interim Guidelines* prepared for the British Columbia Mine Waste Rock Pile Research Committee (Piteau Associates 1991) as required by the Health, Safety and Reclamation Code (BC MEMPR 2008).

A minimum factor of safety of 1.3 to 1.5 is required for deep-seated, short-term (end of construction) conditions for an RSF with an assessed high consequence of failure. A factor of safety of 1.1 is applicable for an RSF with an assessed low consequence of failure. For deep-seated, long-term conditions a minimum factor of safety of 1.5 is required for an RSF with a high consequence of failure, or 1.3 for an RSF with a low consequence of failure. The design is also required to meet a minimum factor of safety for potential earthquake conditions. The selected earthquake return period is 10,000 years with a design earthquake ground acceleration of 0.14 g. A minimum pseudo-static factor of safety of 1.0 is required. Detailed deformation analysis is required if the calculated pseudo-static factor of safety is less than 1.0.

Two areas of the RSF require site specific design considerations based on potential failure consequence. The RSF slope to be constructed on the north side of the Water Storage Facility (WSF) has been assessed as Extreme consequence in accordance with the Canadian Dam Association (CDA) *Dam Safety Guidelines* (2007). A minimum safety factor of 1.4 is required for both short-term and long-term conditions. The design is required to meet a minimum pseudo-static factor of safety of 1.0 for earthquake conditions based on a 10,000 year return period design earthquake ground acceleration of 0.14 g. Detailed deformation analysis will be required if the calculated pseudo-static factor of safety is less than 1.0. In addition, fluctuating water levels in the WSF will affect the toe area of the RSF, and a minimum safety factor of 1.2 is required for the rapid drawdown conditions.

The consequence of failure of part of the Mitchell RSF located adjacent to the Mitchell Ore Preparation Complex (OPC) and infrastructure in the Mitchell Creek Valley is assessed as high (in accordance with the CDA [2007] guidelines). The design is required to meet a minimum factor of safety of 1.3 for short-term conditions and of 1.4 for long-term conditions, considering the lower strength clay layer in some areas of the foundation. The target minimum required pseudo-static factor for earthquake conditions is 1.0.

The target factor of safety requirements and seismic parameters for the Mitchell and McTagg RSFs are summarized in Table 26.3-1.

The Sulphurets Pit Backfill is rated as low hazard with a minimum required static factor of safety of 1.3, and a minimum pseudo-static factor of safety of 1.0.

The waste rock consigned to the RSFs is classified as moderately strong rock with an initial friction angle of 40°. Stress levels within the RSF will vary considerably due to variations in the height of the storage facility and will affect the effective strength of the rock. The friction angle could decrease by 2° to 4° under the high stresses. Additional long-term reduction in shear strength may result from geochemical and physical weathering following exposure of the waste

rock to moisture and oxygen. The long-term strength of the rock has been assumed to reduce to 30° for closure design.

Table 26.3-1. Target Factor of Safety Requirements and Seismic Parameters for the Mitchell and McTagg Rock Storage Facilities

Condition		Minimum Factor of Safety		
		Mitchell RSF		
		Near WSF	Near OPC	McTagg RSF
Static	Short-term	1.4	1.3	1.3
	Long-term	1.4	1.4	1.3
Rapid drawdown		1.2	n/a	n/a
Pseudo-static		> 1.0	> 1.0	> 1.1
Seismic loading (g)		0.07	0.07	0.07

n/a = not applicable.

Surface water diversion channels and spillways are designed to convey the 200-year peak flow during the mine operation phase. At closure, the diversion channels are designed to resist erosion during the 1,000-year peak flow and to route the probable maximum flood (PMF). The central portions of the closure channels will carry base flows sized for the 200-year return period 24-hour flow and will be designed to be resistant to long-term erosion. The PMF includes storm flows that are in excess of the capacity of the McTagg Twinned Diversion Tunnels and Mitchell Diversion Tunnels, assuming failure of the diversion inlets/tunnels.

26.3.3.3.2 Construction

Details of RSF construction are included in Appendix 4-J. A stable foundation is required under the RSFs to reduce the risk of RSF failure. Site preparation for the RSFs will include:

- removal of merchantable timber;
- stripping of organic, weak, and soft soils and/or of highly weathered rock where required; and
- proof-rolling where practical.

The layout of the Mitchell RSF involves placement of mine waste rock across the Mitchell Creek Valley to an elevation of 810 m followed by successive raising of dump platforms or benches to a final elevation of 1,200 m on the south slope of the valley. The layout of the McTagg RSF involves placement of mine waste rock to an elevation of 900 m on the west and north margins of the McTagg Creek Valley (elevations of closure channels) and to an elevation of 1,020 m along the eastern margin. Construction of the Mitchell and McTagg RSFs will include:

- Construction of mine waste rock storage areas by bottom-up construction to achieve stable dump slopes. This method of construction involves dumping waste rock from haul trucks and spreading it with a dozer starting at the lowest elevation and successively increasing the elevation of the dump platform. Final dump configurations are generally

designed with "as dumped" angle of repose slopes with intermediate benches or terraces to form an overall slope of 26° to 30° to allow for re-sloping as required to accommodate the reclamation plan.

- Establishment of the Mitchell RSF pre-production ore stockpile on the north side of the Mitchell RSF in Year 5, and the construction of a temporary land-bridge of mine waste rock between the Mitchell and McTagg RSFs in Year 15 to facilitate hauling of open pit waste across the Mitchell Creek valley without elevation change.
- Removal of the ore stockpile and land-bridge just before the end of open pit operations to allow for the construction of surface water closure channels.

Stability analyses were completed for various design RSF configurations including three typical sections at the Mitchell and McTagg RSFs (the slope south of the Mitchell OPC, the slope above the WSF, and the slope in the McTagg Creek Valley). Based on the results of site investigations, generally favourable foundation conditions have been encountered in the Mitchell and McTagg Creek valleys, with the exception of localized weaker lacustrine silts in an area of the central Mitchell Creek Valley near the Mitchell OPC. Special design measures are considered necessary in this area to provide stability conditions that meet the minimum required factor of safety for design stability. The design and mitigation requirements include preloading the toe area of the Mitchell RSF located to the south of the Mitchell OPC with a toe berm to consolidate the weak foundation soils and to allow dissipation of pore pressure prior to raising the RSF.

Stability analyses were also completed for a typical design dump configuration at the Sulphurets Pit Backfill.

Mining at Kerr Pit will commence after Year 27, and waste rock will be transferred to the mined-out Sulphurets Pit. Construction of the Sulphurets Pit Backfill in the mined-out Sulphurets Pit will be completed so that drainage from the waste rock can be collected and routed to a treatment plant to remove selenium. Construction of the Sulphurets Pit Backfill will involve the following:

- A rock drain will be constructed to route groundwater seepage under the Sulphurets Pit Backfill.
- The backfill will be placed at an overall slope angle of 2H:1V.
- The waste rock will be covered by layers of bituminous geomembrane to reduce infiltration of water into the waste rock.
- Drainage will be collected for pre-treatment to remove selenium.

The control of surface and subsurface water flow is important to maintain stable conditions in the area of the RSFs. Tunnels, surface ditches (channels), and subsurface rock drains will be designed and constructed to divert water away from the RSF areas. Components of the water control and diversion plan include the following:

- The McTagg Twinned Diversion Tunnel and Mitchell Diversion Tunnels will be constructed before the start of mining activity to route the majority of runoff and glacial meltwater (i.e., non-contact water) around the RSFs.

- Non-contact water from the north slope of Mitchell Creek Valley will be diverted in the Mitchell RSF North Slope Diversion consisting of a pipeline and collection ditches. Initially the diversion outlet will be directed toward the Phase 1 McTagg inlet. Runoff from other catchment areas will be diverted by surface diversion channels located in natural ground or in channels constructed along the edge of the RSF. Several of the smaller catchments in snow avalanche areas, or in areas of difficult terrain, will be diverted by pipelines.
- In Year 5, the non-contact water diversion channel constructed along the northern edge of the Mitchell RSF will be re-established in pipelines under a temporary ore stockpile that will be placed on the Mitchell RSF. As the McTagg RSF rises, the surface section of the diversion channel will be re-established and will connect with channels that run across the toe of the Mitchell RSF, along the southeast side of the WSF, and around the WSD to a spillway that discharges downstream of the WSF seepage dam into Mitchell Creek. In Year 15, a temporary land-bridge will be constructed between the Mitchell and McTagg RSFs. At this time, the pipeline under the Mitchell RSF pre-production ore stockpile will be extended under the land-bridge and will connect with surface pipelines to route the freshwater to the southeast WSF diversion. During this period, additional surface channels will be constructed to divert freshwater from natural terrain above the area of the Mitchell RSF pre-production ore stockpile and land-bridge to lined channels over the Mitchell RSF.
- Construction of the McTagg RSF begins in the McTagg Creek Valley after Year 10. A lined diversion ditch and pipelines will be constructed along portions of the north perimeter and along the west perimeter of the McTagg RSF and will be raised as the McTagg Creek Valley is filled. Non-contact water collected from valley slope runoff will be directed in the diversion channel and will be routed via a rock-cut spillway and stilling basin across the toe of the Mitchell RSF and around the east side of the WSF to be discharged into Mitchell Creek downstream of the WSD.
- Prior to Year 5, contact water from upstream of Mitchell Pit will be routed through Mitchell Creek Valley to the WSF. The flow will be diverted in a rock-cut channel north of the starter pit and in a lined diversion channel around the Mitchell RSF to a step spillway drop structure and into the WSF.
- After Year 5, contact water from the Mitchell surface diversion inlets will be routed around the Mitchell Pit through the Mitchell Pit north wall dewatering adit. In addition to routing water around the pit, the adit functions as a dewatering tunnel for pit wall stability. The adit also accepts water pumped from the pit. The adit will feed into the Mitchell Valley Drainage Tunnel to allow contact water to discharge directly into the WSF.
- During the underground mining phase, a lined channel will convey contact water around the Mitchell RSF to the WSF.
- Contact water from precipitation or groundwater infiltrating into the Mitchell RSF will be routed to the WSF through a rock drain constructed beneath the RSF. The rock drain, consisting of mined rock that is not potentially acid-generating, will be provided to reduce flushing of acid-generating waste rock and to assist in lowering the degree of

saturation within the RSF to promote stability. A rock drain will also be constructed under the McTagg RSF. The engineered rock drains under the Mitchell RSF and the McTagg RSF will be constructed within the major natural drainages by dumping select, competent waste rock from dump platforms such that the coarse rock material segregates at the dump toe to form the rock drains. The rock drain located below the southwest portion of the Mitchell RSF serves an additional purpose in allowing the toe of the RSF to be flooded by the fluctuating pond water levels of the WSF and to control stability under rapid drawdown conditions when the pond water level is reduced.

- All diversion channels built over mine waste rock will be lined with a moraine blanket over liners to reduce infiltration of water into the RSF. A layer of rip-rap will be provided and sized for erosion protection.

26.3.3.3.3 Operation

For the purposes of ensuring the safety of mine personnel working below areas of active dump construction or driving on access roads below rock storage areas, the following safety measures may be required:

- the construction of catch berms to impede rock rollout; and
- the establishment of exclusion zones at the toe of active dumps.

Seasonal accumulations of snow are expected in working areas of the Mine Site and in the water diversion channels, and will be removed periodically and prior to freshet. The snow will be considered to be contact water and will be disposed of in areas that drain to the WSF for treatment. Storage of snow and control of snow melt will include:

- Designated snow dumps located on the south facing slope of the McTagg RSF and on areas of the Mitchell RSF above the WSF where the snow will melt during the summer.
- Location of snow dumps in non-critical areas of the RSFs.

Geohazards including debris flows, debris slides, and frequent snow avalanches could affect the diversion structures. The storage capacity of the WSF is sufficient to handle additional volumes of water in the event that the diversion channels do not function; however, the following design and control measures have been considered:

- Diversion channels have been strategically located to avoid landslide and snow avalanche prone terrain wherever possible, and designed to minimize the risk of failure and to maximize channel efficiency; however, it is anticipated that ongoing maintenance of water diversion channels and structures will be required.
- Diversion channels will be constructed with a minimum 5 m base width to allow for snow removal by snow blowers or Caterpillar D-6 dozers. Snow and debris will be removed in a timely manner if the channels become blocked.

Periodic shotcrete reinforcement and rock bolting may be required along sections of rock-cut channels and spillways where discontinuities in the rock may lead to leakage or structural weakness.

26.3.3.3.4 Closure

For long-term stability and reclamation purposes, slopes of the Mitchell and McTagg RSFs will be re-contoured at closure. The modifications to the RSF areas will include:

- Re-contouring the Mitchell and McTagg RSF slopes below an elevation of 1,100 m (treeline) to an overall slope of 2H: 1V (27°) with a 50 cm soil cover and vegetated.
- Re-contouring the western face of the Mitchell RSF below an elevation of 840 m.
- Above the treeline, higher benches are proposed to be left un-vegetated to reflect existing talus slopes present in the Mitchell and McTagg Creek valleys.

Diversion of non-contact water and contact water will continue after completion of construction of the RSFs. Components of water control during the closure and post-closure phases will include:

- At about Year 29, surface closure channels will be constructed at an elevation of 810 m on the north side of the Mitchell Creek Valley at the toe of the Mitchell RSF after removal of the Mitchell RSF pre-production ore stockpile and the Mitchell RSF land-bridge. The closure channels in Mitchell Creek Valley will consist of two parallel lined channels within a larger unlined channel. One of the lined channels will convey non-contact water around the WSF, and the other channel will direct contact water to the WSF. In the event of extreme floods beyond the storage capacity of the WSF, flows will be routed around the WSF.
- The West McTagg closure channel will be 50 m wide except in snow avalanche prone areas where the width will be increased to 100 m to allow for up to 50% blockage and for reduced flow if impacted by avalanches. Flow from the West McTagg closure channel will pass through an enlarged rock-cut spillway, widened to 65 m to accommodate storm flows up to the PMF. The flow will be diverted over the RSF to join the non-contact water flow routed from the Mitchell Creek Valley. The combined flow will cross the toe of the Mitchell RSF and will be routed through a widened rock-cut channel forming the Lower Mitchell closure channel located to the east of the WSF. This channel will divert flows past the WSF and down into Mitchell Creek via a rock cut spillway.
- After closure, once the water level in the flooded Mitchell Pit reaches 810 metres above sea level (msal), the Mitchell Pit Lake will overflow and will be directed in an outlet pipe around the Mitchell Pit closure dam. This contact water will be diverted to the Mitchell North closure channel and via the South Mitchell closure channel into the WSF. A spillway will be constructed at 820 masl and will route flood flows, considered to be non-contact water, over the closure dam and into the Mitchell North closure channel.
- All water diversion channels built over mine waste rock will be lined with a bituminous liner to reduce infiltration of water into the RSF. A layer of rip-rap will be placed to provide erosion protection, and will be sized based on the PMF.
- All flat surfaces of the RSFs will be sloped into the dump to minimize erosion at the edge of berms or dump platforms.

Ongoing maintenance of diversion channels, collection ditches, and water management structures will be undertaken, including maintenance of the dewatering pipeline from Kerr Pit to the Selenium Treatment Plant, and maintenance of the pipeline and diversion ditch from the Sulphurets Pit Backfill to the Selenium Treatment Plant.

Temporary mine closure for periods longer than one year will require construction and maintenance of temporary water management structures such as ditches and erosion control measures on the surfaces of the RSF.

26.3.3.3.5 Post-closure

The post-closure phase includes complete reclamation of the RSFs and continued treatment of water collected in the WSF until the water quality meets acceptable standards for direct discharge to the environment. At that time, all facilities will be decommissioned and flows downstream of the Mine Site will be restored to pre-mine conditions.

26.3.3.4 Monitoring

A monitoring program will be developed to visually check the condition of RSF slopes and surface water control diversion channels during RSF construction and operation. The monitoring program will also include the installation of geotechnical instrumentation for the collection of data to confirm design assumptions, to warn of potential failure or deformation of RSF slopes, and to evaluate stability performance.

The results of the monitoring program will be used to measure the success of the management strategies and to identify where additional mitigation may be necessary. Monitoring will continue for a period of time after mine closure to confirm that reclamation objectives are being achieved and to identify repair or maintenance requirements. Inspection and monitoring may include:

- visual inspection of RSF platform, crest, and slopes to check for signs of cracking, settlement, or bulging;
- visual inspection of the RSF toe area to check for signs of ground heave or seepage;
- installation of piezometers during construction in the area of the Mitchell RSF foundation where lacustrine deposits are present to monitor pore pressure and phreatic levels;
- installation of slope inclinometers in areas close to the Mitchell OPC during operation to monitor foundation deformation;
- installation of surface survey monuments during RSF construction;
- deployment of wireline extensometers as required; and
- inspection of surface water diversion ditches, channels, and pipelines to check the structural condition and to ensure that they are clear of obstruction.

A schedule for routine inspection and instrumentation monitoring will be developed at the time of mine permitting based on the mine construction and operation schedule. Instrumentation trigger levels and response criteria will also be established and included in an operation procedure for the RSFs.

Additional inspections of RSF slopes and surface water control structures will be undertaken following extreme rainfall events or significant earthquake events. Records will be kept to track RSF crest advance and loading rates, location of snow dumps, waste rock material quality, and any other information required to assess RSF performance.

Geohazards, such as debris flows, debris slides, and snow avalanches, in areas that could adversely affect worker safety and mine infrastructure, including surface water diversion structures, will be monitored and identified hazards will be controlled as necessary.

Monitoring will continue during periods of temporary mine closure.

26.3.3.5 Reporting

Regular inspection of active and inactive RSFs and review of pertinent data will be conducted by mine personnel. Inspection records will be maintained on site for review by the design engineer and by government mine inspectors. The information collected may be used for external reporting purposes.

The Health, Safety and Reclamation Code (BC MEMPR 2008) requires that an annual performance report be submitted for waste rock storage facilities that are classified as high risk. Information on the development and reclamation of the waste rock storage facilities may also be included in the annual reclamation and environmental monitoring report submitted to the BC government as required by the *Mines Act* (1996j) regulations under the Health, Safety and Reclamation Code (BC MEMPR 2008).

The mine manager is ultimately responsible for mine operations. The engineering department, reporting to the Superintendent of Health and Safety, will be responsible to maintain the RSF monitoring records and generate reports at the required frequency.

26.4 Tailing Management Facility Management and Monitoring Plan

Tailing produced after the mined ore has passed through a process of high pressure grinding, flotation, and leaching at the Treaty OPC will be transported by slurry pipeline to the TMF. Conventional flotation tailing will be stored in two cells, the North Cell and the South Cell. A separate tailing stream consisting of sulphide-rich carbon-in-leach (CIL) residue tailing, produced as a waste product in the cyanide leaching process, will be transported in a pipeline to a fully lined CIL Lined Pond located in the Centre Cell between the North and South cells, and will operate during the filling of the North and South cells. The TMF is designed to store 2.3 Bt of tailing produced over the 51.5-year mine life.

The TMF will ultimately consist of three storage cells retained by four compacted cyclone tailing dams, the North dam, the Splitter dam, the Saddle dam, and the Southeast dam. The tailing dams will be constructed to final heights of 218 m, 194 m, 168 m, and 239 m, respectively. The general layout of the TMF is shown in Figure 26.4-1.

Starter dams will be constructed at the North, Splitter, Saddle, and Southeast dams. The starter dams will be earthfill embankments with shells of compacted random fill supporting a central till core. The core will be keyed into the underlying foundation to cut off seepage through weathered near-surface soils and any pervious stratum. A 1.5 m-thick drain blanket will be placed to depress phreatic levels in the downstream half of the dam.

The North, Saddle, and Southeast dams will be raised as compacted cyclone sand dams with till cores constructed by the centreline method with a crest width of 20 m. The Splitter dam will be built by a modified centreline method with a till core. The North and Southeast dams will have downstream slopes of 3H:1V. The Saddle dam will have a downstream slope of 1.5H:1V, and the Splitter dam will have a downstream slope of 2.5H:1V. The Saddle and Splitter dams forming the Centre Cell and CIL Lined Pond will have a supplementary geomembrane liner within the dam cores that will extend across the Centre Cell basin floor to maintain saturated conditions in the CIL tailing and to limit seepage from the CIL Lined Pond.

Seepage from the tailing dams will be collected in seepage collection ponds constructed downstream of the tailing dams. The North, Saddle, and Southeast seepage collection dams will be constructed of compacted till with 3H:1V upstream and downstream slopes. An inclined till core will be provided on the upstream face to restrict seepage. Seepage under the seepage collection dams will be restricted by constructed slurry trench cut-off walls with a grout curtain where bedrock is encountered.

The TMF will be developed in stages:

- **Stage 1 (Year 0 to 25)** involves construction and operation of the North Cell between the North dam and the Splitter dam to store flotation tailing, and it involves construction and operation of the Centre Cell and CIL Lined Pond between the Splitter dam and the Saddle dam to store CIL tailing. Surplus water from the North cell will be discharged by pipeline to Treaty Creek under controlled conditions. Surplus water from the Centre Cell will be reclaimed and treated at the Treaty OPC, and the excess will be pumped to the North Cell. Surplus water in the North Cell will be discharged via pipeline to Treaty Creek.
- **Stage 2 (Year 25 to 30)** is an interim stage that includes the first five years of tailing deposition in the South Cell between the Saddle dam and the new Southeast dam and ongoing filling of the Centre Cell. Surplus water from the closed North Cell will be discharged by pipeline to North Treaty Creek under controlled conditions, and surplus water from the operational South Cell will be discharged to Treaty Creek. Reclamation of the North Cell will be undertaken during this period.
- **Stage 3 (Year 31 to 51.5)** involves raising the tailing dams to ultimate height and filling the South and Centre cells. Water from the closed North Cell will be discharged by pumping to North Treaty Creek until water quality meets discharge requirements for

discharge to Teigen Creek (Year 45), when a spillway will be completed at the North dam to route flows to Teigen Creek. Surplus water from the South Cell will be discharged by pipeline to Treaty Creek under controlled conditions.

- **Stage 4** represents initial closure during Year 51.5 to Year 54.5, when reclamation of the South Cell and Centre Cell and a flood control spillway will be constructed at the Southeast dam. During this period, the closed North Cell will discharge to South Teigen Creek, and the closed South Cell to North Treaty Creek.
- **Stage 5** represents final closure when the surface water diversions are removed once water quality meets discharge requirements to North Treaty Creek and South Teigen Creek.

Requirements for the design, operation, and closure of TMFs on a mine site are legislated under the *Mines Act* (1996j) and are covered by sections of the Health, Safety and Reclamation Code (BC MEMPR 2008). In accordance with a Memorandum of Understanding between the BC Ministry of Energy, Mines and Petroleum Resources (now BC MEMNG) and the Water Stewardship Division and Environmental Protection Division of the BC Ministry of Environment (now Ministry of Forests, Lands and Natural Resource Operations and Ministry of Environment respectively), the *Mines Act* (1996j) regulations apply to tailing storage facilities unless a water licence or waste permit is required. It has been assumed that a waste permit may be required, but that a water licence will not be required for the TMF.

The Health, Safety and Reclamation Code (BC MEMPR 2008) applies to "major impoundments" and "major dams." A major impoundment is defined as an impoundment that has a maximum depth of material greater than 10 m at any point, or a maximum height of retaining dam or dike at any point that exceeds 15 m, or is a storage facility designed to contain more than 1 million m^3 of fill, or any other impoundment or water management facility so declared by the Chief Inspector. A major dam is defined as a dam that is used to store and control water, slurry, or solids and that has a maximum height at any point that exceeds 15 m or that is between 10 and 15 m in height and has either a crest length that exceeds 500 m, a flood discharge rate that exceeds 2,000 m^3/second, or a reservoir capacity that exceeds 1 million m^3, or any other dam so declared by the Chief Inspector (BC MEMPR 2008).

The tailing dams and associated seepage recovery dams proposed for the KSM Project fall into the category of major dams.

26.4.1 Legislation and Standards

BC's *Mines Act* (1996j) provides guidance and approvals for all activities on a mine site, from exploration through to development, production, closure, and reclamation. It also requires project proponents to obtain a permit approving the work system and reclamation program. To obtain this permit, a detailed Mine Development Plan and Reclamation Program has to be submitted to the Chief Inspector of BC MEMNG for approval.

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Treaty Warehouse and Warehouse Pad
East Catchment Diversion Tunnel Portal Access Road
Treaty OPC Waste Management Facilities
Concentrate Storage and Loadout Area
Treaty OPC Stormwater Runoff Pipeline
North Cell Seepage Collection Dam Spillway
Treaty Runoff Collection Channel
Treaty Process Plant
TWT 10 - Sediment Control Pond
North Cell Seepage Collection Dam (Partially Reclaimed)
CIL Plant
Treaty Construction Laydown Area
North Cell Seepage Collection Pond
TWT 8 - Sediment Control Pond (Reclaimed)
North Cell Seepage Reclaim Pipeline
East Catchment Diversion Tunnel Portal
SEC Crusher Building
TWT 8 Unlined Muck Pad (Reclaimed)
Treaty OPC Fine Ore Stockpile
MTT Process Plant Portal
TWT 9 - Sediment Control Pond (Reclaimed)
TWT 10 - Collection Ditch (Reclaimed)
Water Supply Well
TWT 9 - Pipeline (Reclaimed)
North Cell Dam (Partially Reclaimed)
East Catchment Diversion Tunnel Phase 2
Water Pipeline
Treaty Operating Camp
Northwest Diversion
TWT 13 - Sediment Control Pond (Reclaimed)
Portal Laydown Area (Reclaimed)
Treaty Administration Building
Treaty Fuel Storage
East Catchment Diversion Dam Spillway
North Cell Till Stockpile
Northeast Buried Pipeline
East Catchment Diversion Tunnel Phase 1
East Catchment Diversion Pond
Treaty CSFC Landfarm / Landfill
Treaty OPC Batch Plant and Laydown
Upper East Catchment Diversion Pond
Treaty OPC Site Diversion Ditch
East Catchment Diversion Dam (Partially Reclaimed)
Camp 5: Treaty Plant Camp (Reclaimed)
Treaty OPC Batch Plant Stockpile
TWT 11 - Collection Pipeline
North Cell Closure Pond
Northeast Diversion Ditch
Upper East Catchment Diversion Dam (Partially Reclaimed)
Water Supply Well Access Road
Reclaim Barge
Northeast Service Road
Upper East Catchment Diversion Dam Spillway
Treaty Creek Transmission Line
North Cell (Partially Reclaimed)
TWT 12 - Sediment Control Pond (Reclaimed)
TWT 11 - Collection Ditch
Waste Area (Reclaimed)
Splitter Dam
Pump House with Potential Clarification System
CIL Lined Pond
Reclaim Barge
Saddle Dam
Reclaim Barge
Southeast Service Road
North Treaty Lower Road (Covered / Reclaimed)
South Cell Pond
Waste Area (Reclaimed)
Southeast Diversion Ditch
Reclaim Barge
South Cell
Additional Channel Armouring and Diversion Dams at Junction with Major Streams (Partially Reclaimed)
TWT 15 - Sediment Control Structure (Reclaimed)
Waste Area (Reclaimed)
Southeast Dam (Partially Reclaimed)
Waste Area (Reclaimed)
North Treaty Upper Road
Southeast Dam Diversion Ditch
Waste Area (Reclaimed)
Southwest Diversion Access Road
Southeast Seepage Collection Pond
Waste Area (Reclaimed)
TCAR Southwest Diversion Ditch
TWT 15 - Pipeline (Reclaimed)
Treaty Saddle Road
South Cell Soil Storage Area
Southeast Seepage Collection Dam Spillway
TMF Discharge Pipeline
Southeast Seepage Collection Dam
South Cell Seepage Reclaim Pipeline

Incinerator
Diversion Ditch
Collection Ditch
Diversion Pipeline
Collection Pipeline
Effluent Discharge Pipeline
Diversion Tunnel
Spillway
Tunnel
Transmission Line
Access Road
Infrastructure
Dam
Lined Pond
Pond
Tailing Cell
Landfarm / Landfill
Ore Stockpile
Soil Storage
Till Stockpile
Haul Road

1:45,000
0 1,000 2,000
Metres

GIS #: KSM-15-321
Date: February 05, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 26.4-1

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Tailing Management Facility General Arrangement

Under the *Mines Act* (1996j), the Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide:

- a mine plan showing the location of the TMFs;
- designs for major impoundments and dams developed in accordance with the criteria provided in the CDA *Dam Safety Guidelines* (2007);
- an operation, maintenance, and surveillance (OMS) manual for major dams and impoundments prior to commissioning;
- design for dam slopes that meet long-term stability criteria in accordance with the CDA (2007) *Dam Safety Guidelines*;
- an Emergency Preparedness Plan for dams classified as High or Very High failure (or Extreme) consequence;
- an annual dam safety inspection report;
- the installation of a flood control spillway at closure;
- a reclamation plan for tailing ponds and impoundment structures; and
- a dam stability monitoring program.

The Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide plans for the prediction, and if necessary, prevention, mitigation, and management of ML/ARD. Details for ML/ARD management and monitoring are included in the Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14).

The Health, Safety and Reclamation Code (BC MEMPR 2008) also requires proponents to provide plans for soil salvage and handling, erosion control, and soil contamination prevention. Details for soil management and monitoring are included in the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Section 26.13).

The EMP for construction of the tailing dams, seepage collection dams, and water control structures is included in the Construction Management Plan (Section 26.2).

Plans for the control and diversion of water on the Mine Site, including the management of water around the TMF, are provided in the Water Management Plan (Section 26.17).

A set of detailed mine development and reclamation plans will be submitted at a later date as part of the Mine Plan and Reclamation Program Permit application. The following sections outline the general provisions included in these documents in terms of tailing operation and monitoring.

26.4.2 Dam Stability Plan

26.4.2.1 Objective

The objective of the Dam Stability Plan is to construct and operate the tailing dams to provide safe and stable storage for processed tailing and CIL tailing residue and to construct and operate

the seepage collection dams to provide safe and stable storage of seepage collected downstream of the tailing dams. The management and monitoring plan is intended to provide a basis for confirming design assumptions and for tracking performance during construction, operation, and after the mine closes.

26.4.2.2 Targets

Targets of the Dam Stability Plan include the following:

- prepare the foundation of dam sites;
- construct dams to meet short-term (during construction) and long-term stability criteria; and
- control surface and subsurface water.

26.4.2.3 Actions to Avoid, Control, and Mitigate

26.4.2.3.1 Design Criteria

The tailing dams and the seepage collection dams have been classified based on the dam classification scheme presented in the CDA (2007) *Dam Safety Guidelines*. The classification scheme considers incremental losses associated with loss of life, environmental and cultural values, and infrastructure and economic values. The North dam, Saddle dam, and Southeast dam are classified as Extreme failure consequence. The Splitter dam is classified as High failure consequence. The seepage collection dams are classified as significant failure consequence.

Dam design flood and earthquake levels are selected based on the dam classification.

The required minimum static factor of safety for dam design is 1.5 using peak frictional strength parameters and estimated operating pore pressures in the dam materials and underlying foundation soils. For earthquake conditions, the minimum required factor of safety is 1.0 based on pseudo static analysis, assuming 50% strength reduction in any uncompacted tailing deposits. Assuming full liquefaction of uncompacted tailing deposits, the minimum required post-earthquake factor of safety against sliding of the dam is 1.2.

The following design criteria are based on an Extreme consequence classification for the North dam, Saddle dam, and the Southeast dam:

- seismic design to withstand the maximum credible earthquake based on a 10,000-year return period design earthquake ground acceleration of 0.14 g;
- flood storage without discharge during operation based on the PMF resulting from a 30-day probable maximum precipitation (PMP) plus the 100-year snow accumulation melt;
- freeboard of 1.0 m above maximum flood level during operation; and
- closure spillways with the capacity to convey the PMF event.

The following criteria are based on a High consequence classification for the Splitter dam:

- seismic design to withstand the 2,475-year design earthquake ground acceleration of 0.08 g;
- flood storage without discharge during operation based on the PMF resulting from a 30-day PMP plus 100-year snow accumulation melt; and
- freeboard of 1.0 m above maximum flood level during operation.

The following criteria are based on a Significant consequence classification for the seepage collection dams:

- seismic design to withstand the 2,475-year design earthquake ground acceleration of 0.08 g;
- minimum water depth of 6 m for floating a reclaim barge and achieving adequate water clarification;
- surge storage equivalent to 14 days of tailing dam seepage assuming failure of the reclaim pumping system;
- flood storage without discharge based on 200-year, 24-hour flood event;
- freeboard of 3 m above maximum flood level; and
- spillways designed to pass the 500-year, 24-hour flood event.

The tailing dams will be raised once per year during the summer months with completion by the end of October. The dam raise will be capable of storing the following:

- tailing deposition for 12 months;
- average increase in the reclaim pond volume;
- PMF flood volume based on the 30-day PMP combined with the 100-year snow accumulation 30-day melt. The PMF assumes that the diversions are inoperative during this extreme flood event; and
- freeboard at least 1 m above the peak PMF flood level.

Diversion channels will be constructed around the TMF and the Treaty OPC to divert non-contact surface runoff around the facilities. The design criteria for the diversion channels include:

- minimum flow of 2 m^3/second to Teigen Creek from the northeast buried pipeline to maintain the base flows;
- sized to divert the 200-year, 24-hour peak daily flood flow;
- minimum 5-m base width to permit snow cleaning with a Caterpillar D6 bulldozer or snow blower;
- specified diversion efficiency; and
- freeboard of 0.3 m above the design flow water level.

26.4.2.3.2 Construction

Details of dam construction, including material properties and construction specifications, are included in Appendix 4-AC (KCB 2012a).

A stable foundation is required under the tailing dams and seepage collection dams to reduce the risk of dam failure. Site preparation for the tailing dams and seepage collection dams will include the following measures:

- Vegetation will be removed, followed by scarification and re-compaction. The stripped soils will be stockpiled for dam reclamation.
- Soils suitable for reclamation purposes, located between the tailing dam and extending 500 m upstream of the tailing dam, will be stripped. The exposed ground surface will be inspected for evidence of highly pervious zones (talus or colluvial materials) that could cause increased seepage or piping of tailing into the foundation.

Foundation preparation is required to control seepage under the North, Splitter, and Southeast dams and to reduce the risk of potential soil liquefaction in loose alluvial soil under the Saddle dam. The following foundation treatment will be carried out:

- Excavation of a key trench at the North dam to tie the till core of the starter dam into the foundation till or bedrock. A soil-bentonite slurry trench cut-off wall will be constructed where weathered near surface soils or pervious bedrock strata are too deep to excavate a key trench.
- Excavation of a soil-bentonite slurry trench cut-off wall through pervious alluvial soils located below the centreline of the starter dam of the Splitter dam and Southeast dam. The cut-off wall will extend 3 m into low permeability basal till or into bedrock to a maximum depth of 25 m.

A slurry wall will not be required under the Saddle dam because the liner under-drain for artesian pressure relief below the CIL Lined Pond extends under the starter dam to the primary finger drains. The following foundation treatment will be carried out at the Saddle dam:

- Construction of a 35 m high and 100 m wide toe-berm for control of potential liquefaction.

Construction of the tailing dams will be carried out in stages to provide optimum storage of flotation tailing and CIL tailing residue and to allow progressive reclamation of the dam slopes.

Stability analyses were completed for the North Cell, Splitter, Saddle, and Southeast dams based on assumed soil parameters and using piezometric elevations that were based on seepage analyses. The results of the analyses for operation and closure conditions indicate that the feasibility dam designs meet or exceed the minimum required factor of safety for design stability. The calculated factor of safety for the Splitter dam is slightly less than the minimum criteria required for post-earthquake stability; however, this factor is considered adequate given

that the dam is only an internal structure and that the factor of safety will exceed the minimum criteria during later stages and closure. Construction of the tailing dams will include:

- Starter dams built with compacted random fill followed by cyclone sand shell construction.
- Vertical till core at each dam to restrict seepage. The width of the core is 20% of the dam height, with a minimum width of 20 m to allow for possible future dam raises. The core will be constructed of locally borrowed till with a minimum fines content of 25% and a maximum hydraulic conductivity of 1×10^{-7} m/second.
- A system of finger drains at the base of the cyclone sand dam shell to keep the water level depressed within the dam. All drains will be installed in trenches into the native ground to prevent erosion of the drains during initial placement of the cyclone sand and to provide pressure relief in the foundation soils.
- Construction of the cyclone sand shells of the dams by hydraulic sluicing of the sand into cells oriented parallel to the dam crest. The cells will be nominally 10 m to 50 m wide and 150 m to 300 m long.
- Compaction of the cyclone sand by the trafficking of dozers and the effects of downward drainage into the base of the constructed cell.

The North Cell, Saddle, and Southeast seepage collection dams will be built early in the construction phase to be used as sediment control facilities during the construction of the tailing starter dams and during the development of borrow areas upstream of the seepage collection ponds. The dams will be constructed of compacted till in a similar manner as for the tailing starter dams. Construction of the seepage collection dams will include:

- an inclined compacted till layer on the upstream face to restrict seepage;
- a slurry trench cut-off wall extended through alluvium and 3 m into basal till or bedrock depending on the thickness of overburden, and a bedrock grout curtain at the North and Southeast seepage collection dams;
- a slurry trench cut-off wall extended through alluvium and 3 m into basal till or bedrock at the Saddle seepage collection dam; and
- rip-rap placed on the upstream face to reduce surface erosion.

Perimeter diversions will be constructed before construction activity begins on the TMF dams. The commissioning of the perimeter diversions will reduce flows in the construction areas.

The control of surface water flow around the TMF is important to reduce the volume of water entering the tailing impoundment so that the water balance can be maintained during TMF operation. Surface ditches (channels), tunnels, and pipelines will be designed and constructed to divert water away from the TMF during the period of operation. The TMF water management plans include:

- Northeast diversion ditch and Northwest diversion ditch constructed around the North Cell with additional diversions around the Treaty OPC to divert non-contact runoff water into a tributary of Teigen Creek at the north end of the TMF.
- At start-up, the Northwest Diversion will be extended along the entire south side of the TMF valley to capture local flows from the south valley slope, diverting non-contact water into Teigen Creek. Once in operation, the South Cell area will be diverted by the addition of the Southeast diversion ditch, which routes non-contact flows to Treaty Creek around the east side of the South Cell.
- To maintain flows toward Teigen Creek, an additional diversion from the east catchment will be constructed. The diversion will consist of the East Catchment diversion tunnel with an inlet constructed at the East Catchment diversion dam. The diversion tunnel is located to avoid a potential landslide zone.
- Northeast buried pipeline to maintain base flows to the south tributary of Teigen Creek.
- Temporary diversions during development of the Saddle dam.

Landslides, debris flows, and frequent snow avalanches may occur in the East Catchment Valley and could affect dam stability, creek diversion structures, and mine personnel safety. Mitigation of slope hazards in the East Catchment Valley includes:

- locating tailing dam centrelines to avoid debris flow paths;
- developing tailing beaches to push the TMF pond to the west side of the tailing impoundment where there is less of a threat of snow avalanches or debris flows;
- locating diversion channels to avoid landslide and snow avalanche paths where possible;
- installing pipeline covered with drain rock in the base of diversion ditches that are subject to frequent snow avalanches or debris flows to maintain flow in the event of a blockage;
- constructing the East Catchment diversion tunnel to divert creek flow below a landslide and snow avalanche area to the south tributary of Teigen Creek. The tunnel inlets and dam are located in an area of lower risk;
- constructing a back-up tunnel inlet and dam farther up the valley;
- implementing snow avalanche control measures to reduce the size of potential avalanches, and installing avalanche and debris flow barriers where possible; and
- designing spillways with a narrow low flow channel cut along the spillway invert centreline to minimize the effects of ice blockage.

26.4.2.3.3 Operation

During operation, the elevation of annual North dam and Splitter dam crest raises will be set to accommodate 8.6 Mm³ operating pond volume and 12 months of future tailing storage, and to store the PMF of 29 Mm³ with at least 1 m of freeboard above peak flood level.

The elevation of annual Saddle dam crest raises will be set to provide 12 months of CIL tailing storage and to store 3 m of water cover above tailing and the PMF of 13 million m³ with at least 1 m freeboard above the peak flood level.

Based on the projected filling curve over the mine life for the South Cell, the elevation of annual dam crest raises will be set to provide 12 months of tailing storage and to allow storage of the PMF of 50 Mm³ with at least 1 m freeboard.

A tailing beach will be developed behind the North and Splitter dams by controlling tailing deposition to increase the safety against pond overtopping of the tailing dam and to reduce seepage through the tailing dam and underlying foundation. The tailing beach is predicted to be 380 m wide at the end of Year 1 and to increase to a width of 820 m at the end of the operating life.

Seepage and runoff water from each tailing dam will be collected at downstream seepage collection dams and pumped back to the TMF.

Collection sumps located upstream of the seepage dams will settle solids transported by runoff or produced by dam construction activities. These sediments will be slurried at the collection sumps and pumped back into the TMF.

Accumulated snow avalanche and debris-flow deposits will be removed regularly from TMF structures. The snow will be moved to temporary dumps where it will melt during the summer months.

26.4.2.3.4 Closure

Closure and reclamation activities for the TMF will be undertaken in stages. Some closure works will be carried out at the North Cell during ongoing operation of the South Cell. Reclamation activities at the South Cell and Centre Cell will commence at mine closure starting in Year 51.5.

Reclamation and initial closure activities at the North Cell will include:

- reclamation of the North dam and tailing beach; and
- discharge of surplus water by pumping it to North Treaty Creek. When the water quality in the North Cell meets applicable discharge standards (approximately Year 45), a rock cut closure spillway will be constructed from the North Cell to Teigen Creek, allowing discharge to Teigen Creek, and returning Teigen Creek drainage patterns closer to pre-mining configuration.

Reclamation and initial closure activities at the South Cell and Centre Cell will include the following:

- Initial discharge of surplus water from the reclaimed Centre Cell to the South Cell where it will be pumped to Treaty Creek.

- Breach of the Saddle and Splitter dams when the water quality in the South Cell and the Centre Cell reach acceptable standards; the combined water from the three cells will discharge to Teigen Creek via the Ultimate North dam closure spillway.
- Construction of the Treaty Creek closure spillway excavated into rock on the west abutment of the Southeast dam. The spillway will extend beyond the toe of the Southeast seepage collection dam to a stepped rock-cut channel discharging into North Treaty Creek. The Southeast seepage collection dam spillway is provided for redundancy in case of extreme flood events.
- Use of excavated rock from spillway construction for reclamation of the tailing surface and dam slopes.
- All surfaces of the tailing beaches will be vegetated and the tailing dam slopes will be armoured with a layer of graded rock fill to resist erosion and a layer of soil to promote vegetation growth. The dam crest will be capped by a layer of till and re-vegetated.
- Seepage water collected in the seepage collection ponds will be pumped back to the North and South Cell ponds.

26.4.2.3.5 Post-closure

The post-closure phase is 250 years, during which time the water quality within the TMF impoundment will be monitored. Once water quality in the TMF meets discharge requirements, the following activities will be carried out:

- Drainage patterns will be established close to the pre-mining configuration by re-directing the East Valley flows into the TMF. Operations will have the ability to route overflow to either Teigen or Treaty Creek through the Ultimate North dam closure spillway or the Treaty Creek closure spillway.
- The East Catchment diversion tunnel will be permanently closed with tunnel plugs installed at the inlet and outlets.
- All diversion channels, except for the local diversions around the seepage ponds, will be removed.

26.4.2.4 Monitoring

A monitoring program will be developed that will include requirements for inspection of dams and water control structures and procedures for instrumentation monitoring during the construction, operation, and closure phases. This information will be included in an OMS manual as required by Section 10.5.2 of the Health, Safety and Reclamation Code (BC MEMPR 2008). The OMS manual will include principles for the safe operation of the TMF and will include details for monitoring, training, and inspections associated with dam safety (Appendix 35-C; KCB 2012c).

The results of the monitoring program will be reviewed on a regular basis to measure the success of the management strategies, to compare the recorded data against design criteria, and to identify where design changes or additional mitigation may be necessary.

The tailing and seepage collection dams will be monitored during operation by piezometers to measure phreatic levels in the dam and foundation soils and settlement pins and to measure deformations of the structures. The monitoring instruments will be installed on representative sections of the dams. Table 26.4-1 summarizes the minimum number of instrumentation that may be required based on the current dam designs. The final locations of the sections and instruments will be determined after the detailed design has been completed and prior to permitting.

Table 26.4-1. Summary of Dam Instrumentation

Dam	Number of Instrumented Sections per Dam	Piezometers		Displacement Survey Pins	Slope Inclinometers
		Dam	Foundation		
Tailing Dams	3	12	9	-	6
Seepage Collection Dams	1	2	1	2	-

A program of visual and instrumentation monitoring for the tailing dams and seepage collection dams may include:

- inspection of the dam crests and slopes for signs of cracking, slumping, settlement, seepage or piping;
- inspection of dam spillways for potential blockages due to snow avalanche, landslide, or rock fall debris;
- inspection of pumps and piping systems;
- inspection of surface water diversion channels and structures to identify sections where repairs may be required;
- inspection of diversion channels to identify damage or blockages attributable to snow avalanche or snow accumulation and to identify excessive erosion during spring runoff;
- installation of piezometers to measure pore water pressures in the dams and dam foundations;
- installation of survey monuments to measure dam fill settlement and surface displacement;
- monitoring of pond water levels;
- monitoring of tailing beach widths;
- monitoring of seepage downstream of the dams;
- monitoring of flows in the diversion channels; and
- monitoring of geohazards, in particular snow accumulation and avalanche potential.

A schedule for routine inspection and instrumentation monitoring will be developed at the time of mine permitting based on the mine construction and operation schedule. Threshold values (warning levels) for each instrument and response criteria will be established and included in an OMS manual. A contingency measure for increasing dam stability could be to place additional

fill to flatten the downstream slopes of the dams. Contingency measures for reducing net seepage losses from the tailing facility, if required, could be strategic deposition of tailing on the inside of the impoundment to reduce the seepage losses.

Geotechnical instrumentation installed at the tailing and seepage collection dams will be monitored during construction and operation. The instrument readings will be recorded twice per month during normal operating conditions. In addition to the above instruments, seepage from the dams will be monitored by weirs installed downstream of the dams.

Pond levels will be recorded monthly and used, in conjunction with pond filling curves, to plan the tailing discharge and the operation of the seepage collection ponds.

Flows in the diversion ditches will be recorded on a regular basis and will be used in assessment of the TMF water balance.

Inspection of the diversion channels will be carried out monthly. Clearing snow and debris may be necessary at critical channel sections up to four times each year.

Additional inspections of the dams and water control structures will be undertaken following extreme rainfall events, significant runoff events, or significant earthquake events.

The TMF will remain in operation after the end of mining operations until such time as the quality of the water stored in the impoundment reaches an acceptable level for discharge and reclamation is completed. The dam and associated facilities will require ongoing monitoring and maintenance to ensure dam safety and to meet regulatory requirements for dam safety.

In the event of temporary mine closure, visual inspection and maintenance of the dams, diversion channels, collection ditches, and spillways will be required.

26.4.2.5 Reporting

A review and evaluation of the visual and instrumentation monitoring data will be carried out regularly to identify the need for contingency measures to reduce seepage and/or to increase dam stability. The monitoring results and corrective actions will be included in the site documentation management system and reported to senior management and regulatory agencies as required.

An annual dam safety inspection report, describing the operation, maintenance, and surveillance of the tailing dams and water management facilities, will be prepared and submitted to BC MEMNG as required by Section 10.5.3 of the Health, Safety and Reclamation Code (BC MEMPR 2008).

Comprehensive dam safety reviews will be carried out periodically based on the consequence of dam failure for each individual dam. The frequency of review and reporting will be in accordance with the CDA (2007) *Dam Safety Guidelines*. The frequency of review is every 5 years for dams classified as Extreme consequence, every 7 years for dams classified as High consequence, and every 10 years for dams classified as Significant consequence.

The mine manager is ultimately responsible for mine operations. The engineering department, reporting to the Superintendent of Health and Safety, will be responsible to maintain the TMF monitoring records and generate reports at the required frequency.

26.5 Water Storage Facility Management and Monitoring Plan

The WSF is designed to collect and temporarily store Mine Site contact water, to attenuate seasonal and storm flows, and to permit the use of pumps to regulate the flow of water to the Water Treatment Plant (WTP) prior to its release to the environment. Contact water represents surface and/or subsurface water that has been in contact with waste rock stored in the RSFs and with exposed bedrock in the open pits, underground, and general Mine Site. The water storage pond will have a minimum low pond volume of 1 Mm^3 for sediment control. During operation, the pond volume will be determined by water inflows and limitations on water treatment discharge rates, on a monthly basis.

The water storage pond will be retained by a 165 m high WSD constructed in the Lower Mitchell Creek Valley, approximately 1.2 km downstream of the confluence with McTagg Creek. Details of the WSD are shown in Figure 26.5-1.

The water stored in the WSF will be pumped over the WSD and then directed by gravity through pipelines to the WTP for treatment.

The WSD is designed to minimize seepage and to be resistant to low pH water (pH less than 5) stored in the WSF. The low pH water will comprise acid rock drainage from the RSFs and historically low pH levels attributable to naturally occurring acid rock drainage (ARD) from exposure of mineralized deposits in the Mitchell Creek Valley. The WSD also serves as a secondary sediment control structure.

The WSD will be a rock fill dam with a low permeability central asphalt core to resist acidic water and filter zones between the core and the rock fill shell. The WSD design includes an upstream dam slope of 2.25H:1V and a downstream dam slope of 1.75H:1V. Non-acid generating rock will be used to construct the downstream rock fill shell and sections of the upstream rock fill shell that will be in contact with the dam core and the drains beneath the dam. The bedrock foundation will be grouted to further reduce seepage.

Drainage galleries will be constructed in the downstream abutments of the WSD to intercept water that may bypass the seepage mitigation works.

Seepage from the WSD and seepage water that bypasses the drainage galleries will be collected in a seepage collection pond formed by the construction of the WSF seepage dam located downstream of the WSD. A pipeline will transport the collected seepage water to the WTP. As backup, a pump system and pipeline will be provided to return seepage water to the WSF. The WSF seepage dam is designed as a 25 m-high rock fill dam with 3H:1V upstream and downstream slopes and an impervious asphalt central core. The foundation and abutments of the WSF seepage dam will be grouted along the centreline to reduce seepage under the dam.

Requirements for the design, operation, and closure of water storage facilities on a mine site are legislated under the *Mines Act* (1996j) and *Water Act* (1996n). In accordance with a Memorandum of Understanding between the BC Ministry of Energy, Mines and Petroleum Resources (now BC MEMNG) and the Water Stewardship Division and Environmental

Protection Division of the BC Ministry of Environment (now the BC Ministry of Forests, Lands and Natural Resource Operations and BC Ministry of Environment respectively), the *Mines Act* (1996j) regulations apply to flooded impoundments that are required to store and regulate the flow of water contaminated by ARD. The *Water Act* (1996n) regulations apply if the flooded impoundment requires a water licence.

The requirements under the *Mines Act* (1996j) are covered by the Health, Safety and Reclamation Code (BC MEMPR 2008). The Health, Safety and Reclamation Code (BC MEMPR 2008) applies to "major impoundments" and "major dams." A major impoundment is defined as an impoundment that has a maximum depth of material greater than 10 m at any point, a storage facility that is retained by a dam or dike that exceeds a height of 15 m at any point, a storage facility that is designed to contain more than 1 million m^3 of material, or any other impoundment or water management facility so declared by the Chief Inspector. A major dam is defined as a dam that is used to store and control water, slurry, or solids, and that has a maximum height that exceeds 15 m at any point or that is between 10 and 15 m in height with either a crest length that exceeds 500 m, a flood discharge rate that exceeds 2,000 m^3/second, or a reservoir capacity that exceeds 1 million m^3, or alternatively any other dam so declared by the Chief Inspector (BC MEMPR 2008).

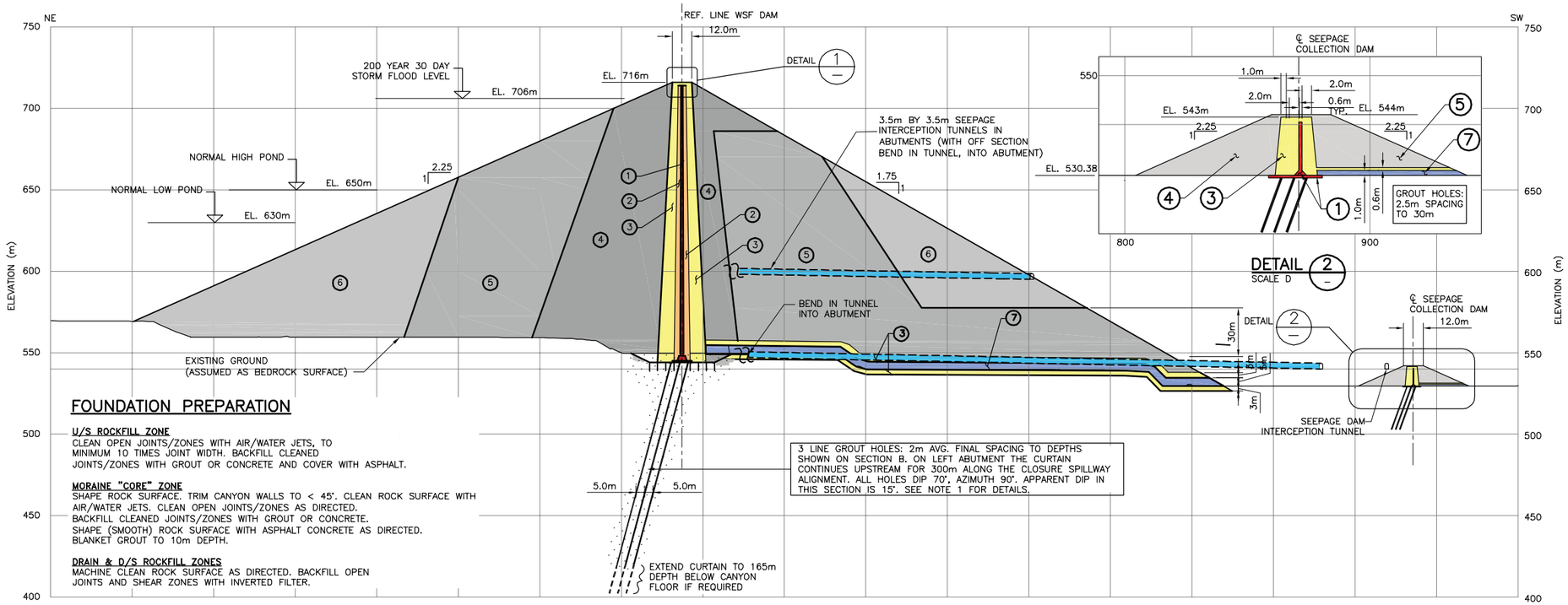
The WSD and associated WSF seepage dam proposed for the KSM Project fall into the category of major dams.

26.5.1 Legislation and Standards

BC's *Mines Act* (1996j) provides guidance and approvals for all activities on a mine site, from exploration to development, production, closure, and reclamation. It also requires project proponents to obtain a permit approving the work system and reclamation program. To obtain this permit, a detailed Mine Development Plan and Reclamation Program has to be submitted to the Chief Inspector of BC MEMNG for approval.

Under the *Mines Act* (1996a), the Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide:

- a mine plan showing the location of water management facilities;
- designs for major impoundments and dams developed in accordance with the criteria provided in the CDA *Dam Safety Guidelines* (2007);
- an OMS manual for major dams and impoundments prior to commissioning;
- design for dam slopes that meet long-term stability criteria in accordance with the CDA (2007) *Dam Safety Guidelines*;
- an Emergency Preparedness Plan for dams classified as High or Very High failure (or Extreme) consequence;
- an annual dam safety inspection report;
- installation of a flood control spillway at closure;
- a reclamation plan for impoundment structures; and
- a dam stability monitoring program.



ZONE	MATERIAL
1	ASPHALT CONCRETE CORE
2	TRANSITION ZONE A OF GRAVEL (0–60MM)
3	TRANSITION ZONE B OF CRUSHED ROCK (0–150MM)
4	WELL COMPACTED QUARRIED NON–REACTIVE ROCK (0–700MM)
5	WELL COMPACTED QUARRIED ROCK (0–700MM)
6	WELL COMPACTED NATURAL GRAVEL OR QUARRIED ROCK (0–1000MM)
7	DRAIN

FOUNDATION PREPARATION

U/S ROCKFILL ZONE
CLEAN OPEN JOINTS/ZONES WITH AIR/WATER JETS, TO MINIMUM 10 TIMES JOINT WIDTH. BACKFILL CLEANED JOINTS/ZONES WITH GROUT OR CONCRETE AND COVER WITH ASPHALT.

MORAINE "CORE" ZONE
SHAPE ROCK SURFACE. TRIM CANYON WALLS TO < 45°. CLEAN ROCK SURFACE WITH AIR/WATER JETS. CLEAN OPEN JOINTS/ZONES AS DIRECTED. BACKFILL CLEANED JOINTS/ZONES WITH GROUT OR CONCRETE. SHAPE (SMOOTH) ROCK SURFACE WITH ASPHALT CONCRETE AS DIRECTED. BLANKET GROUT TO 10m DEPTH.

DRAIN & D/S ROCKFILL ZONES
MACHINE CLEAN ROCK SURFACE AS DIRECTED. BACKFILL OPEN JOINTS AND SHEAR ZONES WITH INVERTED FILTER.

NOTES

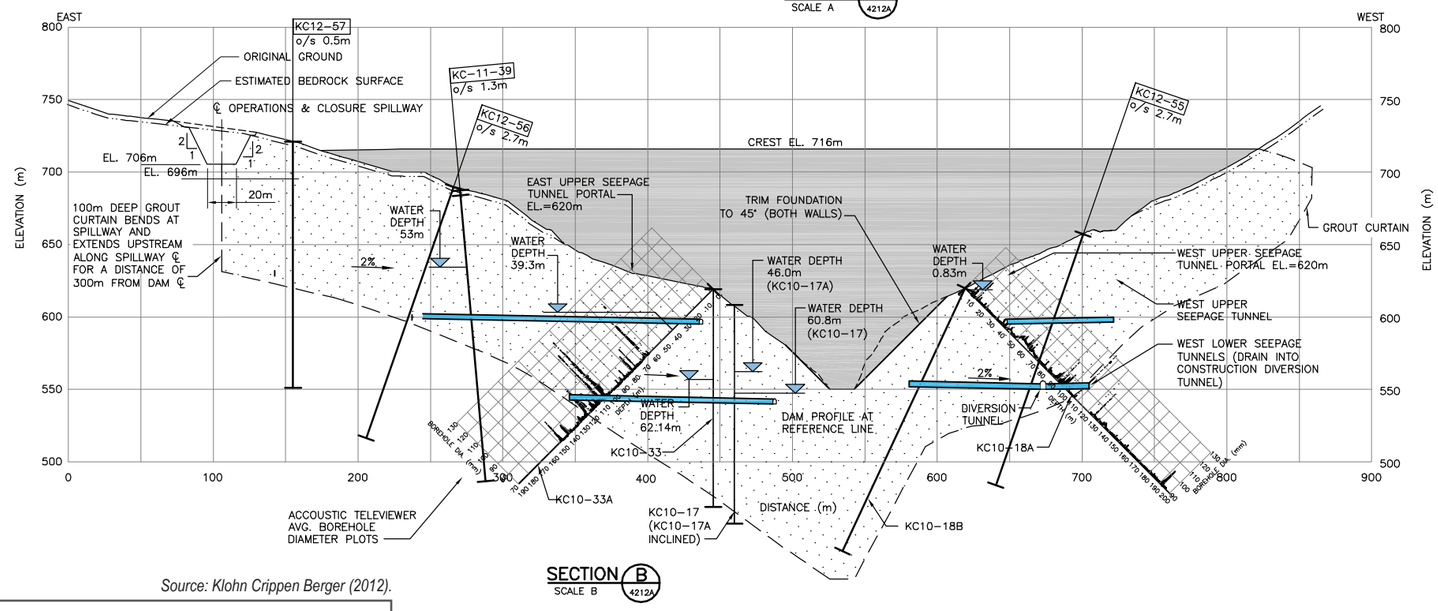
1. GROUT HOLES ON EACH ROW WILL BE DRILLED AND GROUTED USING SPLIT–SPACING TECHNIQUE. THE OUTER ROWS WILL BE GROUTED FIRST; THE CENTRE ROW LAST. PRIMARY HOLES WILL BE AT 8M SPACING. SPLIT–SPACING WITH SECONDARIES AND TERTIARIES WILL RESULT IN A FINAL HOLE SPACING ON EACH ROW OF 2 M. ADDITIONAL HOLES MAY BE REQUIRED LOCALLY IN HIGH TAKE AREAS.

GROUTING WILL BEGIN ON THE OUTER ROW PRIMARIES WITH HIGH MOBILITY GROUT (HMG). WHERE GROUT TAKES ARE HIGH, PROGRESSIVELY THICKER GROUTS WILL BE APPLIED UNTIL REFUSAL IS OBTAINED. THICKER GROUTS INCLUDE HIGHER VISCOSITY HMG'S AND SANDED HMG.

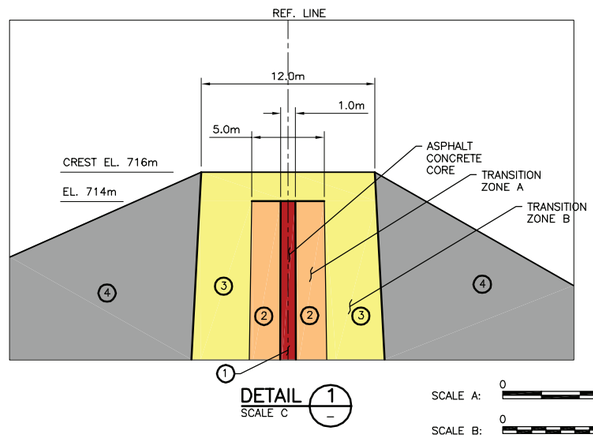
HMG MIX WILL COMPRISE:
- HIGH SULPHATE RESISTANT CEMENT
- BENTONITE (TO MINIMIZE BLEED)
- SILICA FUME (TO FILL SMALL VOIDS AND THUS REDUCE PERMEABILITY)
- SUPERPLASTICIZER (TO REDUCE WATER CONTENT, REDUCE BLEED AND INCREASE STRENGTH WHILE PROVIDING DESIRED VISCOSITY)
- WHELAN GUM (TO BIND EXCESS WATER AND REDUCE WASHOUT OF CEMENT AND FINES)
- CLEAN WATER

QUALITY CONTROL INCLUDES:
- GROUT QUALITY BY MARSH CONE VISCOSITY OR VISCOMETER AND API PRESSURE FILTER BLEED RESISTANCE, AND
- PERFORMANCE BY LUGEON WATER PRESSURE TESTS IN VERIFICATION DRILLHOLES ALONG THE CENTRE ROW. MAX. ALLOWABLE = 1 LUGEON (1 LUGEON ≈ 6 x 10 m/s)

SECTION A
SCALE A 4212A



SECTION B
SCALE B 4212A



DETAIL 1
SCALE C

NOT FOR CONSTRUCTION

SCALE A: 0 100m
SCALE B: 0 100m
SCALE C: 0 10m
SCALE D: 0 50m

Source: Klohn Crippen Berger (2012).

SEABRIDGE GOLD KSM PROJECT
Rescan Engineers & Scientists

Figure 26.5-1

Water Storage Facility Dam Sections

The Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide plans for the prediction, and if necessary, prevention, mitigation, and management of ML/ARD. Details for ML/ARD management and monitoring are included in the Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14).

The Health, Safety and Reclamation Code (BC MEMPR 2008) also requires proponents to provide plans for soil salvage and handling, erosion control, and soil contamination prevention. Details for soil management and monitoring are included in the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Section 26.13).

Plans for the control and diversion of water on the Mine Site, including the management of water around the WSF, are provided in the Water Management Plan (Section 26.17).

A set of detailed mine development and reclamation plans will be submitted at a later date as part of the Mine Plan and Reclamation Program Permit application. The following sections outline the general provisions included in these documents in terms of WSF operation and monitoring.

26.5.2 Dam Stability Plan

26.5.2.1 Objective

The objective of the Dam Stability Plan is to construct and operate the WSD to provide safe and stable storage for contact water, and to construct and operate the WSF seepage dam to provide safe and stable storage of seepage collected downstream of the WSD. The management and monitoring plan is intended to provide a basis for confirming design assumptions and for tracking performance during construction and after the mine closes.

26.5.2.2 Targets

Targets of the Dam Stability Plan include the following:

- prepare the foundations of dam sites;
- construct dams to meet short-term (during construction) and long-term stability criteria;
- control seepage water quality; and
- control surface and subsurface water flow.

26.5.2.3 Actions to Avoid, Control, and Mitigate

26.5.2.3.1 Design Criteria

The WSD and the WSF seepage dam have been classified based on the dam classification scheme presented in the CDA (2007) *Dam Safety Guidelines*. The classification scheme considers incremental losses associated with loss of life, environmental and cultural values, and infrastructure and economic values. The consequence classification of the WSD is Very High based on the CDA guidelines (2007); however, in view of the extended life of the facility, the consequence category has been upgraded to Extreme, which is the highest rating level. The WSF seepage dam is classified as Significant failure consequence.

Target minimum factors of safety (FOS) have been set for WSD stability for various conditions. A minimum FOS of 1.5 is required for static long-term steady-state conditions, a minimum FOS of 1.3 is required for static end of construction conditions, and a minimum FOS of 1.2 is required for rapid drawdown conditions using peak frictional strength parameters and estimated operating pore pressures in the dam materials and underlying foundation soils. For earthquake conditions, the target minimum FOS is 1.0 based on pseudo-static analysis, and 1.2 assuming post-earthquake strength parameters. The estimated dam settlement due to the design earthquake is less than 100 mm.

Stability requirements for the WSF seepage dam include a minimum FOS of 1.5 for static conditions and a minimum FOS of 1.0 for pseudo-static conditions.

The dam design criteria for flood and earthquake parameters are selected based on the dam classification. The following criteria are based on an Extreme consequence classification for the WSD:

- seismic design to withstand the maximum design earthquake of magnitude 7.0 with a ground acceleration of 0.14 g;
- containment without discharge of the 200-year return period precipitation with snow melt;
- spillway design to pass an inflow design flood equivalent to the PMF; and
- freeboard above the spillway invert elevation based on the PMF with 1.4 m for wave run-up or the wave height produced from a probable maximum snow avalanche entering the WSF (estimated as 8 m);

The dam design criteria for flood and earthquake parameters selected for the WSF seepage dam are based on a Significant consequence classification and include the following:

- seismic design based on a 1:1,000 return period earthquake;
- containment without discharge of the 200-year, 24-hour storm runoff event from the local catchment of the dam between the high operating level and the spillway; and
- spillway design based on the 500-year inflow design flood;

Surface water management is designed to divert non-contact water around the WSF, and contact water into the WSF prior to treatment. The design criteria include:

- non-contact water diversion structures design based on the 200-year peak flow.

26.5.2.3.2 Construction

Details of dam construction, including material properties and construction specifications, are included in Appendix 4-AC.

A stable foundation is required under the WSD and the WSF seepage dam to reduce the risk of dam failure. Site preparation for the WSD will include:

- organics and loose surficial soils will be removed down to dense overburden; and
- the overburden soils in the area of the asphalt core and adjacent transition zones will be excavated down to bedrock, and the upper part of the bedrock will be treated with blanket grouting.

Stability analyses were completed for the WSD based on assumed soil parameters and using piezometric elevations that were based on seepage analyses. The results of the analyses for operation and closure conditions indicate that the feasibility dam designs meet or exceed the minimum required factor of safety for design stability.

Prior to construction of the WSD, a 1.3 km-long WSF diversion tunnel will be built to divert flows in Mitchell Creek around the WSD during the construction period. The tunnel will be decommissioned and plugged when construction of the dam and spillway are complete.

The WSD will be constructed over a period of approximately two years. The main features associated with the WSD include:

- construction of a 20 m-high cofferdam at the upstream toe of the WSD comprising rock fill with a geomembrane liner;
- trimming of the abutment slopes in the vicinity of the dam core to a slope of 45º;
- construction of a concrete plinth along the centreline of the asphalt core and adjacent transition zones;
- completion of a grout curtain to a depth of 100 to 130 m to minimize seepage through the dam foundation;
- construction of a system of seepage interception tunnels constructed in the dam abutments between the grout curtain of the WSD and the grout curtain of the WSF seepage dam. Drain holes drilled upward and downward from the tunnels will draw down the phreatic surface, and the water collected in the tunnels will be directed to the WSF seepage collection pond. Four tunnels will be constructed immediately downstream of the WSD grout curtain and two tunnels will be constructed upstream of the WSF seepage dam grout curtain;
- construction of the dam including an asphalt core, transition zones, and rock fill shells;
- excavation of a rock-cut spillway on the left (east) abutment with discharge to Mitchell Creek downstream of the WSF seepage dam; and
- rock excavated from the spillway channel, including not potentially acid generating waste rock from Sulphurets Pit and material excavated during construction of the Lower Mitchell closure channel rock cut channel will be used for dam construction.

The main features associated with construction of the WSF seepage dam include:

- completion of a grout curtain extending 160 m laterally into the dam abutments to minimize seepage;

- construction of the dam, including an asphalt core, transition zones, and rock fill shells; and
- excavation of a rock-cut spillway on the left dam abutment (southeast side).

The control of surface water flow is required to minimize the amount of non-contact water reporting to the WSF to reduce water treatment requirements. Surface ditches (channels), tunnels, and pipelines will be designed and constructed to divert water away from the WSF during operation. The key elements of the WSF water management plan include:

- Construction of the McTagg Twinned Diversion Tunnel and the Mitchell Diversion Tunnels will be initiated concurrently with construction of the WSD to route the majority of runoff and glacial meltwater (i.e., non-contact water) away from the Lower Mitchell Creek Valley;
- Runoff from the steep west slope above the WSF area will be partially collected and diverted around the WSF in a buried pipeline; and
- Construction of a diversion channel around the east side of the WSF that will manage the 200-year, 24-hour average flow return period.

Tunnels, diversion channels, and pipelines will be constructed to divert contact water to the WSF and will include:

- Construction of the Mitchell Pit north wall dewatering adits on the north side of Mitchell Pit with an extension under the Mitchell Creek Valley to the WSF. In addition to functioning as a dewatering tunnel for the pit wall stability and accepting water pumped from the pit, the dewatering adits will be used to route water from the Mitchell diversion surface inlets directly to the WSF. In later years, the adits will also transfer contact water from the Iron Cap Underground Works.
- Construction of surface water channels that will divert contact water from areas upstream of the WSF.
- Installation of a pipeline and a lined collection ditch from the Sulphurets laydown area and runoff collected from the Sulphurets Pit and Sulphurets Pit Backfill.
- Construction of a dewatering pipeline that will run from Kerr Pit to the WTP.

26.5.2.3.3 Operation

Water levels in the WSF will fluctuate during the year. During normal operating conditions, the freeboard will be greater than 60 m. This level will reduce to 10 m based on the 200-year flood event when water levels are expected to reach the spillway inlet level for a short period in the fall.

Contact water from the Mitchell and McTagg RSFs and from mine development areas upstream of the WSF will be diverted to the WSF. Contact water diverted from Kerr Pit and drainage from Sulphurets Pit Backfill will be diverted to the WSF via the Selenium Treatment Plant.

The WSD has been located to avoid potential snow avalanche paths; however, avalanche paths are present on the west side of the water reservoir and in the area of Mitchell Creek downstream

of the WSF seepage dam. The avalanche hazard will be monitored, and avalanche control, using explosives or Gasex exploders, will be implemented as required to remove accumulations of snow from the slope.

26.5.2.3.4 Closure and Post-closure

The WSF and WTP will remain in operation after the end of mining operations; therefore, closure activities will be associated with control of surface water flows and storm flows in excess of the capacity of the diversion tunnels. Components of water control during the closure and post-closure phases will include the following:

- The closure channels for contact and non-contact water are designed to convey the 1,000-year peak flow without damage and the PMF with possible damage requiring repairs. The closure channels will have a central sub-channel sized for the 200-year return period 24-hour average flow. Non-contact water will be routed around the WSF, and contact water will be routed into the WSF.
- The rock cut channel and spillway that form the Lower Mitchell closure channel will be widened to 50 m to divert peak PMF flow around the WSF and down into Mitchell Creek via a rock cut spillway entering the WSF spillway chute.
- The calculation of the PMF includes storm flow in excess of the capacity of the Mitchell Diversion Tunnels and McTagg Twinned Diversion Tunnels and assuming failure of the diversion inlets/tunnels.
- All diversion channels built over mine rock fill will be lined with a bituminous liner to reduce infiltration and will have rip-rap protective cover sized for the PMF event.
- Ongoing maintenance of diversions, collection ditches, pipelines, and other water management structures will be required.
- The pipeline from Kerr Pit to the WTP will be maintained until water quality is adequate for direct discharge into Sulphurets Creek.

In the event of temporary mine closure, the following activities will be carried out:

- operation of the WSF and WTP, including the Selenium Treatment Plant if it is in operation at the time;
- maintenance of surface water diversion structures and pipelines;
- construction and maintenance of temporary water management structures as required to control surface water flow; and
- periodic removal of sediment accumulation in the WSF and diversion tunnel sediment traps.

26.5.2.4 Monitoring

A monitoring program will be included in the OMS manual as required by Section 10.5.2 of the Health, Safety and Reclamation Code (BC MEMPR 2008). The OMS manual will include principles for the safe operation of the WSF and will include requirements for monitoring, training, and inspections associated with dam safety.

The results of the monitoring program will be reviewed on a regular basis to measure the success of the management strategies, to compare the recorded data against design criteria, and to identify where design changes or remediation work may be necessary.

The WSD will be monitored during construction and operation by piezometers to measure pore water pressures in the dam and dam foundation and by survey monuments to measure dam fill settlement and surface displacement. The geotechnical monitoring instruments will be installed on seven sections of the dam.

A program of visual and instrumentation monitoring for the WSD and WSF seepage dam may include:

- inspection of the dam crests and slopes for signs of cracking, slumping, settlement, seepage, or piping;
- inspection of dam spillways for potential blockages;
- inspection of pumps and piping systems;
- inspection of surface water diversion channels and structures to identify sections where repairs may be required;
- inspection of diversion channels to identify damage or blockage due to snow avalanche or snow accumulation and to identify excessive erosion during spring runoff;
- routine tunnel inspections during low flow periods;
- installation of piezometers to measure pore water pressures in the dam and dam foundation;
- installation of survey monuments to measure dam fill settlement and surface displacement;
- installation of monitoring wells downstream of the WSF seepage dam to monitor groundwater quality;
- monitoring of flow into the WSF seepage collection pond;
- monitoring of flow and turbidity from the seepage collection tunnels;
- monitoring reservoir levels in the WSF to ensure low pond levels in advance of freshet each year;
- monitoring of the water level in the WSF for correlation with recorded seepages; and
- monitoring of geohazards, in particular snow accumulation and avalanche potential, as part of snow avalanche control.

A schedule for routine inspection and instrumentation monitoring will be developed at the time of mine permitting based on the mine construction and operation schedule. Threshold values (warning levels) for each instrument and response criteria will be established and included in the OMS manual.

Geotechnical instrumentation installed in the WSD will be monitored during construction and operation. During dam construction, the monitoring records will be reviewed on a daily basis to check the response of the dam and foundation to earthfill loading. The frequency of monitoring for the piezometers may be decreased to bi-monthly readings once the effects of initial construction have dissipated. Surface movement monuments will be surveyed twice per year during operation.

It is anticipated that the inspection of diversion channels will be carried out monthly. It may be necessary to clear snow and debris at critical channel sections several times each year.

Water quality monitoring of seepage through the dam embankments and foundation will be monitored monthly during operation. Water flows from the WSD seepage interception tunnels will also be monitored to identify the need for remedial grouting.

Monitoring of snow accumulation on steep slopes will be undertaken during the snow avalanche season.

Additional inspections of the dams and water control structures will be undertaken following extreme rainfall events, significant runoff events, or significant earthquake events.

The WSF and WTP will remain in operation after the end of mining operations. The dam and associated facilities will require ongoing monitoring and maintenance to ensure dam safety.

In the event of temporary mine closure, visual inspection and maintenance of the dams, diversion channels, collection ditches, spillways, and tunnels will be required.

26.5.2.5 Reporting

A review and evaluation of the visual and instrumentation monitoring data will be carried out regularly to identify the need for contingency measures to reduce seepage and/or to increase dam stability. The monitoring results and corrective actions will be recorded and reported to senior mine management and regulatory agencies as required.

An annual dam safety inspection report describing the operation, maintenance, and surveillance of the water management facilities will be prepared and submitted to BC MEMNG as required by Section 10.5.3 of the Health, Safety and Reclamation Code (BC MEMPR 2008).

Comprehensive dam safety reviews will be carried out periodically based on the consequences of dam failure. The frequency of review and reporting will be in accordance with the CDA guidelines (2007). The frequency of review is every 5 years for dams classified as Extreme consequence, every 7 years for dams classified as High consequence, and every 10 years for dams classified as Significant consequence. The first dam safety review will be carried out five years after completion of construction of the WSD.

The mine manager is ultimately responsible for mine operations. The engineering department, reporting to the Superintendent of Health and Safety, will be responsible for maintaining the TMF monitoring records and generating reports at the required frequency.

26.6 Domestic and Industrial Waste Management Plan

This plan discusses the management of domestic and industrial wastes at the KSM Project site.

26.6.1 Legislation and Standards

The minimum standards of acceptability of the Domestic and Industrial Waste Management Plan for the KSM Project are to comply with federal and provincial legislation such as:

- *Environmental Management Act* (2003) and its regulations;
- *Health Act* (1996f);
- *Forest and Range Practices Act* (2002c);
- *Fisheries Act* (1996c);
- *Water Act* (1996n);
- *Mines Act* (1996j);
- Health, Safety and Reclamation Code (BC MEMPR 2008);
- *Wildlife Act* (1996q);
- *Land Act* (1996h);
- *Environment and Land Use Act* (1996b);
- *Soil Conservation Act* (1996l);
- *Canada Transportation Act* (1996a);
- *Canadian Environmental Protection Act* (1999);
- *Hazardous Products Act* (1985d);
- Controlled Products Regulations (SOR/88-66); and
- *Transportation of Dangerous Goods Act* (1992b).

26.6.2 Objective

The primary purposes of the Domestic and Industrial Waste Management Plan (the Waste Management Plan) is to protect workers and the public, and to minimize any potential adverse effects to the environment, including fish and wildlife and their habitat, while ensuring compliance with regulatory requirements, permit and licence obligations, and the Proponent's Environmental Policy. The secondary purpose of the plan is to minimize the risk and cost associated with the recycling, storage, handling, disposal, and removal of waste from all aspects of the KSM Project. A material is considered a waste when it can no longer be used for its original purpose.

The Waste Management Plan documents the Proponent's approach to waste management and outlines strategies that will be used to process the various waste streams to ensure maximum environmental protection. The Waste Management Plan will be reviewed regularly and revised as required to ensure continued best practices and compliance.

In order for the Waste Management Plan and associated procedures to work to their full extent, everyone on the site must be made aware of the plan and their corresponding responsibilities. All KSM Project personnel, including contractors, need to be active participants.

26.6.3 Targets

The targets for the Waste Management Plan are to ensure that:

- all employees and contractors on site have at least overview training in Project waste management strategies, achieved through site orientation training;
- every work area has a designated waste collection or disposal area;
- every waste collection or disposal area has designated and secure areas or containers for disposal of specific waste types;
- appropriate spill kits are available wherever there is a potential for a spill; and
- site workers are trained in spill prevention and spill response.

26.6.4 Actions to Avoid, Control, and Mitigate

The Waste Management Plan focuses on the wise use of resources, which includes the four R's: reduce, reuse, recycle, and recover. Where possible, all of these methods will be exhausted before disposing of waste materials.

26.6.5 Waste Reduction

Reducing the amount of material that is consumed is the most effective way of reducing the amount of waste that is generated. Consumption will be assessed by evaluating all procedures, processes, and consumed materials for possible reductions in raw material usage, as well as possible reductions in generated waste volumes. Examples of waste reduction measures that may be used include:

- product review, selection, and substitution; recyclable/reusable and non-hazardous materials will be used instead of non-recyclable/non-reusable and hazardous materials;
- ordering chemicals or lube products in bulk/returnable containers;
- keeping a workable minimum inventory to prevent expiration of products and resulting generation of waste;
- decreasing the amount of solid waste by reducing the use of disposable items;
- training personnel on waste minimization and reuse; and
- decreasing the amount of packaging on supplies by requesting that the suppliers provide less packaging materials on over-packaged products.

26.6.6 Material Reuse

Materials brought to the Project site should be used to the maximum extent possible, and where applicable, reused on the site. Examples of reusable materials include:

- scrap metal, conveyor belts, and wood;
- chemical containers that can be returned to the supplier to be refilled; and
- waste oils, glycols, and solvents that can be reused for secondary jobs.

26.6.7 Recycling

A recycling program will be incorporated at the KSM Project for successful management of waste streams. The program will recycle as many products as possible on site (e.g., salvageable lumber and scrap metal, paper, cardboard, and salvageable parts from vehicles).

Other recyclable materials will be shipped off site to the nearest recycling facility. Products that will be shipped off site include:

- used oil filters (oil removed, crushed, and recycled separately);
- lead-acid and alkaline batteries;
- plastic petroleum pails;
- used/damaged auto parts;
- oil-based paints; and
- empty drums.

26.6.8 Recovery

Recovery is the final level of waste minimization and involves extracting usable material or energy as a by-product for other uses. Opportunities for recovery will be evaluated throughout the life of the Project.

26.6.9 Tracking and Enforcement

The management of domestic and industrial waste from the KSM Project will be accomplished through the implementation and monitoring of domestic and industrial waste management procedures. Monitoring and enforcement of these procedures is fundamental to ensuring that the Waste Management Plan is functioning to its full extent for the life of the Project.

An imperative step in achieving compliance with the procedures is to ensure that all employees, contractors, and sub-contractors are aware of the plan and procedures and how the procedures apply to them. For example, all persons at the Project will be made aware of the recycling program and of how to direct waste to the correct waste stream through an orientation and training program on domestic and industrial waste procedures. Permanent employees will receive regular retraining and updates when new procedures or changes are introduced.

Waste produced by Project activities and personnel will be separated at the point of generation. Each department will be accountable for its workers, including the Proponent employees, contractors, and sub-contractors, to ensure that the waste is handled correctly as per the waste management procedures. Tracking waste streams is essential to ensure that each department is performing its waste management procedures responsibility.

26.6.10 Tracking

Off-site and on-site disposal will be documented by tracking waste type, volume, method of disposal, and location. Tracking of the waste streams by each department will show where changes can be made to further improve the waste management system over the life of the Project. Tracking will also alert management to areas or departments that may require new procedures or particular attention. A summary of the tracking will be reported annually by each department to the Environmental Superintendent, along with an analysis of the effectiveness of the existing systems and any proposed improvements.

26.6.11 Audit Program

An audit program is required to alert management when enforcement is necessary to ensure compliance with the plan and procedures. The Mine Manager will appoint a small audit team. Responsibilities of the audit team may include the following:

- Inspect Project facilities (heavy mobile equipment shops; the mill maintenance shop; carpentry, paint, and sheet metal shops; tire shops; small vehicle maintenance shops; instrumentation shops; accommodation/recreation buildings; underground lunch rooms; hydroelectric facilities; the explosives plant; the process plant, etc.) for proper waste segregation, storage, and disposal. Waste streams and methods of disposal will be inspected and analyzed periodically to ensure compliance.
- Inspect the waste disposal areas to ensure proper waste segregation, storage, and disposal.
- Perform periodic reviews of the waste collection areas including procedures, training, equipment, records, and employee awareness.
- Review the inspection findings with area supervisors, operation personnel, transporters, and contractors to correct deficiencies, improve procedures, maintain awareness and communication, and recognize positive or negative performance.

26.6.12 Waste Types and Sources

The KSM Project will generate several forms of industrial and domestic waste throughout the life of the Project. This management plan discusses the solid waste, including hazardous waste, that may be generated, as well as their storage and final disposal methods.

26.6.13 Waste Types Generated during Construction

Waste produced during construction will be generated at the road, tunnels, mine, and Treaty OPC construction camps, and by the construction of the mine and adjacent facilities, access corridors, Treaty Process Plant, and TMF.

The long duration of the construction phase, combined with the wide range of phase activities such as tunnelling, TMF construction, and pre-stripping, means that waste will be similar between the construction and operation phases. The primary difference will be the addition of waste related to production in the Treaty Process Plant during operation.

The types of waste that will be generated during KSM Project operation are listed in Table 26.6-1.

Table 26.6-1. Typical Domestic and Industrial Waste Generated at the KSM Project

Type of Waste	Example of Waste	When Generated			
		C	O	CI	PC
Domestic Waste	Aluminum cans and glass	X	X	X	X
	Domestic garbage	X	X	X	X
	Paper materials	X	X	X	X
	Plastics	X	X	X	X
	Putrescible food waste	X	X	X	X
Industrial Waste	Aerosols	X	X		
	Batteries	X	X	X	X
	Building materials and bulk debris	X	X	X	
	Cement	X	X	X	
	Conveyor belts	?			
	Culvert pieces	X	X	X	
	Fluorescent light ballasts	X	X	X	X
	Glass	X	X	X	X
	Incinerator ash	X	X	X	X
	Insulation material scraps	X	X	X	
	Packaging	X	X	X	X
	Rebar	X	X	X	
	Scrap metal	X	X	X	
	Scrap wood	X	X	X	
	Steel balls	?			
	Tires	X	X	X	
	Transformers	X	X	X	
	Vehicles	X	X	X	
	Wiring	X	X	X	
Chemical and Hazardous Waste	Acids	X	X	X	X
	Biohazardous waste (first aid room waste)	X	X	X	
	Glycol	X	X	X	X
	Hydraulic oil	X	X	X	X
	Laboratory chemicals	X	X	X	X
	Oil filters	X	X	X	X
	Oily rags	X	X	X	X
	Sharps (razors, needles)	X	X	X	
	Solvents	X	X	X	X
	Used absorbent pads	X	X	X	X
	Used oil	X	X	X	X

C = construction, O = operation, CI = closure, PC = post-closure

Domestic and industrial waste produced during the operation phase will be controlled and monitored throughout the life of the KSM Project.

26.6.14 Waste Collection/Disposal Facilities

26.6.14.1 Construction

In order to meet the construction schedule of the access corridors, tunnels, the Treaty Process Plant, the TMF, WSF, WTP, and the Mine Site, 12 construction camps will be required as listed in Table 26.6-2. On completion of construction, the number of camps will be reduced to two operating camps, as shown in the same table.

Table 26.6-2. KSM Project Camps

Camp #	Camp Name	Camp Capacity (persons)
1	Granduc Staging Camp	80
2	Ted Morris Camp	50
3	Eskay Staging Camp	50
4	Mitchell North Camp	125
5	Treaty Plant Camp	700
6	Treaty Saddle Camp	120
7	Unuk North Camp	40
8	Unuk South Camp	40
9	Mitchell Initial Camp	140
10	Mitchell Secondary Camp	400
11	Treaty Marshalling Yard Camp (Relocated Camp 12)	60
12	Highway 37 Construction Camp	60
	Mitchell operating camp	350
	Treaty operating camp	250

Each construction camp will have its own waste disposal facilities with clearly marked containers or areas for each type of waste. For example, the inert non-reactive solid waste (tires, conveyor belts, rebar, wood, etc.) will be stockpiled for later disposal in one of the Project landfills or in a licensed off-site landfill. Hazardous waste (petroleum waste, batteries, etc.) will be stored in appropriate sealed containers within a bermed area for transfer off site.

26.6.14.2 Waste Disposal Methods/Facilities for the Construction Camps

All construction camps will have incinerators to handle putrescible kitchen waste and portable sewage treatment plants (rotating biological contactors or other similar units) to handle both black and grey water waste. Sewage plant effluent will be discharged to a tile field more than 100 m from the high water mark. Sludge will be removed as required for efficient operation of the plants and will be hauled for disposal in a licensed landfill. Solid inert waste and hazardous waste will be stored until it can be transferred to appropriate disposal facilities.

Clearly labelled sealable containers will be provided at each camp and staging area for the different types of materials (e.g., hazardous waste and recyclable waste). Electric fencing will be used to deter

bears from entering waste disposal facilities (i.e., incinerator; see Section 26.21 for additional discussion of measures to mitigate wildlife attractants). Sealed containers from the camps will be hauled for disposal at the next most accessible disposal point. Ideally, inert non-reactive solid waste materials that cannot be recycled, reused, or burned in an incinerator will be stored until they can be disposed in Project landfills once the landfills are established and road access is available. Where road access is available to public roads before the Project landfills are available, inert non-reactive waste from construction camps and staging areas may be hauled to licensed off-site landfills.

26.6.14.3 Operation

Central disposal facilities will be established at the Mitchell and Treaty OPCs where waste materials will be organized for coordinated disposal. These central disposal facilities will be created in the latter part of the construction phase and will be operational by the start of the operation phase. Waste materials from sites in the Unuk River drainage will be directed to the Mitchell OPC, and those from the Bell-Irving River drainage will be directed to the Treaty OPC.

The waste collection areas, landfills, and sewage effluent/sludge disposal systems will have waste containment and runoff control structures that will prevent the escape of untreated waste to the surface or ground water systems. Regular audits of these waste containment and runoff control structures will be conducted, and the records of these inspections will be kept for review upon the request of the site manager or an inspector. Regular inspection audits will be conducted on all the disposal systems as well to ensure that the waste is being handled correctly and filtered into the correct waste streams.

26.6.14.4 Waste Collection Areas

The waste collection areas will function as a storage area for waste until the waste is processed further or transferred off site to the appropriate approved recycling or disposal facilities or landfill. The waste collection areas will be properly designed to contain and prevent contamination of the environment. They will also be designed to adequately and safely store a sufficient quantity of waste over a prescribed time limit of one to three months. Where required, the waste collection areas will be covered and fenced to prevent attracting wildlife and to provide protection from weather. Additionally, hazardous waste disposal facilities will be adequately designed to contain spills.

The waste collection area will consist of three parts:

- **Recycle/reuse area:** This area will contain the items that can be recycled/reused on the site. Inert materials to be stored in this area include tires, scrap metals, and waste wood. These items will be placed in designated containers or areas within the recycle/reuse area of the waste collection area. This method will allow personnel to search the recycle/reuse area of the waste collection area for materials to reuse. Once these containers or areas become full, the contents will be either disposed of in a designated on-site facility or shipped off site for recycling at an approved facility.
- **Hazardous waste area:** The hazardous waste area will contain hazardous waste that is required to be shipped off-site. Hazardous waste, including used glycol, acids, solvents, laboratory chemical waste, oil that cannot be burned in incinerators, oily rags, absorbent pads, hydraulic fluid, and any other hazardous chemicals, will be stored in a bermed

containment area. Hazardous waste will not be permitted to accumulate to excessive volumes, but will be shipped off site to avoid crowding.

- **Removal area:** This area will contain waste that will be disposed of in an on-site facility. Waste will include domestic and industrial waste that is not hazardous or recyclable.

The waste in the waste collection area will be segregated and stored using accepted management practices including the following:

- Fire prevention systems that are adequately designed for the materials being stored will be used.
- Spill kits, protective equipment, and other necessary equipment to clean and mitigate spills will be used.
- Only containers in good condition will be used to store items.
- Containers and liner materials will be compatible with the waste being disposed.
- Containers and drums will be labelled to identify the waste content and initial date of storage.
- Sufficient storage space will be left between containers to allow for safe access and handling of containers.
- Incompatible waste will not be stored in the same containers and will be stored at a safe distance from each other.

26.6.14.5 Landfills

Two landfills will be established, one each in the Mitchell and Treaty OPCs. The landfills will be used to dispose of only solid inert, non-reactive waste such as used conveyor belts, empty dry latex paint cans, grinding balls, air filters, non-recyclable plastics, and incinerator ash. To deter wildlife attraction to the landfill, the landfill will be fenced and only solid inert waste that will not act as a wildlife attractant will be deposited there. The garbage will be periodically covered with not potentially acid generating waste rock or local till to prevent wind loss and to mitigate wildlife attraction.

Signs will be posted around the landfills to identify the disposal area, and the landfills will be audited regularly to ensure that they are only used for disposal of approved waste products. The audits will be recorded and evaluated for potential areas of improvement.

26.6.14.6 Incinerators

Incinerators will be used at all camps and at the Mitchell Truck Shop, whenever possible, for waste disposal. The Treaty operating camp will share an incinerator with the Treaty Process Plant and related facilities. The incinerators will be used to dispose of all waste that is a wildlife attractant, including food waste and food-related products. Food waste is a prime wildlife attractant and will therefore be incinerated in a timely manner, thus leaving no trace of attractants for wildlife. All kitchen, dining room, office, and accommodation waste will be incinerated to reduce the potential of attracting wildlife. All resultant incinerator ash will be placed in a landfill.

Incinerator areas will be fenced, further reducing wildlife interactions.

26.6.14.7 Sewage Plant Effluent/Sludge

The sewage waste disposal facilities will consist of rotating biological contactors or other similar units and tile fields appropriately sized for each camp or location. Sewage plants will be located at the Mitchell Truck Shop and near the primary crusher as well as at each camp. The effluent from the rotary bioreactors will be discharged to a tile field placed 100 m from the high water mark for further treatment. The sludge from the rotary bioreactors will be periodically pumped and disposed of in an appropriate manner depending on the final analysis of the sludge. During operation, the sludge may be deposited in the landfills or in the TMF.

26.6.14.8 Procedures for Managing Specific Waste

The waste collection areas provide a means to collect the waste streams and transfer them to their correct disposal areas. Specific areas will be designated for each type of waste and will be clearly labelled.

Table 26.6-3 shows the typical waste types to be expected at the KSM Project, their treatment strategies, and handling/disposal methods.

Table 26.6-3. Waste Treatment and Disposal Plan during Operation

Type of Waste	Treatment	Waste Disposal Area
Hazardous Waste		
Petroleum Waste Stream		
Used oil	reuse/off-site recycling	oil storage tank vehicle maintenance shops
Oily rags and absorbent pads	off-site disposal	waste collection areas
Oil and fuel filters	off-site recycling	waste collection areas
Hydraulic fluid	off-site recycling	waste collection areas
Chemical Waste Stream		
Glycol	off-site recycling	waste collection areas
Acids	off-site recycling	waste collection areas
Solvents	off-site recycling	waste collection areas
Waste batteries	off-site recycling	waste collection areas
Aerosol cans	disposal in approved facility	waste collection areas
Paints	reuse/off-site recycling	waste collection areas
Laboratory chemical waste	disposal in approved facility	waste collection areas
Process Plant reagents	return to supplier	Process Plant reagent storage area
Biological waste	incineration/disposal in approved facility	waste collection areas
Explosives materials and detonators	return to supplier	explosives magazines/ explosives plant

(continued)

Table 26.6-3. Waste Treatment and Disposal Plan during Operation (completed)

Type of Waste	Treatment	Waste Disposal Area
Non-hazardous Waste		
Inert Solid Waste		
Paper and corrugated cardboard	reuse/incineration/off-site recycling	incinerators/waste collection areas
Plastics	reuse/recycle/disposal	waste collection areas/landfills
Tires and conveyor belts	reuse/recycle/disposal waste	waste collection areas/tire recycling facilities/landfills
Vehicles	reuse/recycle	waste collection areas
Scrap metal	off-site recycling	waste collection areas
Waste lumber	recycling/disposal	waste collection areas/incinerators or landfills
Electrical equipment	reuse/disposal	waste collection areas
Solid Domestic Waste		
Food waste	incineration	incinerator
General camp waste	incineration	incinerator
Sewage		
Sewage	sewage treatment plant	all camps, Mitchell Truck Shop, Mitchell OPC Primary Crusher
Sewage sludge	disposal	landfills, TMF, or off-site licensed landfill

26.6.14.9 Hazardous Waste

Hazardous waste will be produced in all KSM Project phases. It includes materials such as waste oil, laboratory chemicals and solvents, lead-acid batteries, oil filters, and used oily rags and absorbent pads.

The Hazardous Waste Regulation (BC Reg. 63/88) under the *Environmental Management Act* (2003) defines "hazardous waste" as:

> *(a) dangerous goods if they*
>
> > *(i) are no longer used for their original purpose, and*
> >
> > *(ii) meet the criteria for Class 2, 3, 4, 5, 6, 8 or 9 of the federal dangerous goods regulations, including those that are recycled, treated, abandoned, stored or disposed of, intended for recycling, treatment or disposal or in storage or transit before recycling, treatment or disposal,*
>
> *(b) PCB wastes,*

(b.1) biomedical wastes,

(c) wastes containing dioxin,

(d) waste oil,

(e) waste asbestos,

(f) waste pest control product containers and wastes containing pest control products, including wastes produced in the production of treated wood products using pest control products,

(g) leachable toxic waste,

(h) waste containing tetrachloroethylene,

(h.1) wastes listed in Schedule 7,

(i) waste containing polycyclic aromatic hydrocarbon…

but does not include

(j) household refuse that is collected from residential premises,

(k) domestic sewage,

(l) dangerous goods that are defective, surplus or otherwise not usable for their intended purpose and that are in the process of being returned directly to a manufacturer or supplier

(m) asphalts and tars used in the manufacture of asphaltic concrete and roofing materials,

(p) waste wood products treated with wood preservatives or wood protection products registered under the Pest Control Products Act (Canada),

(q) household hazardous waste that

> *(i) is removed from a return collection facility in accordance with an authorization from the owner of the return collection facility, and*
>
> *(ii) is to be reused for its originally intended purpose,*

(r) wood ash, or pulp mill dregs and grit, that would be hazardous waste only because they are classified under the federal dangerous goods regulations as class 8, or

(s) waste that

> *(i) has a pH greater than or equal to 2.0 and less than or equal to 12.5, and*
>
> *(ii) would be a hazardous waste only because it is classified under the federal dangerous goods regulations as class 8 because of pH.*

Hazardous waste requires special handling and training procedures. All employees, contractors, and sub-contractors who are handling hazardous waste for the KSM Project will be provided with Workplace Hazardous Materials Information System training or will be required under contract to have that training, so they can identify hazardous waste and know how to handle it appropriately. Transportation of Dangerous Goods training will be provided, or required of employees, contractors, and sub-contractors who are receiving, off-loading, and storing potentially hazardous materials, or involved in the storage and shipment off-site of hazardous waste.

Hazardous waste will be transferred to an approved hazardous waste facility that will issue a certificate of destruction. Periodic audits of this facility to ensure proper handling and destruction of hazardous waste will be considered.

All hazardous materials and dangerous goods will be stored in clearly labelled containers or vessels and handled in accordance with regulations appropriate to their hazard characteristics.

26.6.14.9.1 Petroleum Waste Stream

Petroleum products will be used widely at the KSM Project. The waste generated from the petroleum products will be used oil, diesel fuel, lubricants, gasoline, jet B, oily rags and absorbent pads, and solvents. These products have to be handled with caution because they can potentially adversely affect the environment. The handling, storage, and spill contingency for petroleum products are outlined in the Spill Prevention and Emergency Response Plan.

To properly manage the petroleum waste stream and make the individual waste streams easier to reuse, recycle or recover, the waste will be segregated into the following classes:

- **Used Oil**

  Oil will be used for every vehicle, piece of equipment, and generator on the Project site. Used oil will be generated from regular maintenance to these sources. The used oil will be collected and stored in used oil storage tanks located in the vehicle maintenance shops with secondary containment areas. Used oil generated during the construction phase will be collected in barrels in secondary containment areas at camps or staging areas.

  The used oil will be reused where possible, such as for fuelling incinerators, or will be shipped off site to a licensed disposal facility for recycling.

- **Oil and Fuel Filters**

  Used oil filters and fuel filters will be crushed and stored in marked barrels. The barrels will be inventoried and stored in the bermed hazardous waste section of the waste collection areas until they are shipped off site to a licensed disposal facility for recycling. During the construction phase they will be stored adjacent to the used oil containers.

  Oily rags and absorbent pads will also be shipped off site to a licensed disposal facility, or if permitted, will be incinerated.

- **Hydraulic Fluid**

  Hydraulic fluid that is not reused will be stored in marked drums in secondary containment in the vehicle maintenance shops or within the bermed hazardous waste section of the waste collection areas, until it is shipped off site to a licensed disposal facility for recycling.

- **Petroleum-contaminated Soil and Rock**

  The amount of petroleum-contaminated soil and rock will be minimized by procedures outlined in the Spill Prevention and Emergency Response Plan (Section 26.10). These procedures include precautionary measures such as lining of storage facilities and using secondary containment for fuel storage areas, regular inspection and maintenance of equipment, strategically placed spill kits and absorbent matting. Even with precautions, soil and rock contamination can still occur.

  Petroleum contaminated soil will be removed to the waste collection area for off-site treatment and disposal. Alternatively, one or more land farm sites will be developed for on-site biological treatment of the contaminated soil using proven technologies.

26.6.14.9.2 Chemicals

- **Glycol**

  Glycol (antifreeze) is used in vehicles and various types of equipment. It is a toxic substance that has a negative effect on the environment and can be a wildlife attractant if spilled because of its sweet smell and taste. Used glycol will be stored in labelled containers, which will be inventoried and stored in secondary containment areas of the vehicle maintenance areas or in the bermed hazardous waste section of the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

- **Acids**

  Old lead acid batteries from vehicles will be labelled, inventoried, and stored in the bermed hazardous waste section of the waste collection areas, until they are shipped off site to a licensed disposal facility for recycling.

- **Solvents**

  Solvents are used as degreasing agents for vehicle and equipment parts. Non-toxic citrus based alternatives, detergents, and jet-streams will be used as much as possible in lieu of petroleum-based solvents. Where petroleum-based solvents are required, they will be recycled to the greatest extent possible until they no longer have their desired cleaning properties before being considered waste. Waste solvents will be stored in labelled containers, which will be inventoried and stored in the bermed hazardous waste section of the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

- **Waste batteries**

  Rechargeable batteries will be used to the extent possible to minimize the amount of waste produced. Containers will be placed in buildings around the KSM Project site to collect the old batteries. Spent batteries will be stored in the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

- **Aerosol cans**

  Pump bottles will be used as much as possible in place of aerosol cans to reduce the amount of waste produced. Aerosol cans that are misdirected into the incinerator waste stream can pose a safety concern; therefore, separate waste containers for aerosol can collection will be placed around the camps and other facilities, and cleaning staff will be alerted to separate aerosol cans that make it into the waste stream. Empty aerosol cans will be disposed of in the landfill.

- **Paints**

  When the paint cans are completely emptied and dried they will be disposed of in the landfill. Residual paint from latex-based paints will be dried before disposal in the landfill. Residual paint from oil-based paints will be collected for off-site recycling. The cans from oil-based paints will be properly sealed and stored in a crate in the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

26.6.14.9.3 Laboratory Chemical Waste

The laboratory personnel will determine which laboratory chemical waste cannot be safely incinerated or disposed of in the landfill. This waste will be stored in appropriate containers and placed in the waste collection areas until they are shipped off site to a licensed disposal facility.

26.6.14.9.4 Biological Waste

The first aid areas will generate small amounts of hazardous waste in the form of needles, syringes, scalpel blades, and blood- and tissue-contaminated materials. This waste will be properly contained in biohazard containers in the first aid area under the supervision of the first aid staff. The blood- and tissue-contaminated materials will be incinerated and the other biohazardous waste will be shipped off site to an approved disposal facility.

26.6.14.10 Non-hazardous Waste

Non-hazardous waste will be produced in all phases of the KSM Project. They include materials such as domestic garbage, food waste, paper materials, aluminum cans, glass, plastics, inert bulk waste, etc.

26.6.14.10.1 Inert Solid Waste

- **Paper**

  Paper waste consists of office paper, newspaper, general packaging, and food packaging. Paper waste will be reduced in a number of ways, such as minimizing the use of paper,

recycling the paper waste, and reusing it. Minimizing the use of paper will be achieved by using voice message devices, telephone or verbal messaging, emails, and printing and photocopying on both sides of the paper. Recycling will be achieved by placing paper recycling boxes in all the buildings where paper will be used (offices, accommodation buildings, kitchens, etc.). The recycle boxes will be emptied into a crate in the waste collection areas to be shipped off site to a paper recycling facility. Reusing paper waste will be achieved by such approaches as using shredded paper as packaging material and reusing paper from the recycling bins for notepads. Paper packaging from food products will be burned in the incinerator.

- **Corrugated cardboard**

  Corrugated cardboard waste will be generated mainly from packaging of materials. Cardboard will be collected along with the paper for recycling and will be stored in a crate in a dry location in the waste collection areas to be shipped off site to a paper recycling facility.

- **Plastics**

  Plastic waste will be generated mainly from food packaging, cleaning products, and lubricants. To reduce the amount of waste produced, the maximum practical package size will be purchased for products, and disposable plastic dishes will not be used. Some of the plastics, such as pails and barrels, will be reused. Clean materials of appropriate plastic types will be collected at waste collection areas for off-site recycling.

  Plastics that contained food products will be incinerated to prevent attracting animals. Plastics that contained non-hazardous materials will be sent to the landfill for disposal. Plastics that contained hazardous materials will be fully drained and stored in the waste collection areas before being shipped off site to an approved disposal facility.

- **Tires and conveyor belts**

  Tires will be re-treaded and repaired as many times as feasible. When they are no longer safe to use, they will be reused for different purposes such as for storing material in the parts laydown area, or as impact barriers in the open pits and at road intersections. The tires that are not reused in some part of the Project will be inventoried and stored in the waste collection areas for transport to a tire recycling facility.

  Conveyor belts have a finite life. When they can no longer be used, the belts, along with other large rubber items from the mine operation, will be assessed for other uses such as floor pads and protective material in loading docks, etc. Rubber that cannot be reused will be sent to the landfill.

- **Vehicles**

  Regular maintenance will prolong the life of vehicles and equipment. When they are no longer usable for the Project, they will be driven or shipped off site to be reused or

recycled. The unusable vehicles and equipment will be stored in a laydown area until they are shipped off site.

- **Air filters**

  Air filters will be collected in bins in the truck shops and disposed of in the landfills.

- **Scrap metal**

  Scrap metal will be generated during the construction and maintenance processes and from equipment (siding, piping, equipment parts, etc.) and will contain ferrous and nonferrous types. Scrap metal will be minimized by prompt maintenance of equipment, and will be reused wherever possible for on-site needs and projects. The scrap metal will be segregated and placed in designated laydown areas and bins for reuse or salvage. The unused scraps will be shipped off-site to a licensed disposal facility for recycling.

- **Waste lumber**

  Waste lumber will be generated during construction and throughout the Project life from building by-products. Waste lumber will be reused as much as possible on the Project site. Waste lumber not immediately reused will be placed in designated bins in the waste collection areas for incineration.

- **Electrical equipment**

  Waste electrical equipment will consist of generators, transformers, and distribution lines that have reached the end of their service. When they are no longer functional or re-buildable; usable parts will be extracted for reuse and the rest of the parts will be shipped off site to a licensed disposal facility for recycling.

26.6.14.10.2 Solid Domestic Waste

Domestic waste will include putrescible food waste, recyclable containers (cans and bottles), packaging, inert non-combustible domestic waste, and paper products.

- **Food waste**

  Putrescible food waste and packaging from food materials will be incinerated in a timely manner to minimize the attraction of wildlife. The ash from the incinerator will be disposed of in a landfill.

- **General camp waste**

  General camp waste will consist of waste from accommodations, offices, and recreation areas. Personnel will be informed of the items that are recyclable and need to be placed in the recycling containers. The remainder of the materials will be incinerated.

26.6.14.10.3 Sewage Sludge

The domestic sewage generated from the camps and offices will be treated in rotary bioreactors or similar packaged sewage treatment facilities. The effluent will be discharged to a tile field, placed at least 100 m from the high water mark, for further treatment. The biosolids from the

sewage treatment plants will be periodically pumped and disposed of in an appropriate manner depending on the final analysis of the sludge. Options for disposal include the landfills and the TMF, as well as shipment off site to a licensed facility.

26.6.14.10.4 Transporting Waste

Reputable certified transportation contractors will be used for the transport of goods and materials to and from the site. KSM Project personnel will periodically inspect the transporters' performance and compliance with BC and federal transport regulations, contract requirements, and overall performance.

26.6.14.11 Closure and Decommissioning

Activities during the closure phase will be similar to the activities during the construction phase. A range of materials will become available for salvage, recycling, or disposal with the dismantling and removal of buildings, surface structures, fuel tanks, etc. The Reclamation and Closure Plan will cover the closure, reclamation, and decommissioning of the KSM Project in detail.

26.6.14.12 Waste Management during Closure

Significant amounts of waste will be generated from the dismantling of buildings and process-related materials. The approach for waste management during closure will be to identify feasible salvage and recycling options.

Upon closure, the buildings, facilities, and process equipment will be dismantled and either disposed of at the site landfill (inert non-reactive materials only) or removed from the site for recycling and/or disposal. Any equipment or materials with market value will be removed for capital recovery.

26.6.14.13 Decommissioning of the Waste Management Facilities

Some of the waste management facilities at both the Mitchell and Treaty OPCs, such as the waste collection areas, incinerators, and the sewage plants, will be retained to support facilities remaining on the Project site for ongoing site maintenance and inspection purposes. The Mitchell-Treaty Twinned Tunnels (MTT), WTP, Mitchell Diversion Tunnels, McTagg Twinned Diversion Tunnels, hydroelectric facilities, and related accommodation and maintenance facilities will be retained. Other facilities will be dismantled and/or removed from the site. All scrap metal will be disposed of in a manner acceptable to an inspector. The remaining area after removal of structures will be reclaimed; for example, concrete foundations will be covered and re-vegetated.

The landfill will be covered with waste rock and reclaimed to ensure long-term stability and erosion control. All reclamation details and processes are described in detail in the Reclamation and Closure Plan.

26.6.15 Monitoring

Monitoring of waste management procedures is discussed in Section 26.6.9, Tracking and Enforcement. Waste will be tracked by each department, and key sites with potential for leaks or spills will be inspected on a regular basis defined by the level of the risk.

26.6.16 Reporting

Inspection reports will be delivered to the managers responsible for the inspected sites with copies to the Environmental Superintendent.

26.6.17 Responsible Person

Each department head will be accountable for his or her workers, including the Proponent employees, contractors, and sub-contractors, to ensure that waste is handled correctly as per the waste management procedures.

Overall, responsibility for the management of domestic and industrial waste will belong to the Environmental Superintendent.

26.7 Dangerous Goods and Hazardous Materials Management Plan

This document details the management of dangerous goods and hazardous materials used at the KSM Project, except for explosives, which are specifically addressed in the Explosives Manufacture, Storage, Handling and Use Management Plan. This plan will be refined prior to construction and operation in order to consider final Project design and input from contractors and on-site Project staff. The plan will apply to the Project site and will define contractual arrangements relating to the transportation of dangerous goods and hazardous materials to and from the Project site.

26.7.1 Legislation and Standards

The minimum standards of acceptability of the Dangerous Goods and Hazardous Materials Management Plan for the KSM Project are to comply with federal and provincial legislation such as:

- *Environmental Management Act* (2003) and its regulations;
- *Health Act* (1996f);
- *Fisheries Act* (1985c);
- *Water Act* (1996n);
- *Mines Act* (1996j);
- Health, Safety and Reclamation Code (BC MEMPR 2008);
- *Environment and Land Use Act* (1996b);
- *Canada Transportation Act* (1996a);
- *Canadian Environmental Protection Act* (1999);
- *Hazardous Products Act* (1985d);
- Controlled Products Regulations (SOR/88-66); and
- *Transportation of Dangerous Goods Act* (1992b).

26.7.2 Objectives

The objectives of the Dangerous Goods and Hazardous Materials Management Plan are to:

- protect the health and safety of employees and the public; and
- prevent the release of deleterious substances that may harm intrinsic ecosystem functioning, including components of the biophysical environment such as water quality, air quality, and vegetation communities, as well as the fish and wildlife that depend on them.

26.7.3 Targets

The Dangerous Goods and Hazardous Materials Management Plan targets are to:

- have in place a Workplace Hazardous Materials Information System (WHMIS) that meets the intent of the *Hazardous Products Act* (1985d) and the Controlled Products Regulations (SOR/88-66) prior to commencement of construction, and that will continue for the life of the Project with adjustments as required to reflect changing types and levels of activities and knowledge gained with experience; and
- maintain an effective inspection procedure that confirms the effectiveness of the equipment intended to transport and store the products and that ensures compliance with established systems throughout the life of the Project.

26.7.4 Actions to Avoid, Control, and Mitigate

Identification of Dangerous Goods and Hazardous Materials

Dangerous goods and hazardous materials will be required on the Project site at every Project phase, from construction to post-closure. Material Safety Data Sheets (MSDSs) will be required for each of these products prior to their delivery to the Mine Site. These products will be imported to the Project site and used throughout the Project facilities, including the Process Plant, the Mitchell Truck Shop, the camps, and the WTP. Most of the products will be consumed on site, but some (e.g., hydraulic fluid and batteries) will require disposal after use. This management plan addresses the contractual arrangements for transportation of these products to and from the Project site, and their proper and safe storage, use, and disposal on site. The Waste Management Plan (Section 26.6) will address the disposal of the products. Table 26.7-1 lists typical dangerous goods and hazardous materials that may be found on the Project site.

26.7.4.1 Transport of Goods and Materials

As part of the transporter's contract and spill response plan the following will be required:

- MSDSs will accompany all goods and materials.
- Non-compatible materials will be transported in a separate shipment.
- Fire extinguisher and fire prevention materials will be adequate and appropriate for the material being transported.
- Containers will be appropriate for the material being shipped.

Table 26.7-1. Typical Dangerous Goods and Hazardous Materials on Site by Project Phase

Product	Phase			
	Construction	Operation	Closure	Post-closure
Diesel fuel	Used throughout; stored at camps and staging areas in 205-L barrels, double-wall tanks, or fabric bladders with secondary containment	Used throughout; stored at Mitchell and Treaty OPCs, explosives plant, and Camp 10: Mitchell Secondary Camp, and underground maintenance shops in either double-wall tanks or with secondary containment	Used throughout; stored at Mitchell and Treaty OPCs, and Camp 10: Mitchell Secondary Camp in either double-wall tanks or with secondary containment	Used throughout; stored at Mitchell and Treaty OPCs in either double-wall tanks or with secondary containment
Gasoline	Used throughout; stored at camps and staging areas in 205-L barrels with secondary containment	Used throughout; stored at Mitchell and Treaty OPCs, Mitchell Truck Shop, and underground maintenance shops in either double-wall tanks or with secondary containment	Used throughout; stored at Mitchell and Treaty OPCs, and the Mitchell Truck Shop in either double-wall tanks or with secondary containment	Limited use, small quantities stored at Mitchell and Treaty OPCs in either double-wall tanks or with secondary containment
Lubricating oil	Used throughout; stored at camps and staging areas in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in bulk tanks with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in bulk tanks with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment
Lubricants and greases	Used throughout; stored at camps and staging areas in tubes, pails, and drums with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in bulk tanks with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in bulk tanks with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment
Ethylene glycol	Used throughout; stored at camps and staging areas in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment
Hydraulic fluid	Used throughout; stored at camps and staging areas in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops and the Mitchell Truck Shop in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment
Batteries	Used throughout; stored at camps and maintenance facilities on pallets	Used throughout; stored at maintenance shops and the Mitchell Truck Shop	Used throughout; stored at maintenance shops and the Mitchell Truck Shop	Used throughout; stored at maintenance shops
Solvents	Used and stored at the maintenance facilities; stored in 205-L barrels with secondary containment	Used and stored at maintenance shops and the Mitchell Truck Shop; stored in 205-L barrels with secondary containment	Used and stored at maintenance shops and the Mitchell Truck Shop; stored in 205-L barrels with secondary containment	Used and stored at maintenance shops; stored in 205-L barrels with secondary containment

(continued)

Table 26.7-1. Typical Dangerous Goods and Hazardous Materials on Site by Project Phase (completed)

Product	Phase			
	Construction	**Operation**	**Closure**	**Post-closure**
Lime	Used at Temporary Water Treatment (TWT) facilities and WTP; stored in large bulk bags at each TWT facility and otherwise in bulk	Used at WTP; stored in bulk	Used at WTP; stored in bulk	Used at WTP; stored in bulk
Flocculent	Used at TWT facilities, WTP; stored in 25-kg bags at each TWT facility and in bulk	Used at WTP and Process Plant; stored in bulk	Used at WTP; stored in bulk	Used at WTP; stored in bulk
Surfactant	Not required	Used at Process Plant; stored in bulk	Not required	Not required
Propane	Used at camps and other temporary and permanent facilities for space heating; stored in portable and permanent tanks/cylinders	Used at camps and other facilities for space heating; stored in portable and permanent tanks/cylinders	Used at camps and other facilities for space heating; stored in portable and permanent tanks/cylinders	Used at camps and other facilities for space heating; stored in portable and permanent tanks/cylinders
Domestic products	Stored and used primarily at camps and kitchens for cleaning	Used primarily at camps and kitchens for cleaning	Used primarily at camps and kitchens for cleaning	Used primarily at camps and kitchens for cleaning
Laboratory chemicals	Preservatives for environmental samples; stored in 1- to 5-L containers	Preservatives for environmental samples, reagents for laboratory analyses; stored in 1- to 5-L containers	Preservatives for environmental samples; stored in 1- to 5-L containers	Preservatives for environmental samples; stored in 1- to 5-L containers
Process Plant reagents	Not required	Will include lime, potassium amyl xanthate (PAX), sodium diethyl and sodium di-secondary butyl dithiophosphate (A208), sodium di-isobutyl dithiophosphinate (3418A), cyanide, Na_2S, Na_2SiO_3, NaOH, $CuSO_4$, metabisulphite (MBS), HCl, H_2SO_4, and antiscalant. Dry reagents will be stored in bulk bags up to 1-tonne size, liquids in tanks	Not required	Not required
H_2SO_4	Used primarily in the TWT facilities; stored in framed 1-m^3 totes at each TWT facility	Process Plant reagent	Not required	Not required
Water treatment sludge (treatment by-product)	Stored temporarily in an engineered cell or covered structure near the Mitchell WTP	Transported to the Process Plant via the ore conveyor for disposal in the Tailing Management Facility	Stored in secure landfills on top of the RSFs	Stored in secure landfills on top of the RSFs

- Containers will be properly secured.
- Containers and trucks will be properly marked, labelled, and placarded.
- Manifests will be maintained in accordance with federal and provincial regulations.
- Spill response materials will be adequate and appropriate for the materials being transported.
- Drivers will be adequately trained and equipped for spill first response, containment, and communication.

Actions to Avoid, Control, and Mitigate

An inventory of dangerous goods and hazardous materials is a key element of the management plan. The inventory will list all chemicals on site, and will include MSDS and WHMIS information on the products to ensure that Project personnel have all the necessary information for their safe transportation, use, and disposal. Before any chemical is brought to the site, the supplier or contractor will supply an MSDS for the product.

Minimizing the risk of safety infractions and/or environmental damage from accidental releases of hazardous materials includes the following practices:

- knowing which hazardous materials are on site through the maintenance of an inventory system;
- allocating clear responsibility for managing hazardous materials;
- understanding the actual or potential hazards and environmental impacts associated with the storage and handling of these materials;
- minimizing the use and/or generation of hazardous materials;
- constructing storage facilities that safely contain the materials in all foreseeable circumstances;
- implementing physical controls and procedures to ensure that no materials escape during routine operation as well as in upset conditions;
- having emergency response plans in place to ensure immediate action to minimize the environmental effects should accidental or unplanned releases occur;
- monitoring all discharges and reporting unplanned discharges if they occur; and
- keeping records to avoid reoccurring safety and environmental problems.

Materials will be stored in appropriate containers within suitably contained areas. All the process reagents will be prepared in a separate reagent preparation and storage facility in a containment area. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during operation. Appropriate ventilation and fire and safety protection will be provided.

The following actions will be implemented to avoid, control, and mitigate risk:

- manufacturers provide safe packaging and labelling for packaged materials, as a condition of purchase agreements;
- storage areas are appropriately climate-controlled, dry, and well-ventilated;
- containers holding the materials remain sealed to prevent accidental leakage and/or spillage;
- incompatible chemicals are stored separately in order to prevent deleterious chemical reactions and cross contamination;
- chemical storage areas are designated as non-smoking areas and are located away from food storage areas;
- all personnel handling dangerous goods are trained and provided with appropriate personal protective equipment; and
- all bulk chemical storage sites are outfitted with concrete or lined floors and walls capable of containing 110% of the volume of the largest vessel in the area or as stipulated by appropriate legislation or permits.

The Spill Prevention and Emergency Response Plan provides additional information on response plans in the event of any spills of hazardous materials. A Mine Site-wide communication system (including the access road corridors) will ensure rapid notification of any observed spills. In addition to all staff having basic spill response training appropriate to their positions, the site will have a trained Emergency Response Team with resources to contain and recover spills so as to reduce the size of any spill and thus reduce any potential adverse environmental effect if a spill occurs. Storage areas and transfer stations will have spill kits appropriate for the products being handled. On-site equipment will include a comprehensive spill recovery kit (containing items such as absorbent pads and booms, skimmers, and dike materials) that will be ready to be loaded on a truck for rapid deployment to any spill scene. This kit will be easily transferable to enable delivery by helicopter if required.

Nuclear Equipment Handling and Disposal Plan

Radioactive sources are used in the mining and mineral processing industry for tasks such as process monitoring (e.g., density gauges), exploration (e.g., down-hole logging), monitoring (e.g., neutron moisture gauges), geo-technical assessment (e.g., Troxler soil compaction meters), and research (e.g., for tracer studies).

All aspects of the purchase, handling, use, storage, and disposal of nuclear equipment are regulated in Canada under the *Nuclear Safety and Control Act* (1997) and its regulations. The Proponent and its contractors will comply with all applicable regulations, including requirements for licensing.

The presence of radioactive materials at industrial facilities requires proper management, including management of the potential human health hazard (both occupational and public), because radioactive contamination may not be detected in conventional occupational, environmental, or process stream monitoring.

Periodic checks of radioactive sources will be undertaken to ensure that there has been no significant loss of integrity of the source container that could result in leakage or contamination. All radioactive materials will be appropriately labelled, and the labels will always be visible.

Radioactive sources no longer being used will be stored in appropriate containers in secure storage buildings on site.

Whenever possible, purchase agreements will be established with suppliers to take back the units being taken out of service, or other disposal agreements will be arranged.

Petroleum Products Plan

The materials with the highest risk potential for a spill or accidental release are petroleum products, due to their frequency of use. The quantities of mill reagents and shop materials are significantly smaller, and with the exception of several alkaline products (such as lime), their individual hazard ratings are also lower.

During operation and closure, diesel fuel will arrive at the unloading facility at the Treaty OPC site by tanker truck in B-train configurations, averaging three deliveries per day. From there, some will be pumped through one of the MTT in a pipeline to the Mitchell OPC fuel storage tanks.

The diesel fuel pipeline will be located within the Mitchell-Treaty Conveyor Tunnel. It will be equipped with leak detection systems and automatic shut-off valves. Safety provisions will be consistent with regulations governing petroleum product pipelines, which will use conventional, proven technologies.

Fuel handing, transportation, and storage facilities and activities will be consistent with the Health, Safety and Reclamation Code (BC MEMPR 2008) and the Ministry of Water, Land and Air Protection's (BC MWLAP's; 2002) publication, *A Field Guide to Fuel Handling, Transportation and Storage*. All fuel storage vessels will include secondary containment, and all transfer stations will have concrete spill pads complete with oil/water separators during operation. Tanks and sumps will have high-level alarms. All transfers from tanker trucks to tanks at the Treaty OPC will be done using enclosed lines, hoses, and pumps. All storage and transfer locations will also be equipped with appropriate spill kits. An inspection schedule will be developed for each fuel storage site, taking into account the volume of fuel stored at each site and the respective risks related to that storage. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded and filed with the Mine Manager.

Fuel transfer procedures will include management practices to ensure no overtopping of tanks or spillage. All spills or accidents will be reported immediately. Employees and contractors responsible for transporting or storing hydrocarbons or fueling vehicles will receive training in proper operating procedures and emergency response. Most mobile equipment, including mine haul trucks, will be fuelled from the tanks located at the Mitchell OPC or at Camp 10: Mitchell Secondary Camp. Mobile equipment, such as tracked dozers, will be serviced by a fleet of fuel/lube trucks. These vehicles will be equipped with spill kits.

Hydrocarbon spills will be collected, and contaminated soils and overburden materials will be hauled to an on-site land farm for bioremediation.

Oils, lubricants degreasers, solvents, and other petroleum-based products will be delivered to the site in drums by truck (the drums will often be palletized). These will be unloaded using a fork lift and then stored in a secure area. The lubricants will be dispensed using hose reels and barrel pumps in the Mitchell Truck Shop service bays and maintenance shop areas.

Reagents

The reagents used in the Process Plant will include:

- flotation – PAX, 3418A, A208, fuel oil, methyl isobutyl carbinol (MIBC), lime (CaO), sodium sulphide (Na_2S), and sodium silicate (Na_2SiO_3);
- CIL and gold recovery – lime, sodium cyanide (NaCN), activated carbon, sodium hydroxide (NaOH), hydrochloric acid (HCl);
- cyanide recovery and destruction reagents – metabisulphite (MBS), copper sulphate ($CuSO_4$), sulphuric acid (H_2SO_4), lime, and sodium hydroxide (NaOH); and
- others — flocculent and antiscalant.

All the reagents will be prepared in a separate reagent preparation and storage facility with containment. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during operation. Reagents will be clearly labelled, and MSDSs will be readily available. An inventory will be maintained showing deliveries and consumption. All relevant staff will be trained regarding risks related to each reagent and the measures required for the safe handling, use, storage, and disposal of the reagents, including emergency and spill cleanup procedures. Appropriate ventilation and fire and safety protection, including personal protection equipment, will be provided at the facility.

The liquid reagents (including fuel oil, A208, 3418A, MIBC, HCl, H_2SO_4, and antiscalant) will be added in their undiluted form to various process circuits via individual metering pumps.

Dry reagents will be packaged in large bulk bags that may weigh in the order of 1 t. They will be trucked to the site in conventional transport trucks, and unloaded at the Process Plant into the reagent storage and makeup area. The bags will then be emptied into mix tanks for subsequent pumping and distribution to the appropriate area in the Process Plant. All the solid type reagents (including PAX, Na_2S, Na_2SiO_3 [if required], NaOH, NaCN, $CuSO_4$, and MBS) will be mixed with freshwater to solution strength in the respective mixing tank and then stored in separate holding tanks before being added to various addition points by metering pumps.

Cyanide transportation, storage, and use will be consistent with the International Cyanide Management Code. The 31 International Cyanide Management Code principles and standards of practices include requiring that cyanide transporters implement appropriate emergency response plans and capabilities, employ adequate measures for cyanide management, and implement measures to protect fish and wildlife from direct and indirect discharges of cyanide process solutions to surface water (ICMI n.d.).

Lime will be received by tanker truck and unloaded pneumatically. Lime requires handling and safety precautions due to its serious health hazard because of its caustic nature, risk of burns, and potential to cause irreversible injuries to the eyes. Lime is not generally regulated as a hazardous chemical during transport. Small spills may be cleaned up dry and returned to the process stream. Larger spills may require neutralization with a weak acid. During operation, there will be two lime preparation systems: one at the Mitchell WTP and the other at the Treaty Process Plant. Lime will be slaked, diluted into a solid milk of lime, and then distributed to various addition points through a closed pressure loop.

Flocculent will be dissolved, diluted to less than 0.5% strength, and then added to various thickener feed wells by metering pumps.

During construction, lime and flocculent will be received on flatbed trucks in large bulk bags or 25-kg palletized bags. They will be transported to each temporary water treatment (TWT) facility by helicopter, and small quantities will be stored at each location to optimize transportation logistics.

The same precautions will apply during transportation and preparation of the milk of lime and flocculent at the TWT facilities. Lime will be slaked, diluted into milk of lime, and then transferred into a day tank before being dosed into the water stream at its associated TWT facility.

Flocculent will also be prepared at each TWT facility during the construction phase. Dry flocculent bags will be emptied into a hopper above a metering screw conveyor, which will dose the flocculent depending on the flow to be treated. The dry flocculent will be wetted and diluted before mixing with the water stream to be treated, downstream of the lime addition.

Actions to Avoid, Control, and Mitigate during Construction

Management of dangerous goods and hazardous materials will require strict management during the construction phase because construction activities will be dispersed and conducted by numerous third-party contractors. Contracts will include defined processes for the management of these products, including:

- maintenance of an accurate and detailed inventory of the hazardous materials and dangerous goods, to be shared on an on-going basis with the Proponent or the prime contractor;
- provision by the supplier or contractor of an MSDS before any chemical is brought on site (for full-scale use or for a first plant trial). MSDSs will be kept in an easily accessible location at every site where related dangerous goods or hazardous materials are stored, and a copy will also be retained in a central file at the primary on-site construction office and first aid building for reference in an emergency. The MSDS provides information primarily aimed at worker health and safety, with some secondary information related to environmental impacts and remedial action in the event of spillage typically provided; and
- commitment to train employees regarding transportation, storage, and use of dangerous goods and hazardous materials.

The biggest risk during the construction phase will be leakage of hydrocarbons, due to the frequency of use and number of sites that will be distributed across multiple road construction headings, staging areas, tunnel development sites, and camps. In addition, replenishing supplies at these sites over pioneering roads and by helicopter will require careful management.

Prior to the start of construction, the prime contractor will provide clear written policies for construction phase hydrocarbon transportation, storage, and use. This policy will highlight the need for proper containers for each application; secondary containment for all liquid hydrocarbons; clear procedures for safe transfer between containers and from containers to equipment; constraints on refueling in sensitive areas, such as riparian areas; the use of drip pans for stationary equipment; and the requirement for spill containment and response plans and equipment. Regular inspections of facilities and activities by designated staff will reinforce compliance with the policy. Inspections will be recorded and reported to the Proponent and the prime contractor. All relevant staff will receive training on the policy before being permitted to transport, store, or use hydrocarbons.

During the latter stages of construction, the prime contractor will develop policies and procedures for the commencement of operation, since the transition to operation will be gradual in many areas.

Operation

During operation, the Project operator will apply the refined policy developed during construction.

The Dangerous Goods and Hazardous Materials Management Plan will continue to be anchored by an inventory of all dangerous goods and hazardous materials on the Project site, along with appropriate WHMIS and MSDS information. MSDSs will be kept in an easily accessible location at every site where the relevant dangerous goods and hazardous materials are stored, at the Environment Department, and in the Shipping Office. All facilities and activities will be inspected regularly, with reports being directed to the Mine Manager. New employees will be trained, and existing employees will receive refresher training. Written procedures will be revised as better approaches are identified and tested.

Closure

Risks due to dangerous goods and hazardous materials transportation, storage, and use will decline during the closure phase, other than for disposal of surplus materials. Disposal of surplus materials will be guided by the Domestic and Industrial Waste Management Plan (Section 26.6). Surplus materials will be collected, packaged, labelled, and shipped to appropriate off-site disposal facilities. MSDS information and input from suppliers will be referenced to guide the disposal process. MSDSs will be kept in an easily accessible location at every site where the relevant dangerous goods and hazardous materials are stored, at the Environment Department, and in the Shipping Office. Disposal activities will be inspected by a designated person, and inspection reports will be directed to the Mine Manager.

Post-closure

The requirement for dangerous goods and hazardous materials at the Project site will be reduced during post-closure. The principal product of concern will be lime, which will continue to be

required at the WTP. Flocculent will be required for operation of the WTP. The sludge resulting from the WTP will be trucked for disposal in secure landfills on top of the RSFs.

Diesel fuel will continue to be required by maintenance equipment, and continued operation of camps and maintenance facilities will require small volumes of cleaners, solvents, and assorted hydrocarbons. Procedures established during operation will be modified to appropriately address the management of products for the lower level of activity during post-closure. Monitoring and inspection will continue on a regular schedule.

26.7.4.2 Monitoring

Storage facilities for dangerous goods and hazardous materials will be inspected regularly for leaks or non-compliance with policies, plans, and procedures. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded and filed with the Mine Manager.

26.7.5 Responsible Person

The Mine Manager will have ultimate responsibility for the management of dangerous goods and hazardous materials.

26.8 Explosives Management Plan

26.8.1 Legislation and Standards

Natural Resources Canada (NRCan) is responsible for regulating the manufacture, storage, importation, sale, and some aspects of the transportation of explosives under Section 7(1)(a) of the *Explosives Act* (1985b), which states that the Minister of NRCan must issue a licence for the manufacture (factory) and/or storage (magazine) of explosives.

The following information must be provided to meet NRCan requirements:

- the type and volume of explosives to be used;
- how the explosives will be transported, stored, and used;
- safety measures to be used to reduce the frequency of misfires and other potential incidents involving explosives; and
- explosives monitoring and safety/accident reporting programs.

There are a number of other regulatory considerations relevant to the design, construction, and ultimate operation of an explosives facility and use of explosives on the site. These include:

- the *Explosives Act* (1985b);
- the Ammonium Nitrate Storage Facilities Regulations (CRC, c 1145);
- the Transportation of Dangerous Goods Regulations (SOR/2001-286);
- NRCan's (2010) *Guidelines for Bulk Explosives Facilities*; and

- local and federal regulations.

As per the requirements of the *Explosives Act* (1985b), an in-pit explosives handling plan will be completed by the explosives contractor. The completed plan will include the following elements:

- an estimate of quantities of various materials to be generated;
- consideration of over-break and other reasons for likely adjustments to quantities of materials to be produced;
- consideration of background information concerning ground control and water ingress problems;
- segregation of ore and of potentially acid generating, not potentially acid generating, and acid generating rock materials;
- plans for blending waste materials for possible storage on the surface if they cannot be relocated to the underground mine for long-term impoundment;
- plans for backfilling mine workings; and
- the final location of all mined materials.

The Health, Safety and Reclamation Code (BC MEMPR 2008) also regulates the transportation, use, care, and handling of explosives. An Explosives Storage and Use Permit from BC MEMNG is required before a magazine is located, erected, built, put into service, or modified, or before carrying out any maintenance work including the installation of lighting or heating.

The KSM Project explosives facilities and all employees and contractors handling, transporting, and using explosives, will comply with all regulatory requirements throughout the construction, operation, and closure phases of the Project.

26.8.2 Objectives

The objectives of the Explosives Management Plan are to:

- guide safe and secure transportation, on-site manufacturing, storage, and use of explosives required for the Project; and
- minimize adverse environmental effects of the transportation, on-site manufacturing, storage, and use of said explosives.

26.8.3 Targets

The targets for the Explosives Management Plan are:

- no unintended property damage or injury to persons; and
- no significant environmental effect related to the transportation, on-site manufacturing, storage, and use of explosives.

26.8.4 Actions to Avoid, Control, and Mitigate

Design Criteria

To ensure worker and public safety, design criteria for all manufacturing and storage facilities for explosives at the KSM Project site will conform with the requirements of the *Explosives Act* (1985b), Ammonium Nitrate Storage Facilities Regulations (CRC, c 1145), Transportation of Dangerous Goods Regulations (SOR/2001-286), *Guidelines for Bulk Explosives Facilities* (NRCan 2010), and the Health, Safety and Reclamation Code (BC MEMPR 2008).

Safety Considerations

The Proponent will be responsible for the safe management of explosives on the KSM Project site. This will include the tasks contracted out to a third party. The Spill Prevention and Emergency Response Plan (Section 26.8) will be developed further as part of permitting, and it will include details on procedures for dealing with incidents involving explosives.

Construction

During the construction phase, the use of explosives will be required as part of bedrock excavation associated with the road alignment, borrow source development, and WSF dam and tunnel construction. Required explosives will likely include ammonium nitrate and fuel oil (ANFO) mixtures and packaged stick explosives (dynamite), as well as ignition systems such as detonating cord, boosters, detonators, and connectors. Explosives will be stored in licensed magazines located in accordance with the *Explosives Act* (1985b) and with criteria established by the NRCan Explosives Regulatory Division.

For the road alignment and borrow sources, explosives containers known as “day boxes” will be used in the field in support of bedrock excavation. The day boxes will be stored during non-working hours in secure areas accessible by authorized staff only. Required explosives quantities will be brought into the field each day from these central locations and will be kept in secure areas throughout the workday. Development of the MTT and of the Mitchell and McTagg diversion tunnels will require the stationing of an explosives magazine near each of the development headings.

Each magazine will:

- be in the charge of authorized person(s) who will carry out a weekly inspection of the magazine;
- be locked at all times, except when explosives are being moved, and only authorized person(s) will be in possession of the key;
- have an up-to-date inventory of contents in a special logbook, kept in the magazine, where all entries will be signed by the authorized person in charge;
- be kept clean, dry, and free from grit at all times;
- be kept free of broken explosives packages or spilled explosives and, when necessary, the shelves and floors will be treated with a suitable neutralizing agent to remove all traces of explosive substances;

- have their contents arranged in a tidy and organized manner, including any explosives returned from a workplace;
- not contain any exposed iron or steel except in fixtures; and
- have stock rotated to ensure that the oldest stock for each type and size of explosive will be used first.

Explosives and detonators will not be stored or transported together. Smoking will be prohibited while handling, transporting, or using explosives. Only persons with a valid or provisional blasting certificate will be permitted to conduct blasting operations.

During the early part of the construction phase, explosives will be transported to the Project site using trucking contractors qualified and licensed to transport explosives. This transportation will be consistent with the Transportation of Dangerous Goods Regulations (SOR/2001-286).

Due to the large volumes of explosives required and the remote location of the Mine Site, most of the required explosives will eventually be manufactured at the Mine Site. Current plans are for the initiation of on-site manufacturing in Year 4.

To ensure worker safety, the Explosives Manufacturing Facility and related storage facilities will be located, relative to other Project infrastructure and to each other, with setbacks consistent with the *Explosives Act* (1985b) and its regulations. The manufacturing site selected in the Ted Morris Valley was chosen, in consultation with potential explosives suppliers and plant operators, to ensure the safety of other facilities in the event of a mishap, for its ease of use and access under extreme weather conditions, and for its remoteness from the influence of potential geohazard risks.

Construction and operation of the Explosives Manufacturing Facility will be contracted to a third party, and will be enclosed within a fenced compound for both security and to exclude wildlife that may be harmed by interaction with the facility. The fence will enclose a number of buildings, including a fully contained manufacturing plant, storage tanks and silos, and plant services buildings. There will be a nearby storage area where sufficient prilled ammonium nitrate (AN Prill) to operate for about 10 days in the event that external delivery is suspended will be stored in 1 t tote bags inside locked steel shipping containers. The stored AN Prill will be used in rotation every six months to avoid decay. Another site will be designated for explosives magazine storage. The Explosives Manufacturing Facility will meet NRCan's (2010) *Guidelines for Bulk Explosives Facilities: Minimum Requirements*, as well as local, provincial, and federal regulations. A sump in the building will collect any water for eventual emulsion/oil/water separation and disposal.

The final configuration of the structures on the compound site is under detailed design as part of the permitting process. The general layout of the sites will be designed to allow for ample turning space for B-trains and bulk transport trucks for the raw AN Prill used in the manufacture of the bulk emulsion explosives.

Diesel fuel will be used in the manufacture of the emulsion-based explosive. It will be stored in a diesel fuel storage tank, located at least 25 m away from the Explosives Manufacturing Facility and will likely be re-supplied by tanker truck from the Mitchell OPC fuel storage area.

A surfactant is required in the process to manufacture ANFO explosive. The material, selected by the explosives contractor, will be trucked to the site in B-train tankers and will be pneumatically unloaded into storage tanks located inside the Explosives Manufacturing Facility.

Sodium nitrate and ethylene glycol are required for the emulsion production process and will be stored in a separate building in the fenced compound.

The manufacturing process will also require some 10,000 L/day of clean water, which will be sourced locally from wells or surface runoff.

The truck storage/wash bay facility in the compound will have a sump and evaporation system for collecting wash water and wastes. The resulting residue will either be recycled into the manufacturing process or disposed of on site.

Operation

Explosives will be required during the operation phase to break rock for both open pit and underground mining activities. In addition, there will be ongoing additions to the diversion tunnel network over time and changes to access roads as pits expand.

The Explosives Manufacturing Facility will continue to supply most of the required explosives throughout the operation phase of the Project. Exceptions will be some specialized explosives and the initiation system materials such as blasting cord and detonators. These items will be purchased elsewhere and transported to the site by qualified transport companies consistent with applicable regulations. Any such explosives materials that are not used will be returned to the suppliers for disposal.

During operation, there will be four other explosives storage magazines located on the Mine Site. These will also be operated by the contractor. At least one 2.4 m by 3.7 m (8′ by 12′) magazine for boosters and occasional case powder, and one 1.8 m by 2.4 m (6′ by 8′) magazine for detonators will be required. The magazines will conform to standards set by NRCan. This includes each magazine being bullet-proof, fire resistant, theft-resistant, weather proof, and well-ventilated. The magazines will be located a safe distance away from both the Explosives Manufacturing Facility and any main mine structures or roads.

Studies commissioned to determine optimum rock breakage indicate that a 70/30 emulsion/ANFO blend will likely be used for wet holes, and a 35/65 blend will likely be used for dry holes. It is assumed that 50% of the material to be blasted will be wet.

The explosives will be delivered to the borehole via mobile mixing units (MMUs). These will be bulk explosives loading trucks provided by the explosives supplier. Because of the high snowfall and extreme weather conditions that will be experienced on site, these trucks will be equipped

with Global Positioning System (GPS) guidance and will be able to receive loading instructions for each hole from the engineering office. The capacity of the MMU will be about 14 t.

A smaller "goat" MMU will also be needed for development areas with small access roads and narrow bench working conditions. These goat trucks are similar to a logging skidder and are so named because of their high manoeuvrability. The goat truck MMU will be used at the start of each incremental phase in the Mitchell Pit and the first few benches of the Kerr and Sulphurets pits.

Occasionally, during the high snowfall period, access to a partially loaded blast hole pattern may be cut off for the explosives loading trucks. In these instances, it will be necessary to square off and shoot the pattern using the goat truck. This will include tying in the loaded holes before the snow accumulation gets too high to locate unloaded holes or to find the downlines for primed holes. In these instances, it will be necessary to square-off the pattern by loading some holes to complete already loaded sections of a blast pattern.

Loading of the explosive product will be done at the bottom of each hole. A column charge of 11 m will be required to provide the appropriate powder factor. Crushed rock (stemming) will be placed on top of the explosives in the hole to reduce fly rock and to contain the explosive force from the blast into the rock mass. The stemming will also help to reduce noise generation caused by detonation of the explosives charge. Crushed rock will be delivered to each blast pattern with a haul truck and dumped at the edge of the pattern. A small loader with a side dump bucket will tram the crushed rock to the boreholes as needed.

Occasionally, high snowfalls may inhibit loading of patterns for a period of time. If it is not possible to fully load a blast pattern, the holes that are already loaded will be tied in and blasted before snow accumulation gets too high to find the holes again, or the time delay is so long that the product would decay in the hole.

The blasting crew will operate seven days per week during the daytime shift only. Based on knowledge of existing mines of similar size, previous experience, and the layout of the Project, a crew size of eight people is estimated to be required. The blasting crew will be responsible for setting up the perimeter of the blast area and maintaining proper clearance and access to the blast pattern. They will also prepare the blast holes with boosters and detonating cord and help guide and direct the explosives truck. Once the holes are loaded, the blasting crew will stem the holes, tie in the pattern, and detonate the blast. The blast crew will confirm that the blast pattern and surrounding blast zone are not occupied by personnel or wildlife prior to initiating a blast.

Closure

Very limited volumes of explosives will be required during the closure phase of the Project for such activities as breaking up concrete foundations or for limited slope re-contouring. Management of explosives will continue to be the same as during the operation phase. When explosives are no longer required, the Explosives Manufacturing Facility and related storage areas will be deactivated, and the sites will be ripped, capped with available overburden and topsoil, and seeded. The related access roads will be deactivated when they are no longer required for maintenance of the sites.

Post-closure

The reclaimed Explosives Manufacturing Facility and related storage areas and access roads will be monitored for erosion, geotechnical stability, and re-vegetation success. Any erosion or instability will be addressed. Any significant areas of under-performing re-vegetation will be investigated and remedial action will be taken.

Draft Plan

Of necessity, this Explosives Management Plan is considered preliminary. Additional components in the final Explosives Management Plan will include:

- detailed plans of the Explosives Manufacturing Facility and individual facilities on the site with specific locations of various explosive materials and products and typical quantities within the compound;
- locations and description of various services and connections to the Explosives Manufacturing Facility (e.g., water, fuel, communications); and
- linkage to the Emergency Response Plan – this will include specific information concerning compatibility groups, emergency plans for various classes of explosive materials, criteria for initiation of emergency and evacuation plans, resources, detailed contact lists, reviews, and testing plans, etc.

26.8.5 Monitoring

Blast noise levels will be monitored as described in the Noise Management Plan.

Manifests for delivered explosives and ammonium nitrate will be reviewed by the contractor to ensure that all explosives and related materials are accounted for. Similarly, magazine inventories and logbooks will be maintained and any deficiencies reported to the Mine Manager or appointed designates.

26.8.6 Reporting

Evidence of missing explosives will be reported to the appropriate regulatory authorities.

All safety incidents with explosives will be reported to the Mine Manager and subsequently to the Chief Inspector of Mines as required by the Health, Safety and Reclamation Code (BC MEMPR 2008). Spills of explosives will be reported as required by the Spill Reporting Regulation (BC Reg. 263/90) by the Environmental Department.

26.8.7 Responsible Person

The Mine Manager will be ultimately responsible for the Explosives Management Plan, through the Health and Safety Superintendent and his/her designates. The blasting contractor will appoint a senior person responsible for its on-site operations at all times.

26.9 Emergency Response Plan

26.9.1 Introduction

This Emergency Response Plan (ERP) is intended to provide a conceptual framework for emergency response at the Project. It provides a policy-level overview that will be further expanded and refined as the application and permitting process progresses. It will be updated into a full ERP before construction starts.

An emergency is a situation that affects:

- the environment;
- the health, safety, or welfare of employees or the community;
- mine property; and
- whose magnitude requires a controlled and coordinated response.

This plan is closely associated with the Spill Prevention and Emergency Response Plan, which will be incorporated into the final ERP before construction begins.

26.9.1.1 Legislation and Standards

The Health, Safety and Reclamation Code (BC MEMPR 2008), empowered under the *Mines Act* (1996j), requires that every mine have an ERP.

In summary, the *Mines Act* (1996j) and the Health, Safety and Reclamation Code (BC MEMPR 2008) state that:

- the Mine Manager shall develop and maintain a Mine Emergency Response Plan;
- the Mine Manager is responsible for ensuring that sufficient people, equipment, and facilities are available for emergency response;
- the Mine Manager is responsible for providing training to all personnel involved in emergency operations;
- whenever mine rescue personnel are required at a mine, the mine rescue teams come under the direction of the Mine Manager unless otherwise directed by the Chief Inspector of Mines; and
- the Mine Manager has the financial responsibility for all costs related to establishing, equipping, operating, and maintaining mine rescue teams, apparatus, and equipment as prescribed by the Chief Inspector.

A number of other legislative requirements are applicable to accidental spills and emergency planning. A short list of these and their major applicable components are provided in Table 26.9-1.

Table 26.9-1. Regulatory Requirements — Selected Examples

Legislation and Regulations	Applicable Information
Environmental Management Act (2003)	Provides overall direction on how wastes are to be managed
Spill Reporting Regulation (BC Reg. 263/90)	Stipulates threshold limits requiring reporting
Contaminated Sites Regulation (BC Reg. 375/96)	Specifies standards on how contaminated sites are to be remediated and managed, with the exception of mine wastes
Spill Cost Recovery Regulation (BC Reg. 250/98)	Outlines the fees that may be recovered from any party that engages provincial resources in spill response activities
Fisheries Act (1985c)	Prohibits the release of a deleterious substance to fish habitat
Transportation of Dangerous Goods Act (1992b), Transportation of Dangerous Goods Regulations (SOR/2001-286)	Includes a substance classification system and specifies requirements for transportation of dangerous goods
Canadian Environmental Protection Act (1999), Environmental Emergency Regulations (SOR/2003-307)	Requires preparation of an Environmental Emergency Plan (see following text)

26.9.1.1.1 Environmental Emergency Regulations

The federal Environmental Emergency Regulations (SOR/2003-307) may be applicable to the Project based on whether one or more of 174 listed substances are present on site above threshold quantity limits. There are a number of exceptions—explosives, for example, as they are covered by the *Explosives Act* (1985b) under NRCan. Possible candidate substances for the KSM Project include propane, gasoline, and ammonium nitrate.

The Environmental Emergency Regulations (SOR/2003-307) have a number of requirements including the preparation of an Environmental Emergency Plan. Contents of the plan (section headings) are also specified. The Proponent will prepare a Spill Prevention and Emergency Response Plan for the Project that satisfies the requirements of an Environmental Emergency Plan during Project permitting prior to any construction activities.

26.9.1.2 Objectives

The ERP:

- guides personnel to enable them to respond quickly and properly to an emergency situation;
- provides a common set of practices that govern the diverse and varied activities needed for an orderly emergency response;
- helps mine officials implement strategies for early containment and control of a problem; and
- establishes a common set of rules for training all emergency response personnel.

26.9.1.3 Targets

The ERP includes emergency prevention. The targets after mitigation are to:

- develop procedures to address the full range of emergencies that could potentially be experienced at the Project during each Project phase;
- equip and train staff to competently enact the required procedures;
- initiate timely responses to contain each emergency to prevent it from becoming a crisis;
- appropriately engage government and community groups in the event of an emergency to protect their interests and enlist their assistance as required;
- ensure that effects of emergencies, after mitigation, are not significant; and
- review the plan at least annually to adapt it to changing conditions.

26.9.1.4 Actions to Avoid, Control, and Mitigate

The *Mine Emergency Response Plan: Guidelines for the Mining Industry* published by BC MEMNG (2012), directs that an ERP will include the following elements:

- Policy Directive;
- Mine Emergency Response Plan Coordinator and Planning Group;
- Emergency Identification, Prevention, and Protection;
- Emergency Notification Plan;
- Emergency Management Organization for Incident Command;
- Emergency Operations Centre;
- Duties and Responsibilities of Personnel;
- Mine Emergency Response Procedures;
- Action Plans;
- Mine Plan;
- Evacuation Plan and Map of Escape Routes;
- Check-in/Check-out Procedure for Emergency Operations;
- Mine Rescue Equipment Inventory;
- Mutual Aid Agreement;
- First Responders Consultation;
- Communication Services;
- System for the Dissemination of Information;
- Training Plan;
- Practice Session Plan;
- Plan for Review and Updating; and
- Costs.

The following sections describe how the Proponent will address these requirements in the ERP, which will be developed during the application and permitting process and will evolve as the Project progresses through the construction, operation, closure, and post-closure phases.

Policy Directive

The ERP will include a clear policy outlining the Proponent's support of the plan. The Proponent's top priority is the health and safety of workers and the public. Other priorities are to protect the environment, avoid adverse social and economic effects, and preserve heritage. The KSM Project ERP will be a key element in meeting that priority. While every effort will be made throughout the life of the KSM Project to prevent emergencies, the ERP will ensure that the Project site is resourced with appropriate equipment, procedures, and trained staff to respond quickly and effectively to every potential event throughout the life of the Project.

The Mine Manager will be ultimately responsible for the ERP, and will appoint an Emergency Response Plan Coordinator and an Emergency Response Planning Committee. The Mine Manager will ensure that the Project budget addresses the requirements of the ERP and related training.

Emergency Response Plan Coordinator and Emergency Response Planning Committee

The Superintendent of Health and Safety will act as, or will designate a person to act as, the Emergency Response Plan Coordinator (ERP Coordinator). The ERP Coordinator will be a key member of the Project Management Team and will have the full support of the operating company to successfully implement the ERP. The ERP Coordinator will engage the Emergency Response Planning Committee (the Committee) in the development of a comprehensive plan, and in the regular review of that plan to ensure optimal effectiveness. The Committee role may be delegated to the Occupational Health and Safety Committee.

Emergency Identification, Prevention, and Protection

The ERP Coordinator and the Committee will examine possible eventualities for each area of the Project, together with the possible means of prevention and protection, and the action to be taken. The pre-planning exercise will be reviewed periodically as conditions change over time.

Initially, all areas and processes of the Project will be inspected to determine the risks associated with the work environment, including confined spaces, mine fires, explosions, rock-bursts, landslides, runs of muck, inrushes of water, pit wall failure, avalanches, and reagent spills. Each contractor working on the Project site will be required to develop plans that comply with the Health, Safety and Reclamation Code (BC MEMPR 2008) for the work that they are performing. The Committee will also consider uncommon and unlikely events, such as earthquakes, bomb threats, and sabotage.

The Committee will also review mitigation designed to prevent emergency events from occurring and to reduce the adverse effects of such events. The review will assess the effectiveness of the mitigation and consider alternatives where necessary.

The Committee will confirm the appropriateness of training and procedures, safe working practices, housekeeping programs, and first aid training to help prevent a minor emergency from becoming a crisis or a disaster.

The ERP Coordinator will engage supervisors and workers in the identification of hazards and the development of prevention and protection measures.

Duties and Responsibilities of Personnel

The job titles of key emergency personnel with their corresponding duties and responsibilities will be listed in the ERP.

Emergency Notification Plan

The ERP will include a procedure to notify required personnel to support the efficient notification or call-out of key individuals in the event of an emergency.

Emergency Management Organization for Incident Command

Project management will establish an Emergency Management Organization under the Incident Command System consistent with the BC Emergency Response Management System to enhance the ability to integrate with other first responders and agencies involved in an emergency response. This consistency will allow for error-free communication and clear definition of roles.

The Emergency Management Organization will define a chain of command. The Mine Manager or a designate will be the Incident Commander. Responsibilities will be clearly defined, and each individual in the organization will be able to state verbally their responsibilities in the event of an emergency.

Emergency Operations Centre

An Emergency Operations Centre (EOC) will be established to assist the Incident Command System Emergency Management Organization with support in the event of an incident. The location of the EOC will be carefully selected for ease of access and communication. It will likely be the Treaty Administration Building at the Treaty OPC, but alternative locations may be proposed during specific stages of the Project. The location and telephone numbers will be identified in the ERP and posted prominently throughout the Project.

Mine Emergency Response Procedures

The Emergency Response Procedures will address three levels of response in an emergency operation: Containment, Notification, and Mobilization.

26.9.1.4.1 Containment Level

Containment is the initial step in the effort to control an emergency, and exists from the moment a problem is discovered until emergency response personnel are notified. The steps in the Containment Level include discovery and reporting of the problem, monitoring the situation, and early and immediate action. The goal at this level will be for on-site personnel to follow concise Emergency Response Procedures immediately.

26.9.1.4.2 Notification Level

The Notification Level will start when management decides outside help is needed to handle a situation or additional notification is necessary. Action will be taken immediately to minimize hazards to all persons and to get assistance as efficiently as possible. If an emergency occurs, managers will notify their own workers of the hazards and, if required, get them to safety and notify key personnel in order to activate the Emergency Response Procedures. The procedures to be followed will be clear and concise to avoid confusion or delays.

All supervisors and persons named in a notification process will be trained in how to initiate the Notification Level. Normal operating procedures cease to apply during the Notification Level. The Notification Level procedures will be kept simple, and the Notification plan will contain only those names absolutely required.

26.9.1.4.3 Mobilization Level

The Mobilization Level will take effect when the EOC has been established and senior management has assumed direction of emergency operations. All key persons will report to the Incident Command Post upon arrival at the Mine Site. The Mine Manager or a designate will assume the role of Incident Commander on arrival.

Action Plans

Concise emergency operational procedures will be developed for each potential emergency, to ensure that supervisory and other personnel have an understanding of duties and responsibilities and are aware of the tasks needed to control an emergency situation.

Based on a thorough assessment of the levels of response required, action plans will be written and assigned to those responsible for the execution of Emergency Response Procedures.

Action plans will typically contain the following types of information and documents:

- copies of all documents for recording events;
- lists of emergency support groups with names of contacts and telephone numbers (e.g., police department, fire department, ambulance service, doctors and medical specialists, paramedics, hospitals; and transportation services such as airlines, air charters, and helicopters);
- list of mine rescue equipment available on site;
- list of BC MEMNG contacts;
- list of BC MEMNG Mine Rescue Cache equipment available;
- BC Provincial Emergency Program;
- list of other key provincial personnel contacts and BC government resource agencies;
- list of key Canadian federal, United States federal, and State of Alaska contacts;
- list of key community, First Nations, and Treaty Nations contacts;

- list of specialized equipment and where it can be obtained, e.g., lifting bags or hydraulic jacks; and
- lists of special consultants, technical advisors, and contractors, e.g., avalanche control contractors.

Mine Plan

The ERP will include a copy of the physical layout of the Project (mine plan as per Part 3.7.11 of the Health, Safety and Reclamation Code [BC MEMPR 2008]) and maps covering all underground and surface operations, including the TMF and access roads.

Evacuation Plan and Map of Escape Routes

A copy of the evacuation plan and escape routes will be included and will be consistent with the up-to-date mine plan as per Section 24.1.1.4 above.

Check-in/Check-out Procedure for Emergency Operations

A check-in/check-out procedure for emergency operations will be established.

Mine Rescue Equipment Inventory

A mine rescue equipment inventory list will be compiled annually and submitted to the BC MEMNG Emergency Preparedness Committee in Victoria, BC, via the Regional Inspector.

Mutual Aid Agreement

The KSM Project will establish customized mutual aid agreements with other first responders operating in northwestern BC, including other mine rescue teams, if required by the ERP. Agreements will be in writing and will address capabilities for a response, back-up teams, travel time, and payment of costs incurred.

First Responders Consultation

To ensure that first responders are prepared to respond to a mine emergency, the Mine Manager will consult with identified agencies to provide a copy of the ERP and current Project plans, including an up-to-date map identifying appropriate and safe route(s) of travel to the Project. A review of any hazards that may affect first responders will also be provided.

Communication Services

The ERP will require the establishment of an emergency communication system to ensure:

- the flow of information, including all orders, reports, and assignments during the entire operation;
- timely assessment of changing conditions;
- timely transmission of reports used to monitor conditions and actions; and
- that command officials have the ability to keep track of available personnel, resources, and services.

The ERP Coordinator will identify personnel who are knowledgeable in the operation and the maintenance of communications technology, and will appoint a Communications Coordinator who has a broad background in mining communications. Additional personnel will be assigned as backup support.

The Communications Coordinator will be responsible for:

- evaluating the existing communications system and assessing its capacity for handling calls during an emergency;
- determining and selecting the technical and logistical components of the emergency communications system;
- developing backup and alternative means of communication;
- establishing a policy governing the authorized use of telephone lines at peak periods of an emergency;
- identifying and selecting personnel to activate the communications system and to check to ensure it is operating;
- setting up a rotation schedule and confirming the assignment of personnel who will monitor and record all calls during each shift; and
- establishing a standardized system for recording calls, messages, and information.

System for the Dissemination of Information

The KSM Project will have a formal plan in place in the event of a serious or fatal accident. The plan will follow established protocols for communicating to the public about incidents. Specifically, families will be informed as early as possible. The names of the people affected will not be released publicly until they have been rescued or recovered and authorization from their families has been received.

All outside calls will be directed through the person designated as responsible for public and media relations. A strategy will be developed for the release of information to the media.

Training Plan

The ERP will outline a training plan for all individuals named in the emergency procedures to ensure key personnel will know how to react. All personnel will be able to state verbally what their duties are in an emergency.

Practice Session Plan

Management will test procedures and evaluate performance of personnel in practice drills on a regular basis to develop and build upon a reliable response system. Drills will cover all actions ranging from the moment of discovery to the marshalling and deployment of emergency response teams, and will consist of setting up the Incident Command Post and the EOC, and establishing communications.

Plan for Review and Updating

As frequent revision of the plan is a key element in the program, the Mine Manager will ensure that the ERP is revised and updated at least annually.

Costs

The Mine Manager will ensure that the adequate funds are provided annually in the Project budget for ERP activities.

26.9.1.4.4 Mine Rescue

A Mine Rescue ERP will be developed and filed with the Chief Inspector for Mines. The Mine Manager will ensure that there is a fully trained mine rescue team. A mine rescue team will have a normal complement of six workers, including a team captain, vice-captain, and coordinator. The team will have a qualified trainer and will practice for not less than eight hours in each three-month period of mine operations. A training logbook will be kept on site. Training will include mine rescue, as well as hazardous materials handling, firefighting, crisis management, and incident command training.

Each open pit shift of more than 10 persons will include 4 people trained in mine rescue procedures.

For underground operations, where the number of people employed underground at one time is:

- fewer than 10, the Mine Manager will maintain on-site trained personnel and equipment necessary to provide a first response and assessment, and establish mutual aid agreements with outside groups capable of providing additional personnel and equipment;
- fewer than 20, there will be at least 3 persons trained in mine rescue;
- greater than 10 but fewer than 50, there will be one mine rescue team; or
- greater than 50, there will be 2 mine rescue teams.

During the construction phase, an emergency response team will be assembled from the site personnel. It will be organized and led by either the Engineering, Procurement, and Construction Management or the Health, Safety, Environment, Security, and Community team. Personnel will receive training in:

- first aid;
- firefighting;
- rescue techniques; and
- hazardous material handling and clean up.

The team will be provided with the following emergency equipment, at a minimum:

- protective gear for firefighting and hazardous material handling;
- a fully equipped rescue vehicle;
- an ambulance;

- a fire truck;
- dedicated communications devices (hand-held and vehicle-mounted); and
- tools (e.g., axes, shovels, cutters, and saws).

The complexity of the KSM Project, with two distinct and physically separated work areas, and both open pit and underground mining operations working concurrently, suggests that a larger than normal complement of mine rescue teams may be required during operation.

These teams will form the core of the emergency response organization, responsible for rescue and firefighting duties in the event of an emergency.

26.9.1.4.5 Firefighting

Firefighting equipment will be provided and maintained at locations throughout the site where fire may endanger life or property. The BC Fire Code will dictate the level of firefighting equipment required. Water systems for fire suppression are incorporated into the Project design and will provide at least two hours of fire water in an emergency.

Firefighting personnel will be part of the mine rescue team. A fire truck will be provided at both the Treaty OPC and the Mitchell Truck Shop.

Fire hazard areas, such as fuelling stations, may be designated as areas where no means of producing heat or flame will be permitted. Such areas will be clearly marked with warning signs.

Upon discovering a fire, all employees will be expected to be aware of, and capable of, carrying out initial containment measures. These measures will include an attempt to control the fire with the nearest extinguisher, raising the alarm, and seeking assistance. A fire within the administration building, assay and metallurgical laboratory, warehouse and maintenance building, cold storage/reagent storage building, first aid building, camps, substations, WTP, Energy Recovery Facility, hydroelectric plants, explosives manufacturing facility, Process Plant, or Mitchell Truck Shop will trigger a building evacuation. Similarly, a fire in the MTT or the Sulphurets-Mitchell Conveyor Tunnel, or in either of the block cave mines, will trigger evacuation of the underground areas.

The configuration of the MTT permits egress from the affected tunnel to the parallel tunnel in the event of an emergency such as a fire. The conveyor drive stations will be equipped with a fire-water spray system for any emergency fire suppression. Crosscuts between the two tunnels will be equipped with access doors to contain fires and protect personnel.

The block cave mine operations have been designed to permit escape in the event of a fire. The Mitchell Block Cave Mine will have two access ramps, one each for the ore transport conveyor and for equipment/personnel access. It will also be equipped with refuge stations. The Iron Cap Block Cave Mine will have a conveyor drift as well as an access ramp, and the two will be connected every 300 m to provide emergency egress and a ventilation loop during construction. It will also be equipped with refuge stations. Two fresh air portals and one exhaust portal are planned on the north slope of the Mitchell Creek Valley. These tunnels may act as an

alternative access to the underground from the surface in case of an emergency such as a fire. Both block cave mines will have dedicated water systems for firefighting.

An equipment fire on a single piece of equipment in the pits will not typically trigger the ERP.

If there is a forest fire near the Project site, management will initiate close monitoring of the fire and seek advice from the British Columbia Ministry of Forests, Lands and Natural Resource Operations. Key personnel will be put on standby pending an evacuation. Evacuation would normally be by bus.

Extreme fire conditions may cause the access roads into the Project to be closed to traffic. This could result in the cessation of operation until such time as the roads are once again passable. Water for firefighting, if required, will be drawn from the freshwater diversions or other sources of non-contact water.

26.9.1.4.6 First Aid

Requirements for first aid are set out by the Workers Compensation Board. During the operation phase, first aid stations will be maintained and equipped at the Treaty OPC and the Mine Site with a "doctor on call" program to support emergencies. Emergency vehicles will be provided at both first aid stations. All site personnel will be informed of the first aid and medical arrangements and the protocol for activating the emergency procedure. Notices indicating contact details for first aid personnel (or appointed persons), the emergency contact number and/or radio frequency, and the location of first aid kits will be posted around the site. There will be helipads at both the Mine Site and Treaty OPC that can be used for medical evacuations. A specific procedure will be developed for summoning either a road ambulance or provincial air ambulance. Major trauma cases can be transferred from a helicopter or vehicle to a fixed-wing air ambulance at the Bob Quinn airstrip, located about 49 km northeast of the Mitchell Pit.

An accident and injury procedure will be developed that details the actions and record keeping required for minor, serious, and major injuries.

26.9.1.4.7 Evacuation

Safe evacuation procedures for the Project will be developed and posted in conspicuous places. Each employee will be instructed in the evacuation procedures and will be familiar with the emergency escape routes from the Project. An emergency warning system will be implemented, and drills will be conducted at least every 12 months to ensure that all employees can recognize the evacuation warning. Reports of these tests will be kept and reviewed with the Occupational Health and Safety Committee.

The Mine Manager will implement a system to account for all of the persons on the Project property. This system will facilitate the early determination of any missing persons in the event of an emergency. A written copy of this system will be available for inspection.

In a severe emergency (e.g., because of danger from a major earthquake), the entire Project property might need to be evacuated. A specific site evacuation plan will be developed that includes procedures for plant shutdown and other protection measures. Transportation

requirements will be included in the plan. Each of the Mine Site and Treaty OPC components of the KSM Project has separate road access and the two areas are connected by the MTT, which reduces the likelihood of complete isolation in the event of a road closure.

26.9.1.4.8 Spill of Dangerous Goods or Hazardous Substances

The management of dangerous goods and hazardous substances and the treatment of spills, including spills that are classified as emergencies, are addressed in the Dangerous Goods and Hazardous Materials Management Plan (Section 26.7) and the Spill Prevention and Emergency Response Plan (Section 26.10).

26.9.1.4.9 Snow Avalanche

The KSM Project will operate in a high snowfall area with steep terrain subject to snow avalanches. It will use a comprehensive avalanche management system using controlled initiation of avalanches to limit the size and destructive capacity of avalanches. Infrastructure facilities will be located outside of known avalanche-prone areas or will be designed to withstand the impact of the avalanches. Personnel working in avalanche-prone areas during periods of snow will obtain prior advice on current risks from an avalanche expert and will be equipped with and trained to use avalanche beacons.

The mine rescue team will be trained in avalanche rescue techniques in case an avalanche affects facilities and personnel despite these precautions. Avalanche rescue will not be attempted unless the site is considered to be safe from further danger by contracted avalanche experts. Snowcats used at the Mine Site for winter off-road crew transport will be available to transport the mine rescue team to avalanche sites if the weather does not permit the use of regular vehicles or helicopters.

26.9.1.4.10 Power Failure

The KSM Project will be dependent upon electricity delivered by a transmission line from the Northwest Transmission Line that will parallel Highway 37. In the event that electricity is interrupted, the Project will have several standby diesel power plants located at the Mine Site, Process Plant, and operating camps. These standby plants will have sufficient power to operate critical equipment such as pumps and tunnel fans and to operate the camps. A plan will be in place for the orderly shutdown of all non-essential machinery to reduce risks of injury or damage to equipment when the power is re-established. It is likely that the Project's own small hydroelectric plants will continue to operate and provide electricity to the critical facilities even if power from the grid is interrupted.

Project management will maintain an inventory of transmission line conductors and accessories to facilitate timely repairs to the transmission lines owned by the Project in an emergency.

26.9.1.4.11 Road Closure

The KSM Project will be serviced by two gravel roads through rough terrain. It is expected that one or both of these roads will be blocked or otherwise impassable at times. Possible causes include:

- floods or washouts;
- avalanches or landslides;

- severe weather (heavy snowfall); and
- forest fires.

In the event that either access road is closed, the second road could provide temporary access to both sites by using the MTT.

During the construction phase of the mine, a road closure would disrupt the delivery of materials and supplies. Construction workers will be housed on site, so food and other supplies could reach critical levels in the event of a prolonged closure. Alternative means of transporting such goods will be established during planning.

Medical emergencies may require helicopter support.

The operation phase of the mine requires that workers be transported to the site for rotations of two weeks on and two weeks off. A road closure could result in a rotation of workers being stranded at the Project site. Potable water will be available and food will be delivered by the alternate road or by helicopter. Most emergency conditions are not expected to last more than 24 hours at a time. Extended closures of the Treaty Creek access road will result in Process Plant shutdown due to lack of storage for produced concentrate.

26.9.1.4.12 Water Storage Dam or Tailing Management Facility Failure

The risk of a WSD or a TMF dam failure is very low, provided that the design is carried out by qualified professionals and all details of construction and maintenance are followed. Site layout considerations will avoid placing critical infrastructure and dwellings downstream of the dams as a precautionary measure.

Minor sloughs from the tailing dams will be excavated and the material will be returned to the TMF. Inspections of all dams will be conducted following extreme precipitation or runoff events. High-level alarms will be placed on the seepage recovery ponds and any triggering of alarms will be investigated. Any spills will be contained and the water returned to the TMF or WSF, as appropriate.

A detailed ERP for each dam will be developed during its construction. In the highly unlikely event of a significant failure, an emergency notification program will be immediately initiated to ensure that downstream residents are advised of the event and any potential risks. The Provincial Emergency Program, the Chief Inspector of Mines, and the Royal Canadian Mounted Police and other relevant federal and provincial agencies will also be notified. In the highly unlikely event of a failure or potential failure of the WSD, the emergency notification program will also include the State of Alaska and United States federal agencies.

All available heavy equipment will be dedicated to mitigation as deemed appropriate by geotechnical engineers and government agencies.

26.9.1.5 Monitoring

Monitoring will be conducted during and after an emergency to identify resulting health, safety, or environmental risks. Monitoring requirements will be laid out in the ERP.

26.9.1.6 Reporting

Detailed reports will be compiled on every emergency incident and every incident that might have become an emergency if not for timely response. Reports will be forwarded to relevant government agencies as required by regulations and licences. All reports will be reviewed internally by the Committee in order to identify necessary improvements in the emergency prevention and response procedures.

26.9.1.7 Response Organization

Planning for an emergency situation involves preparing detailed procedures on how and through whom information and instructions will flow. The large size of the KSM Project and its natural division into two distinct areas suggest the following list of personnel and responsibilities during an emergency incident:

26.9.1.7.1 Mine Manager

The Mine Manager will:

- assume overall responsibility for overseeing response;
- oversee all media communications;
- assume or designate command as Incident Commander;
- confirm resource personnel contacts;
- take charge of the deployment effort;
- confirm arrival and assignment of the emergency operations personnel;
- confirm availability of personnel in the rotation schedules;
- develop a plan of action that includes assignment of mine rescue teams and other appropriate personnel; and
- as required, obtain outside assistance, with the first contact to be the Inspector of Mines.

26.9.1.7.2 Health and Safety Superintendents

For incidents in their respective areas, health and safety superintendents will:

- ensure the removal of all persons affected by the incident;
- confirm contact with all resource personnel;
- assume command of incidents in the Unuk River drainage if the Mine Manager is not on site;
- confirm security, emergency medical services, and transportation;

- confirm EOC arrangements and assign persons to log activity and emergency communications;
- assign messengers and runners;
- remove personnel not directly involved in the emergency response;
- implement the ERP;
- determine the extent to which the supervisor in the affected area has been able to comply with instructions;
- establish and maintain communication between the senior on-site official and the affected area supervisor;
- ensure that the evacuation procedure is activated when required and that rescue teams and emergency equipment are quickly and continuously available;
- schedule successive rescue teams; and
- keep a log of activities by time and event.

26.9.1.7.3 First Aid Personnel

First Aid personnel will:

- where applicable, notify a doctor and/or mobilize an ambulance;
- prepare first aid facilities to receive any casualties; and
- consult with a doctor about obtaining additional medical assistance, supplies, or transportation.

26.9.1.7.4 Security Personnel

Security personnel will:

- limit access to the affected area to authorized personnel only;
- obtain assistance from local law enforcement authorities as required; and
- keep a log of activities by time and event.

26.9.1.7.5 Engineering Personnel

All technical engineering staff will:

- provide additional copies of rescue and firefighting maps or plans as required; and
- ensure that the engineering office is staffed at all times (arrange relief engineers to cover shifts).

26.9.1.7.6 Environmental Superintendent (Mine Site or Processing and Tailing Management Area, depending upon the location of the emergency)

The Environmental Superintendent will:

- ensure appropriate response to a spill incident, considering substance properties and environmental receptors;
- report to the appropriate regulatory agencies, as required;
- consult with the Mine Manager to determine if additional resources are required;
- complete paperwork (spill reports);
- conduct incident investigation; and
- update the Spill Prevention and Emergency Response Plan.

26.10 Spill Prevention and Emergency Response Plan

This document is an initial plan and will continue to be developed more fully during the permitting of the KSM Project and the associated construction phase, during which individual contractor input will be compiled into a Project-wide plan. The plan will continue to evolve during operation, based on changes in activities on the Project site and experience gained. This plan will enable site personnel to be prepared in the event of a spill or an emergency situation. It also provides one component of a comprehensive EMS for the site.

26.10.1 Legislation and Standards

A number of legislative requirements are applicable to accidental spills and emergency planning. A short list of these and their major applicable components are provided in Table 26.10-1.

Table 26.10-1. Regulatory Requirements – Selected Examples

Legislation and Regulations	Applicable Information
Environmental Management Act (2003)	Provides overall direction on how wastes are to be managed
Spill Reporting Regulation (BC Reg. 263/90)	Stipulates threshold limits requiring reporting
Contaminated Sites Regulation (BC Reg. 375/96)	Specifies standards on how contaminated sites are to be remediated and managed, with the exception of mine wastes
Spill Cost Recovery Regulation (BC Reg. 250/98)	Outlines the fees that may be recovered from any party that engages provincial resources in spill response activities
Pacific and Yukon Region, Environmental Emergency Regulations (SOR/2003-307)	Applies to 174 listed substances (possible triggers at the KSM Project include propane and gasoline; explosives are regulated by the federal *Explosives Act* [1985a]); Provides a list of requirements for compliance and prescribed timelines; Calls for a plan with specified contents
Fisheries Act (1985c)	Prohibits the release of a deleterious substance to fish habitat
Transportation of Dangerous Goods Act (1992b), Transportation of Dangerous Goods Regulations (SOR/2001-286)	Includes a substance classification system and specifies requirements for transportation of dangerous goods
Canadian Environmental Protection Act (1999), Environmental Emergency Regulations (SOR/2003-307)	Requires preparation of an Environmental Emergency Plan (see following text)

Environmental Emergency Regulations

The federal Environmental Emergency Regulations (SOR/2003-307) may be applicable to the Project based on whether one or more of 174 listed substances are present on site above threshold quantity limits. There are a number of exceptions (e.g., explosives, as covered by the *Explosives Act* [1985a] under NRCan). Possible candidate substances for the KSM Project include propane, gasoline, and ammonium nitrate.

The Environmental Emergency Regulations (SOR/2003-307) have a number of requirements, including the preparation of an Environmental Emergency Plan. Contents of the plan (section headings) are also specified. The Proponent will prepare a Spill Prevention and Emergency Response Plan for the Project that satisfies the requirements of an Environmental Emergency Plan during permitting for the Project prior to any construction activities.

26.10.2 Objective

This plan consists of two distinct parts:

1. a strategy for the management of the handling, transportation, and storage of solid and liquid materials to reduce the risk of spills that might adversely affect people and the environment; and
2. a conceptual plan for the emergency response to such spills.

The purpose of the spill emergency response part of the plan is to outline a pre-determined course of action to:

1. implement during an emergency situation related to a spill;
2. provide a practical plan on how to safely assess an incident;
3. implement an appropriate response; and
4. complete the follow-up and any corrective action in a safe and effective manner.

Plan Approach

The preparation of this Spill Prevention and Emergency Response Plan has required incorporating several assumptions. These assumptions include:

- best management practices have been adopted as the default tools for this management plan;
- further refinement of the plan will be undertaken during final permitting, and the final plan will continue to evolve over the life of the Project; and
- the plan involves spill prevention and emergency response aspects together. The two are often covered in one management plan due to the close links and overlap between them.

A number of associated KSM Project EMPs overlap with this plan. Overlaps include the Dangerous Goods and Hazardous Materials Management Plan, the Emergency Response Plan, and the Domestic and Industrial Waste Management Plan.

26.10.3 Actions to Avoid, Control, and Mitigate

This Spill Prevention and Emergency Response Plan is intended to provide guidance for the initial spill prevention, spill mitigation, and follow-up activities as well as spill-related emergency response plan procedures for the KSM Project. It will be expanded and refined as part of the permitting and associated adaptive management process to ensure that evolving activities are properly addressed and that contractor input is properly included.

Response to an incident must be immediate and effective such that personnel, property, and environmental hazards are minimized.

26.10.3.1 Spill Prevention

The preferred manner to deal with spills is avoidance with appropriate storage, handling, and transportation measures. The prevention of spills is achieved through the implementation of initiatives such as:

- design of facilities to incorporate best management practices for spill containment including:
  - double containment of all fuels and dangerous or hazardous products, with protective barriers where there is potential for impact from vehicles;
  - secondary containment with capacity to accommodate 110% of the largest vessel in the area; and
  - separate storage and sump systems for storage areas of incompatible products;
- documented operational procedures for tasks that have an identified risk; these tasks may include fuel handling (see Figure 26.10-1), explosives manufacturing and handling, or waste management;
- certification of vehicles and drivers for transportation of dangerous goods;
- ensuring that vehicle cargos are adequately contained and secured;
- high level of preventative maintenance;
- regular housekeeping and environmental audits of facilities to ensure maximum protection is in place;
- risk assessment program for identifying vulnerabilities and management of improvements; and
- documented inspection schedule and procedures for dangerous goods and hazardous materials storage sites.

26.10.3.2 Risk Analysis and Management

The analysis of risk and development of management techniques is a standard component of both mitigation planning and emergency planning. A risk-based assessment of potential incidents, their failure mechanisms, and their potential impacts will be used on an ongoing basis to identify potential high risk areas and ensure procedures are in place to address these items.

Before fuel transfer, verify that:

- delivery vehicle is securely parked on the fuel delivery apron and the engine is turned off;
- delivery vehicle and transfer hoses are properly grounded;
- all fuel transfer hoses have been connected properly and couplings are tight;
- transfer hoses grounding continuity have been tested per the maintenance schedule and are not obviously damaged;
- fuel transfer personnel are familiar with procedures;
- personnel are located at both the fuel truck and fuel transfer tank(s), and have the ability to shut off fuel flow manually;
- a means of communication has been established between the two people transferring fuel; and
- a high-liquid-level shutoff device can be substituted for the person at the delivery tank, in which case operation of the shutoff device should be verified each time it is used.

Transfer fuel must be performed as per established procedures of the fuelling contractor

Ensure the contractor (or mine employee in the case of fuelling station tanks) reports any accidents or spills immediately to the Environmental Superintendent or designated Environmental Department staff who will in turn advise the Mine Manager and the Health and Safety Superintendent.

Identification of potential failures is an integral component of preparing a plan. An analysis of selected spill risks is provided in Table 26.10-2. The list is not inclusive, but provides selected materials of greatest concern.

Table 26.10-2. Analysis of Selected Spill Risks

Area of Concern	Cause of Spill	Potential Effect	Potentially Impacted Area	Preventive Measures	Available Response Resources
Moderate and High Risk of Occurrence					
Tailing spill	Pipeline break near Process Plant	Moderate	Absorbed into soil; enter South Teigen Creek	Instrumentation (differential flow and pressure alarms); preventive maintenance; visual inspections	Using dam construction equipment to contain and clean up; use vacuum truck for cleanup; call for assistance
Small hydrocarbon spills	Human error during handling; vehicle accident	Low	Absorbed into soil; enter local creeks; human health	Storage containers in secondary containment; handling procedures	Spill kits strategically located around site and on vehicles; call for assistance
Process reagents	Rupture of container during transport; spill in Process Plant	Low	Absorbed into soil; enter local creeks; human health	Transport safety procedures; proper storage areas in Process Plant	Spill kits; call for assistance
Low Risk of Occurrence					
Large diesel spill	Pipeline break in or adjacent to tunnel	Moderate	Absorbed into tunnel bed; enter local creeks; human health	Instrumentation (differential flow and pressure alarms); preventive maintenance; visual inspections	Use mining equipment to contain and clean up; use vacuum truck for cleanup; oil booms; absorbent pads; call for assistance
Large diesel spill	Rupture of container during transport	Low	Contaminate soil; enter local creeks	Use of newer equipment; transport safety procedures	Spill kits on transport trucks; call for assistance
Ethylene glycol spill	Spill during transport; spill in shops; radiator puncture	Low	Absorbed into soil; enter local creeks; human health	Transport safety procedures; proper storage areas	Spill kits on transport trucks; spill kits strategically located at all sites; call for assistance

A formal risk assessment program will be established for the KSM Project.

26.10.3.3 Materials-specific Actions

Tailing

Most of the tailing pipelines will be aligned upslope of the TMF, so that a pipeline leak or failure would discharge to the TMF. However, about 2 km of the pipelines closest to the Treaty Process

Plant will be upslope of freshwater diversion ditches, and discharges in this area could enter South Teigen Creek. Prevention measures will include the design and operation of the pipeline system with features such as:

- instrumentation to detect line breaks;
- preventive maintenance program to ensure pipeline integrity;
- scheduled visual inspections of pipeline route; and
- containment channel around the pipeline with periodic collection areas to assist in containment of any spills.

In the event of a tailing leak from the pipelines, manpower and site heavy equipment will be mobilized to contain and clean up the spill. Should pore water absorb into the ground in the area of the spill, solids and contaminated soil will be recovered and transported to the TMF for disposal. Seepage water from most of the tailing pipeline alignment (excluding approximately 2 km from the Treaty Process Plant) will eventually flow into the TMF and will therefore be contained.

Petroleum Products

Petroleum products will be used at a number of locations around the KSM Project and associated satellite sites. Spills may occur in the following locations:

- along Highway 37 or the Treaty Creek or Coulter Creek access roads, where diesel fuel is transported by tanker truck to the Project site;
- the Treaty OPC fuel storage area, where highway tankers will deliver diesel fuel for the Project;
- diesel fuel pipeline through the MTT to the Mitchell OPC fuel storage area;
- diesel fuel pipelines from the MTT to underground storage tanks at:
  - the Iron Cap Block Cave Mine;
  - the Mitchell Block Cave Mine; and
  - the Mitchell OPC fuel storage area;
- fuelling stations at:
  - the Mitchell Truck Shop;
  - the Kerr Pit;
  - the Sulphurets Pit;
  - the Iron Cap Block Cave Mine; and
  - the Mitchell Block Cave Mine;
- internal Project access roads where tanker trucks will transfer diesel fuel between the Mitchell OPC fuel storage area and the Explosives Manufacturing Facility and Mine Site fuelling stations;

- diesel generators at the Treaty Process Plant, Mitchell Truck Shop, Mitchell operating camp, all construction camps, all TWT facilities during construction, and tunnel portal construction staging areas;
- the Explosives Manufacturing Facility; and
- locations where fuel transfers occur using portable fuel containers or lube trucks.

Site fuel tanks will be built and installed to comply with all regulatory and best management practices, including the British Columbia Ministry of Water, Land and Air Protection's (BC MWLAP's; 2002) *Field Guide to Fuel Handling, Transportation and Storage.* With the exception of the TWT facilities, all fuel storage vessels will include secondary containment with a sump, and all transfer stations will have concrete spill pads complete with oil/water separators. Tanks and sumps will have high-level alarms. All transfers from tanker trucks to tanks at the Treaty OPC and remote fuelling stations will be done using enclosed lines, hoses, and pumps. The TWT facilities' fuel tanks will be equipped with appropriate bermed spill containment. All storage and transfer locations will also be equipped with appropriate spill kits.

An inspection schedule will be developed for each fuel storage site, taking into account the volume of fuel stored at each site and the respective risks related to that storage. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded and filed with the Mine Manager or its delegate.

Fuel transfer procedures will include best management steps to ensure no overtopping of tanks or spillage. In addition, inventories will be tracked regularly to check on any possible losses. All spills or accidents will be reported immediately. Employees and contractors responsible for transporting or storing hydrocarbons or for fuelling vehicles will receive training in proper operating procedures and emergency response.

Dangerous Goods and Hazardous Materials

The proper storage procedures described in the Dangerous Goods and Hazardous Materials Management Plan will be followed to minimize the risk of spills of those products. They will be clearly labelled and stored in proper containers in secure locations, where they will be accessed by trained personnel. Secondary containment will restrict the spread of spilled product, and conveniently located material safety data sheets and spill kits will facilitate safe and timely cleanup.

Spill Emergency Response Plan

If a spill does occur despite the above precautions, timely and safe response is the key to minimizing adverse effects. This conceptual spill emergency response plan provides a policy-level overview that will be further expanded and refined as the application and permitting processes progress. It will be updated and integrated into the full Mine Emergency Response Plan before construction starts.

An emergency response plan sets out the basic mechanisms, organizational structures, responsibilities, and procedures to guide staff in responding to emergencies. For the plan to be effective, all employees must be made aware of its provisions and their responsibilities under the plan.

Spills may happen as a result of a number of different reasons. These include:

- equipment malfunctions;
- human error; and
- natural events or "acts of God."

An emergency spill is a spill of materials that affects either the environment; the health, safety, or welfare of employees or the community; Project property; or operational efficiency, the magnitude of which requires a controlled and coordinated response. Many factors influence the intensity or complexity of an emergency spill.

In the event of an emergency spill, the Proponent will respond by:

- ensuring the safety of its employees, site personnel, and the public;
- mobilizing the necessary equipment and crews to contain and clean up the spill and rehabilitate the site to protect the environment; and
- ensuring the appropriate stakeholders are notified. These include government agencies and any nearby communities or landowners. The prompt notification of government agencies, most notably the BC Provincial Emergency Program, is essential.

A site-wide communication system (including the Treaty Creek and Coulter Creek access roads) will ensure rapid notification of any observed spills. The site will have a trained Emergency Response Team with resources to contain and recover spills, to reduce the size of any spill and thus to reduce any potential adverse environmental or health effects. On-site equipment will include absorbent pads and booms, skimmers, and dike materials as part of comprehensive spill recovery kits that will be contained on a trailer or truck for rapid deployment to any spill scene. The kits will be easily transferable to enable delivery by helicopter, if required. Comprehensive spill recovery kits will be located at both the Mitchell and Treaty OPCs to ensure availability throughout the Project.

General Spill Action Plan

The following actions will be taken in the event of a spill:

- identification and control of immediate dangers to human life or health;
- identification and control of spill source;
- elimination of additional potential spill sources;
- containment of spill;
- notification of authorities, as appropriate;
- recovery and cleanup; and
- incident investigation and reporting.

The following framework will be incorporated into the Spill Prevention and Emergency Response Plan.

26.10.3.3.1 Initial Response

In the event of a spill on the KSM Project site, including during the transportation of Project-related materials on Highway 37, the following initial response steps will be taken:

- Ensure the safety of the site for all personnel and the public.
- Mitigate immediate hazards associated with the spill material or near the spill (e.g., aromatic substances, flammable material, or ignition sources).
- Notify responsible Environmental Superintendent and Health and Safety Superintendent. For spills on Highway 37 the responsible superintendents will be those for the PTMA
- Identify the spill material and source of the spill.
- If safe to do so:
  - take measures to stop the flow; and
  - construct barriers with available materials (e.g., snow, earth, or absorbent pads) to prevent the spread of material; in particular, prevent the spill from entering any watercourse.
- If the material or circumstance is unsafe, notify the relevant Environmental Superintendent and Health and Safety Superintendent that an Emergency Response Team is required.

26.10.3.3.2 Secondary Response

Environmental receptors will be identified and protected, particularly surface waterbodies. If the spill cannot be handled by on-site trained personnel or on-site available spill response equipment, an external spill response contractor will be arranged to attend to the site. A plan for cleanup and remediation will be developed by the relevant Environmental Superintendent in coordination with external consultants, if required.

26.10.3.3.3 Reporting

A Spill Report will be completed for all Project-related spills. This report will be submitted to the BC Provincial Emergency Program at 1-800-663-3456, if required (see Table 26.10-3), within 24 hours of the spill event.

Table 26.10-3. Reportable Quantities under the Spill Reporting Regulation

Substance Spilled	Examples	Reportable Spill Quantity
Explosives (Class 1)	Ammonium nitrate/fuel oil, stick powder, emulsions	Any
Flammable gases (Class 2, Div 1), other than natural gas	Propane	10 kg

(continued)

Table 26.10-3. Reportable Quantities under the Spill Reporting Regulation (completed)

Substance Spilled	Examples	Reportable Spill Quantity
Non-flammable gases (Class 2, Div 2)	Halon	10 kg
Poisonous gases (Class 2, Div 3)	Aerosols, ammonia, chlorine	5 kg
Corrosive gases (Class 2, Div 4)	Ammonia, chlorine	5 kg
Flammable liquids (Class 3)	Brake or hydraulic fluid, diesel fuel, ethylene glycol, gasoline, paints, solvents	100 L
Waste asbestos	Asbestos	50 kg
Flammable solids (Class 4)	Metal alkyds, aluminium metal	25 kg
Oxidizing substances (Class 5, Div1)	Ammonium nitrate	50 kg
Organic compounds (Class 5, Div 2)	Organic peroxides	1 kg
Poisons (Class 6)	Arsenic, mercury	5 kg
Infectious organisms	Raw sewage	Any
Radioactive materials (Class 7)	Instrumentation in Process Plant	All discharges or a radiation level exceeding 10 mSv/h at package surface and 200 uSv/h at 1 m from the package surface
Products of Class 8	Acids, battery acid, caustic	5 kg
Miscellaneous products (Class 9, Div 1)	Lead, ammonium hydroxide with not more than 10% ammonia	50 kg
Miscellaneous products (Class 9, Div 2)	PCBs, lead compounds, DDT	1 kg
Miscellaneous products (Class 9,Div 3)		5 kg
Waste oil	Waste oil	100 L
Waste containing a pest control product	Pesticides	5 kg
A substance not covered by items in the above categories that can cause pollution		200 kg
Natural gas	Natural gas	10 kg if there is a breakage in a pipeline or fitting operated above 100 psi that results in a sudden and uncontrolled release of natural gas

Sources: ***Environmental Management Act*** **(2003), Spill Reporting Regulation (BC Reg. 263/90);**
Transportation of Dangerous Goods Act **(1992b), and Transportation of Dangerous Goods Regulations (SOR/2001-286).**

The following information will be recorded on the Spill Report:

- the reporting person's name and telephone number;
- the name and telephone number of the company;
- the location and time of the spill;

- the type and quantity of the substance spilled;
- the cause and effect of the spill;
- details of action taken or proposed to comply with regulations;
- a description of the spill location and of the area surrounding the spill;
- the details of further action contemplated or required;
- the names of agencies on the scene; and
- the names of other persons or agencies advised concerning the spill.

Spill Kits

A key component of spill response is having appropriate materials readily available to contain and abate a spill in a timely manner. The Proponent will compile spill kits designed for specific areas, with contents selected to manage the potential materials, volumes, and environmental sensitivities of each area. Typical contents will include oil absorbent pads and booms, absorbent socks, granular absorbent, and protective equipment such as gloves, goggles, and suits. Kits will be stored in weather-resistant containers and located in visible locations. They will be inspected on a regular basis to confirm that they are complete and functional.

The Proponent will maintain a list of suppliers of specialized spill response services and materials that can be contacted to provide support on short notice.

Spill Cleanup Procedures

Typical cleanup techniques for major or serious spills will include the following:

- construct berms around the spill with gravel, earth, or overburden using heavy equipment (e.g., loader, dozer, or excavator);
- excavate a sump using a backhoe, line it with appropriate impervious lining material (e.g., tarp or poly), and divert spill into the sump;
- block culverts with plywood, poly, and/or sandbags;
- divert spill into settling pond or tailing facility where it can be isolated;
- divert spill into site drainage sump and block inlet and/or outlet;
- use vacuum truck to collect spilled material;
- use absorbents (e.g., oil booms or pads) for hydrocarbon spills;
- use granular absorbents where appropriate;
- use emergency response kit; and
- use overpack barrel (310-L size) for containing a leaking 205-L barrel if the leak cannot be stopped.

Specific spill cleanup and disposal procedures will be developed for:

- a fuel spill;
- a reagent spill, especially for a cyanide spill;
- a concentrate spill;
- a tailing pipeline spill; and
- an explosives spill.

If an emergency response is triggered, control of the situation will be transferred to the emergency response team. The team will be guided by the Proponent's overall ERP, of which this plan is a part.

Triggering of Spill Prevention and Emergency Response Plan

Initiation of the Spill Prevention and Emergency Response Plan will be the responsibility of the Mine Manager (or designate). Response mobilization will depend on the nature of the spill, the substances involved, and the location. Members of the emergency response team will be called in for assistance, as they will have been trained in response methods and will have the knowledge of required resources and their locations. All other personnel will be directed to predetermined locations.

Muster stations will be clearly identified around the Project site, and site personnel will have been made aware of them during orientation and follow-up training programs.

Communications Plan

Communications during an emergency spill situation are of vital importance. A Communications Plan will be prepared that provides direction for undertaking communications with regulatory agencies during an emergency spill situation. Section 26.25, Community Engagement Plan, will describe when and how key surrounding communities will be advised of emergencies related to the KSM Project.

The Communications Plan will provide a system to ensure dialogue between the Proponent and stakeholders of the KSM Project. The Communications Plan will continue to evolve through the construction and operation Project phases.

Response Organization

Planning for an emergency spill situation involves preparing detailed procedures on how and through whom information and instructions will flow. The large size of the KSM Project and its natural division into two distinct areas suggest the following list of personnel and responsibilities during an emergency spill incident:

26.10.3.3.4 Mine Manager

The Mine Manager will:

- assume overall responsibility for overseeing response;

- oversee all media communications;
- assume or designate command as Incident Commander;
- confirm resource personnel contacts;
- take charge of the deployment effort;
- confirm arrival and assignment of the emergency operations personnel;
- confirm availability of personnel in the rotation schedules;
- develop a plan of action that includes assignment of mine rescue teams and other appropriate personnel; and
- as required, obtain outside assistance, with the first contact to be the Inspector of Mines.

26.10.3.3.5 Health and Safety Superintendents

Health and Safety Superintendents will:

- ensure the removal of all persons affected by the incident;
- confirm contact with all resource personnel;
- assume command of incidents in the Unuk River drainage if Mine Manager is not on site;
- confirm security, emergency medical services, and transportation;
- confirm Emergency Operations Centre arrangements and assign persons to log activity and emergency communications;
- assign messengers and runners;
- remove personnel not directly involved in the emergency response;
- implement the ERP;
- determine the extent to which the supervisor in the affected area has been able to comply with instructions;
- establish and maintain communication between the senior on-site official and the affected area supervisor;
- ensure that the evacuation procedure is activated when required and that rescue teams and emergency equipment are quickly and continuously available;
- schedule successive rescue teams; and
- keep a log of activities by time and event.

26.10.3.3.6 First Aid Personnel

First Aid personnel will:

- where applicable, notify a doctor and/or mobilize an ambulance;
- prepare first aid facilities to receive any casualties; and

- consult with a doctor about obtaining additional medical assistance, supplies, or transportation.

Security personnel will:

- limit access to the affected area to authorized personnel only;
- obtain assistance from local law enforcement authorities as required; and
- keep a log of activities by time and event.

26.10.3.3.7 Engineering Personnel

Technical engineering staff will:

- provide additional copies of rescue and firefighting maps or plans as required; and
- ensure that the engineering office is staffed at all times (arrange relief engineers to cover shifts).

26.10.3.3.8 Environmental Superintendent (Mine Site or Processing and Tailing Management Area, depending upon the location of the emergency)

Environmental Superintendents will:

- ensure appropriate response to a spill incident, considering substance properties and environmental receptors;
- report to the appropriate regulatory agencies, as required;
- consult with the Mine Manager to determine if additional resources are required;
- complete paperwork (spill reports);
- conduct incident investigation; and
- update the Spill Prevention and Emergency Response Plan.

26.11 Air Quality Management Plan

The Air Quality Management plan consists of three sub-plans, described below:

- an Emissions Management Plan;
- a Fugitive Dust Emissions Management Plan; and
- a Meteorology Monitoring Plan.

26.11.1 Emissions Management Plan

The Emissions Management Plan outlines:

- the legislation and standards relevant to emissions associated with the KSM Project;
- the primary emission mitigation methods that the Proponent will implement; and

- the continual assessment and reporting of emissions that will take place throughout the Project life.

26.11.1.1 Legislation and Standards

The federal government has set National Ambient Air Quality Objectives (NAAQOs) and Canada-wide standards under the *Canadian Environmental Protection Act* (1999). Canada-wide standards are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe, whereas NAAQOs identify benchmark levels of protection for people and the environment. In addition, BC has developed air quality objectives for a number of contaminants.

The applicable standards relating to the KSM Project include:

- NAAQOs (Environment Canada 1999);
- Canada-wide standards (CCME 2000); and
- BC Air Quality Objectives and Standards (BC MOE 2009a).

Table 26.11-1 summarizes the ambient air quality standards relevant to the Emissions Management Plan.

Table 26.11-1. Relevant Ambient Air Quality Standards for the KSM Project

		Concentrations (µg/m^3)					
		Canada			BC Objective		
Pollutant	Averaging Time	Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C
SO_2	1-hour	450	900	-	450	900	900-1,300
	24-hour	150	300	800	160	260	260
	Annual	30	60	-	25	50	80
NO_2	1-hour	-	400	1,000		-	
	24-hour	-	200	300		-	
	Annual	60	100	-		-	
CO	1-hour	15,000	35,000		14,300	28,000	35,000
	8-hour	6,000	15,000	20,000	5,500	11,000	14,300
TSP	24-hour	-	120	400	150	200	260
	Annual	60	70	-	60	70	75
PM_{10}	24-hour		-		-	50	-
$PM_{2.5}$	24-hour		30[a]			25[b]	
	Annual		-			8[c]	

Notes: (-) dash indicates not applicable
a Annual 98th percentile value, averaged over three consecutive years. Canada-wide Standard published by CCME.
b Based on annual 98th percentile value.
c BC objective of 8 µg/m^3 and planning goal of 6 µg/m^3 was established in 2009.

26.11.1.2 Objective

The Emissions Management Plan will establish measures to mitigate emissions from Project activities to meet air emission legislative requirements and to reduce the Project effects to reasonable levels. The objective of the Emissions Management Plan is to mitigate and monitor emissions from Project activities.

26.11.1.3 Targets

The Emissions Management Plan targets are to:

- avoid, control, and mitigate air pollution associated with Project operation; and
- establish a monitoring plan to collect on-site air quality data, results of which will be reviewed annually to determine if any trends are evident and if target criteria are being met.

26.11.1.4 Actions to Avoid, Control, and Mitigate

The main source of emissions during the construction phase of the Project will be from diesel exhaust. Diesel emissions include carbon monoxide, nitrogen oxides, sulphur dioxide, particulate matter, and residual unburned fuel vapours. Emissions will also be produced by the incineration of inorganic and organic wastes.

Activities that will produce emissions during the Project operation phase include blasting, operating diesel-powered mining equipment, and operating haul trucks for transporting waste rock and ore. Transportation of personnel and materials to and from the Mine Site will also produce emissions during operations. Emissions include sulphur dioxide, nitrogen oxides, carbon monoxide, and particulate matter.

In an effort to mitigate emissions during the various phases of the KSM Project, the Proponent is currently implementing, or plans to implement, measures described in detail below.

26.11.1.4.1 Design Criteria

- Equipment and vehicles used on site will be maintained on a regular basis. Regular inspections will be conducted, and all parts showing signs of wear or damage will be promptly replaced because a poorly maintained engine can use up to 50% more fuel (D. Cope Enterprises 2004). Studies have shown 1995 model-year and older vehicles produce smog causing pollutants at a rate up to 19 times greater than a new vehicle; however, a study conducted by Summerhill Impact (formerly Clean Air Foundation) in 2010 determined that older vehicles were in fact 39 times more smog-polluting than a new vehicle (Summerhill Impact 2012). Leaking air directly affects the air to fuel ratio, thereby resulting in inefficient combustion and higher emissions and incomplete burning of fuel results in higher levels of CO (Cheminfo 2005).
- The generators and incinerators used on site will burn fossil fuel. When fuel is burned, air pollutants will be released in the form of exhaust gases. The Off-Road Compression-Ignition Engine Emission Regulation (SOR/2005-32) limits the amount of emissions produced; however, different generators and incinerators vary in the amount of emissions produced within the regulated limit. On November 17, 2011, Environment Canada adopted amendments to the Off-Road Compression-Ignition Engine Emission Regulations

(SOR/2005-32), which align Canadian emission standards with the US Environmental Protection Agency Tier 4 standards that came into force on January 16, 2012. Generators and incinerators for the Project will be in compliance with the Tier 4 standards, and models with lower emission rates will be preferred. Incinerators will also comply with Canada-wide standards for dioxins and furans (CCME 2009) and Canada-wide standards for mercury emissions (CCME 2010).

- During the design phase, an alternatives study was carried out to assess different potential design specifications and facility locations. The report concluded that emissions are anticipated to be similar for each site regardless of where the Process Plant is situated; however, overall Project emissions will be higher for the sites with the longer access routes. Shorter haul routes will reduce emissions associated with construction and material transport during operation. Shorter haul routes also have the benefit of reducing construction and haul costs.
- The alternative options for transporting ore included an ore slurry pipeline or an ore conveyor belt system. The ore slurry pipeline was expected to produce higher emissions due to the higher electricity and diesel requirements. Based on the assessment of technical, environmental, and socio-economic effects, the ore conveyor belt system was chosen.
- The alternative options for waste rock disposal included a number of different sites. Due to the additional power required to pump contact water upstream for treatment, it was concluded that the Gringras Valley RSF would have higher emissions. Based on the assessment of technical, environmental, and socio-economic effects, the Gringras Valley RSF was not chosen.

26.11.1.4.2 Construction

The following measures may be put in place during construction:

- Vehicle design/type:
  - retrofitting older engines (required in BC now for models 1989 to 1993 that weigh more than 8,200 kg) with emission reduction devices;
  - having fleets with engines three years old or newer (can improve efficiency by 4 to 15%);
  - 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 possible;
  - installing catalytic converters and diesel particulate filters on diesel engines; and
  - using low-sulphur diesel, as required by law.
- Vehicle maintenance:

  - checking tire pressure regularly (for every 10 psi reduction in tire inflation, about a 1% improvement in mileage ensues);
  - maintaining fleets regularly; and
  - downloading/recording information from vehicle engines about usage to assist in reporting.
- Driver training and incentives:
  - reducing vehicle idling;
  - minimizing rapid starts and stops;
  - reducing the use of engine breaks near human populations;
  - optimizing driving speed to reduce fuel usage; and
  - implementing driver incentive programs.
- Open Burning:
  - open burning will be conducted in compliance with the Open Burning Smoke Control Regulation (BC Reg. 4/2010);
  - open burning will be scheduled according to forecasted ventilation index prepared by Environment Canada and approved by a director or a forest official; and
  - if venting conditions prevent burning, discussions with the BC Ministry of Environment - Environmental Protection Division and BC Ministry of Forests, Lands, and Natural Resource Operations will be conducted to develop a Burning Plan.

26.11.1.4.3 Operation

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

- Selection of clean, high-efficiency technologies for diesel mining equipment.
- Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination.
- Use of emission control systems (e.g., baghouses, and filters) on stacks and on relevant ventilation systems.
- Installation of incinerators that comply with the *Canada-wide Standards for Dioxins and Furans* (CCME 2009) and with the *Canada-wide Standards for Mercury Emissions* (CCME 2010). Operation of the incinerators will include the following measures:
  - a waste segregation program will be implemented (i.e., materials that are unsuitable for incineration, such as chlorinated plastics, will be diverted to alternate waste disposal facilities); and
  - personnel will be properly trained in incinerator operations.
- Implementation of a recycling program to reduce the amount of incinerated waste.

- Necessary training and instruction for all on-site staff with duties related to the operation of equipment that emit air pollutants or controls air emissions (e.g., the required measures to be implemented during start-up, shut down, and emergency conditions):
  - the site operator will maintain a statement of training requirements for each operational post and will keep a record of the training received by each person whose actions may have an effect on the environment; and
  - these documents will be made available to the regulator on request.
- Adherence to all permits, authorizations, and approvals.

26.11.1.4.4 Closure

Activities during the closure phase will be similar to the activities during the construction phase, but on a smaller scale; therefore, the actions identified for the construction phase above will also be relevant during the closure phase.

26.11.1.4.5 Post-closure

Roads will be decommissioned following closure to limit indirect adverse effects of emissions due to increased human presence in the area in the post-closure phase.

26.11.1.5 Monitoring

Initial stack testing of the incinerators and baghouses are recommended to ensure emissions from the stacks are as expected. Stack testing of a selection of incinerators and process units will be conducted in compliance with permit requirements under the BC *Environmental Management Act* – Air Permit.

Air quality monitoring will be carried out to establish the emissions associated with site activities during operation. Monitoring stations will be located at various locations. Details of any adverse findings will be recorded and reported as required by regulatory authorities.

26.11.1.6 Reporting

The results of the emissions monitoring program will be reported on at the frequency specified in the Air Permit.

26.11.1.7 Adaption

The air quality monitoring data will be reviewed annually to determine if any trends are evident. The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing an increasing trend in emission concentrations; and
- issues raised by on-site staff, regulators, or local communities.

Discussions will be initiated to resolve any issues as soon as possible after the issue has been identified.

Components of the Emissions Management Plan may need to be revised over the life of the KSM Project, based on regulatory changes and technological advances. Any modification made to the Emissions Management Plan will be communicated to regulatory authorities where applicable.

26.11.1.8 Responsible Person

The KSM Project Environmental Officer or other designated person will oversee the air quality operations and monitoring, maintain inspection reports, and provide guidance with the support of a qualified air quality specialist, when required.

26.11.2 Fugitive Dust Emissions Management Plan

The Fugitive Dust Emissions Management Plan outlines:

- the legislations and standards relevant to dust emissions associated with the KSM Project;
- the main emission mitigation methods that the Proponent will implement; and
- the continual assessment and reporting of emissions that will take place throughout the Project life.

26.11.2.1 Legislation and Standards

The applicable standards include:

- NAAQOs (Environment Canada 1999);
- Canada-wide standards (CCME 2000);
- British Columbia Air Quality Objectives (BC MOE 2009a); and
- The Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia (BC MOE 1979).

Table 26.11-2 summarizes the ambient air quality standards used to monitor the KSM Project fugitive dust emissions on ambient air quality.

26.11.2.2 Objective

The main objective of the Fugitive Dust Emissions Management Plan is to ensure that the levels of fugitive dust generated by Project activities are at or lower than levels required to meet the Canada and BC ambient air quality and dustfall objectives. The Fugitive Dust Management Plan will also identify methods to reduce fugitive emissions from Project activities.

26.11.2.3 Targets

The Fugitive Dust Emissions Management Plan targets are to:

- ensure fugitive dust emissions generated by the Project do not cause a medium to long-term exceedance of the standards listed in Table 26.11-1; and

- maintain a monitoring plan to collect on-site air quality data related to dust, results of which will be reviewed annually to determine if any trends are evident and if target criteria are being met.

Table 26.11-2. Relevant Ambient Air Quality Standards for the KSM Project

Pollutant	Averaging Time	Concentrations (µg/m^3)					
		Canada			BC Objective		
		Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C
TSP	24-hour	-	120	400	150	200	260
	Annual	60	70	-	60	70	75
PM_{10}	24-hour		-		-	50	-
$PM_{2.5}$	24-hour		30a			25b	
	Annual		-			8c	
Dustfall	30-day		-			1.7 to 2.9 mg/dm^2/day	

Notes: (-) dash indicates not applicable
a Annual 98th percentile value, averaged over three consecutive years. Canada-wide standard published by CCME.
b Based on annual 98th percentile value.
c BC objective of 8 µg/m^3 and planning goal of 6 µg/m^3 was established in 2009.

26.11.2.4 Actions to Avoid, Control, and Mitigate

The main sources of fugitive dust emissions during the construction phase of the Project will be vehicles travelling on unpaved roads, construction of the access corridor, and other construction activities, including earthworks, topsoil removal, and blasting.

Activities that will produce fugitive dust emissions during the operational phase of the Project include vehicles travelling on unpaved roads, ore transfer, truck loading and unloading, crushing and blasting.

In an effort to mitigate dust emissions during the various phases of the KSM Project, the Proponent is currently implementing, or plans to implement, the following measures:

26.11.2.4.1 Design Criteria

- Mitigation controls for unpaved roads described in Chapter 13, Section 2 of AP-42 (US EPA 2006) include vehicle restrictions, surface improvement, and surface treatment. In the Project design, watering of the road to reach 4% moisture ratio has been included. Watering, part of the surface treatment control, increases the moisture content, which conglomerates particles and reduces the likelihood of them becoming re-suspended. The control efficiency associated with a 4% moisture ratio is 87.5% (US EPA 2006). Roadways will also be properly graded, compacted, and maintained in order to reduce the silt content on the roadway.
- Crushing can be a significant source of dust emissions in the mining process if not properly mitigated. Crushing of low- and high-moisture ore produces significantly

different amounts of particulate matter. Other than increasing the moisture content of the ore, the installation of baghouses is the most common mitigation method. Baghouses will be installed for each crushing circuit to reduce dust emissions by more than 99.5%.

- Dust emissions may be generated by wind erosion when the stockpiled material has small particle sizes. Covering or enclosing stockpiles will shelter them from wind, thereby reducing airborne dust. In the design, enclosing of crushed ore stockpiles have been incorporated to minimize the potential of wind erosion.
- Since the MTT will be used to both transport material and personnel, either wet scrubbers or baghouses will be installed at all appropriate points along the transport line to ensure that the air in the MTT meet the Occupational Health and Safety standards.

26.11.2.4.2 Construction

- Management of access roads and site roads to ensure road watering is performed as required. Roads will be maintained and compacted with appropriate surface material to limit generation of fugitive dust.
- Use of water sprays to suppress dust generation from equipment in the crushing facility, stockpiles, and materials prior to transport, if applicable.
- Consideration of the installation of windbreaks or fences around known problem areas, as required, and stockpiles to limit the dispersion of dust from equipment and stockpiles or from activities likely to generate dust.
- Designate speed limits on site roads.
- Regular wheel-cleaning of vehicles travelling around and leaving the site.
- Enclosing or covering loads carried by vehicles.
- Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.

26.11.2.4.3 Operation

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

- Drop distances between conveyer belt and stockpiles will be reduced as much as feasible and/or dust skirts will be used.
- Proper maintenance of control equipment as specified by the manufacturer.
- Reclamation and covering of run-of-mine stockpiles, where possible.
- The site operator or other designated person will maintain a statement of training requirements for each operational post and will keep a record of the training received by each person whose actions may have an impact on the environment. These documents will be made available to the regulator on request.
- Adherence to all permits, authorizations, and approvals.

26.11.2.4.4 Closure

Activities during the closure phase will be similar to the activities during the construction phase, but on a much smaller scale; therefore, the actions identified above for the construction phase will also be relevant during the closure phase.

26.11.2.4.5 Post-closure

Roads will be decommissioned following closure to limit indirect adverse effects of dustfall due to increased human presence in the area in the post-closure phase.

26.11.2.5 Monitoring

The KSM Project Air Quality Monitoring Program, which began in 2008, consists of dustfall monitoring of particulates, anions, cations, and total metals. Dustfall monitoring began at 5 locations and expanded to 10 during the time of reporting. Each station monitors dustfall over consecutive 30-day periods during the summer and early fall. The locations of the dustfall stations during construction and operation are likely to be slightly different than the baseline locations due to shifting areas of activity on site as the Project progresses. The proposed locations of each of the stations are shown in Figure 26.11-1.

The dustfall monitoring stations are to be sited in accordance with ASTM Standard D1739-98 (ASTM 2010). The stations will be in open areas that are free of structures higher than 1 m within a 20 m radius of the collection container.

The dustfall monitoring stations will collect particulates small enough to pass through a 1 mm screen and large enough to settle by virtue of their weight. This will require containers of a standard size and shape, which are partially filled with deionised water and algaecide to prevent the growth of algae in the canisters. Each dustfall monitoring station will consist of two canisters, each surrounded by a wind screen and mounted on a 2-m pole. One of the containers will be analysed in the laboratory for particulates (total, soluble, and insoluble) and anions (sulphate, nitrate, chloride, and ammonia), and the other for total metals and various cations. The deionized water in the dustfall containers will also contain algaecide as algae interfere with dustfall measurements. The windscreen around the sample container will improve the dustfall collection efficiency and bird spikes will be used to minimize contaminants from bird faeces.

The dustfall monitoring will provide a 30-day average ground-level mass of deposited dust. These values will be compared to the relevant BC dustfall objectives stated in *The Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia* (BC MOE 1979). In addition, analysis of temporal trends will be undertaken to determine if there are any increasing trends in the measured concentrations with consideration to the time of year and meteorological conditions.

The monitoring data will also be used to provide feedback to modify the dust management procedures incorporated at the site, if required. However, sampling does not occur in “real time” and there will be a delay between the events that lead to any elevated dust deposition and the receipt of monitoring results.

26.11.2.6 Reporting

The results of the Dustfall Monitoring Program will be reported in various annual reports and will be provided to senior management and regulatory agencies as required.

26.11.2.7 Adaption

The dustfall monitoring data will be reviewed annually to determine if any trends are evident. The need for any corrective actions to on-site dustfall management or additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing an increasing trend in deposited dust; and
- issues raised by on-site staff, regulators, or local communities.

Discussions will be initiated to resolve any issues as soon as possible after the issue has been identified.

It is possible that components of the Fugitive Dust Emissions Management Plan may need to be revised over the life of the KSM Project, based on regulatory changes and technological advances. Any modification made to the Fugitive Dust Emissions Management Plan will be communicated to regulatory authorities where applicable.

26.11.2.8 Responsible Person

The KSM Project Environmental Officer (or other designated person) will oversee the air quality operations, maintain inspection reports, and provide guidance with the support of a qualified air quality specialist, when required.

26.11.3 Meteorology Monitoring Plan

26.11.3.1 Objectives

The objectives of the Meteorological Monitoring Plan are to measure and characterize the atmospheric conditions within the Project area to establish long-term data and review results annually.

On-site meteorological data are used for a variety of purposes for mining projects. For instance, wind speed and direction data were required for the Project to select sites for permanent camps and mineral processing facilities, in order to accommodate predominant wind patterns and mitigate the effects of fugitive dust and other emissions. Solar radiation, evaporation, and precipitation data are required in water balance calculations for water containment and treatment systems. Precipitation (as both snow and rain) data will facilitate monitoring and predicting potential hazards such as avalanches and landslides (see Chapter 34, Effects of the Environment on the Proposed Project). Meteorological monitoring will also assist in understanding and better predicting the potential effects of climate change on the Project over its lifetime.

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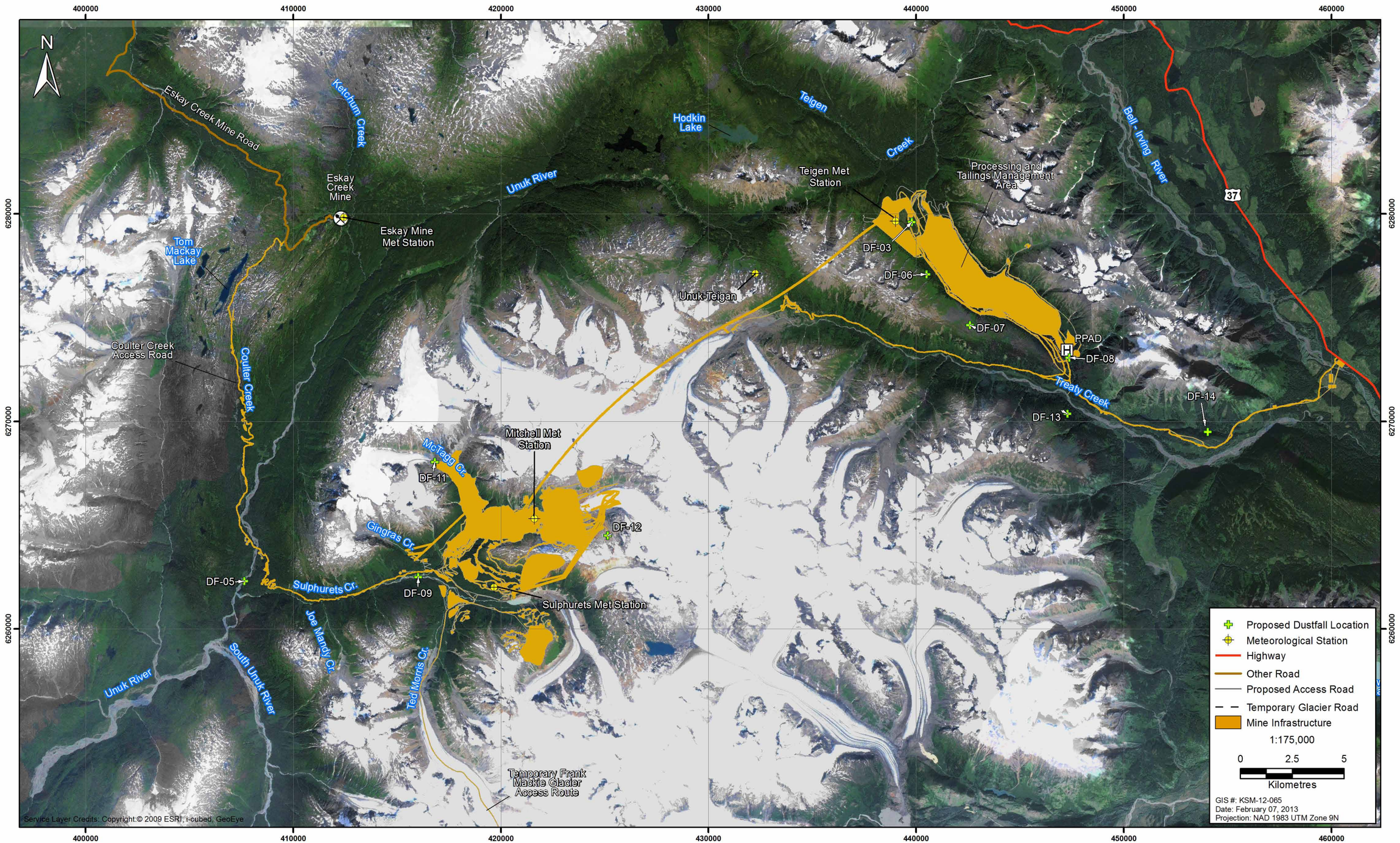

Figure 26.11-1

SEABRIDGE GOLD
KSM PROJECT

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Proposed KSM Project Dustfall Monitoring Stations

26.11.3.2 Monitoring

Since late 2007, a total of five automated meteorological stations have been installed and operated as part of the meteorology baseline monitoring program for the Project. The dates, locations, and measured parameters for these stations are summarized in Table 26.11-3 and are illustrated in Figure 26.11-2. There are four Environment Canada stations in the region of the Project that provide data for comparison to that collected by the KSM Project meteorological stations. The regional meteorological stations are listed in Table 26.11-4 and are illustrated in Figure 26.11-3. The information collected from these stations is documented in the meteorological baseline report for the Project in Appendix 7-B.

Monitoring of meteorological data will continue through the Project life—including temperature, relative humidity, precipitation and snow depth, solar radiation, barometric pressure, and evaporation. The positioning of stations in the area of the Project may shift per regulatory reporting requirements and air quality, hydrological, climate change, safety, and other data needs over the life of the Project.

26.11.3.3 Reporting

The results of ongoing meteorological monitoring throughout the Project life will be reported in Annual Environmental Reports, and will be provided to senior management for the Project as required.

It is possible that components of the Meteorological Monitoring Plan may need to be revised over the life of the KSM Project, based on the needs of the Project, regulatory changes, or technological advances. Any modification made to the Meteorological Monitoring Plan will be communicated to regulatory authorities, such as the BC Ministry of Environment, where applicable. Also, modifications will be made so as to ensure that the continuity of data collection is not disrupted in a manner that would significantly alter its usefulness (such as the ability to provide information pertinent to health and safety, or to interpret air quality, climatic, or hydrological trends resulting from the Project, or that may cause effects to the Project).

26.11.3.4 Responsible Person

The KSM Project Environmental Manager (or other designated person) will be responsible for completion of meteorological reporting for the Project, overseeing the meteorological monitoring operations, maintaining inspection and maintenance reports, and providing guidance on any changes or needs of the program, with the support of a qualified specialist, when required.

26.12 Greenhouse Gas Management Plan

A description of the issue of climate change relating to the need to manage greenhouse gas (GHG) emissions for the Project is discussed in Chapter 6, Greenhouse Gas Emissions (Climate Change). The GHG management plan outlines:

1. the legislative context for mitigating GHG emissions in BC;
2. the main GHG mitigation methods that the Proponent will use for the Project; and
3. the assessment and reporting of Project GHG emissions that the Proponent will undertake.

Table 26.11-3. List of KSM Project Meteorological Stations and Parameters

Station Name	Date Established	UTM Coordinates[a]		Elevation (masl)	Temperature and Relative Humidity	Wind Speed and Direction	Snow Depth[b]	Snow-Water Equivalent[c]	Precipitation[d]	Solar Radiation	Visibility	Barometric Pressure
		Easting (m)	Northing (m)									
Eskay Creek Mine	Sep. 20, 2010	412,450	6,279,825	770	x	-	x	-	x	-	-	-
Mitchell Deposit	Sep. 17, 2008	421,615	6,265,311	830	x	x	-	-	-	-	x	-
Sulphurets Creek	Sep. 30, 2007	419,656	6,261,999	880	x	x	-	x	x	x	-	x
Teigen Creek	Mar. 4, 2008	439,012	6,279,647	1,085	x	x	x	-	x	x	-	x
Unuk-Teigen	Sep. 18, 2008	432,260	6,277,120	1,279	x	x	x	-	-	-	-	-

Notes: m = metres; masl = metres above sea level; dash (-) this type of sensor was not installed at this particular station
[a] UTM coordinates are in reference to NAD83 and Zone 9
[b] via Ultrasonic Gauge
[c] via Snow Pillow
[d] via Tipping Bucket Rain Gauge, Standpipe All Season Precipitation Gauge, or GEONOR Precipitation Gauge

Table 26.11-4. Meteorological Stations in the KSM Project Region

Station	Climate ID	UTM Coordinates[a]		Station Location (with respect to KSM)	Elevation (masl)
		Easting (m)	Northing (m)		
Unuk River Eskay Creek	1078L3D	411,338	6,279,640	19.4 km north	887
Bob Quinn AGS	1200R0J	424,000	6,314,383	58.7 km north	610
Stewart Airport	1067742	438,547	6,204,972	66.7 km south	7
Ningunsaw Pass	4B10	441,930	6,291,816	30 km northeast	647

Notes: m = metres; masl = metres above sea level; [a] UTM coordinates are in reference to NAD83 and Zone 9

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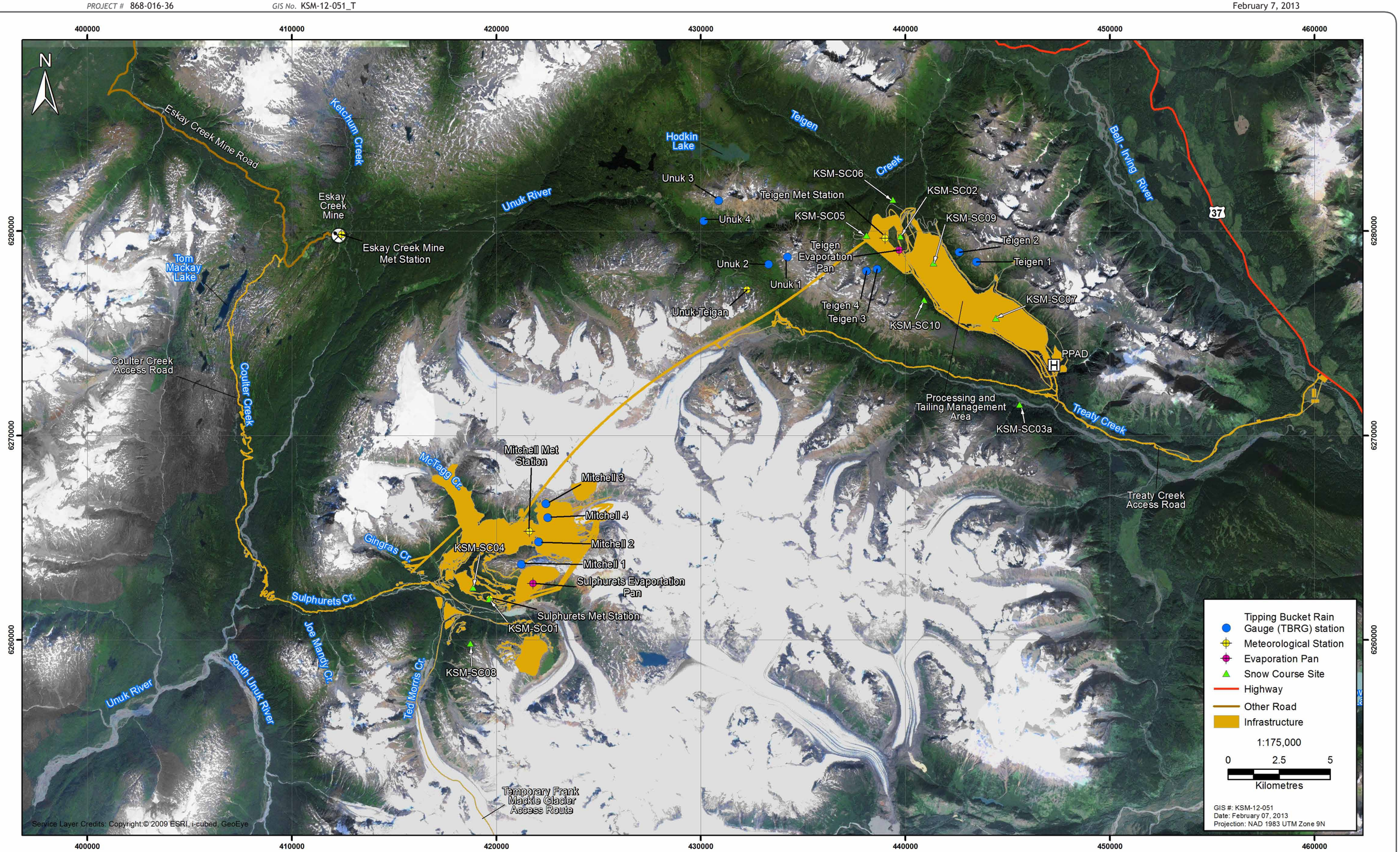

Figure 26.11-2

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KSM Project Baseline Monitoring Stations for Meteorology, Snow, Precipitation and Evaporation

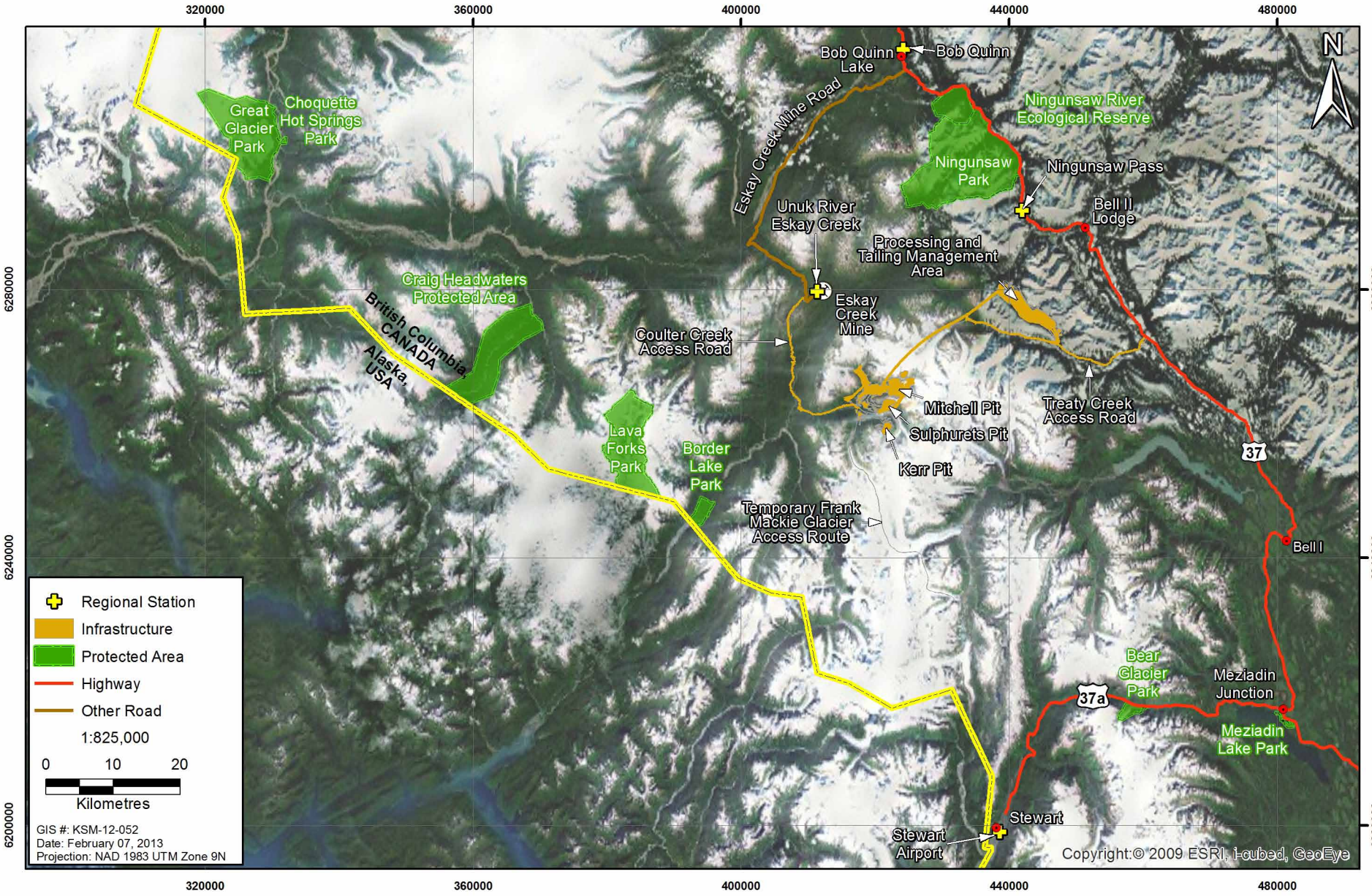

Figure 26.11-3

SEABRIDGE GOLD
KSM PROJECT

KSM Project Regional Stations

Figure 26.11-3

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26.12.1 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 2007; BC MOE 2010c), 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 domains, so organizations can implement carbon management strategies under several voluntary third-party programs that additionally promote best practices in the monitoring, reduction, and transparent reporting of GHG emission inventories.

Regulatory Context

The main pieces of legislation pertaining to carbon management for major projects in BC, including taxation and market mechanisms, are listed in Table 26.12-1. 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 26.12-1. Greenhouse Gas Emission Legislation and Initiatives

Name	Year	Type	Level of Government	Description
Copenhagen Accord (United Nations 2009)	2009	Agreement	International	Canada signed to a GHG[1] 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 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 that 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."
On-road Vehicle and Engine Emission Regulations	2002	Regulation	National	This and newer regulations under the authority of the *Canadian Environmental Protection Act* (1999) and Clean Air Regulatory Agenda regulate the reduction of vehicle emissions and establish emission standards.

(continued)

Table 26.12-1. Greenhouse Gas Emission Legislation and Initiatives (completed)

Name	Year	Type	Level of Government	Description
BC *Climate Action Plan (Government of BC 2008b)*	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 (Government of BC 2008a)	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 tpa 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, the federal government announced new regulations for automobiles and light trucks manufactured between 2017 and 2025, which mandate improvements to engine fuel efficiency such that by 2025, vehicles in this category will consume 50% less fuel and will emit 50% less GHG emissions than similar 2008 models (Environment Canada 2012a). 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 (SOR/2013-24) will mandate manufactured emission reductions for heavy-duty vehicles, commence in 2014, and will also help to lower transport related emissions of the Project compared to current estimates (Government of Canada 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 tpa (Environment Canada 2012b). These types of reductions are why the procurement of new vehicles is listed as a mitigation measure in Section 26.12.1.5.

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 BC 2008b), 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 BC 2008b). BC currently also has a carbon tax, although the general *GHG Reduction (Cap and Trade) Act* (2008b) is currently slated to become the major legislative arm to regulate emissions in BC. The *GHG Reduction (Cap and Trade) Act* (2008a) also enabled the province to be the first Canadian province to join the regional (United States 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* (2008c) 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 BC 2008b). 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 the 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).

26.12.1.1 Greenhouse Gas Emission Reporting and Reduction Requirements

In support of Canada's GHG mitigation targets, since 2010, facilities emitting over 50,000 t of CO_2e[1] have been required to report emissions to Environment Canada for the *Greenhouse Gas Emissions Reporting Program* (Environment Canada 2010), under the jurisdiction of Section 46 of the *Canadian Environmental Protection Act* (1999). Data from the Reporting Program are used to

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

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 2012d).

In BC, since January 1, 2010, facilities emitting over 10,000 t of carbon dioxide equivalent (CO2e) must report to the BC Ministry of Environment, and those emitting over 25,000 t CO2e must also have to 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 (2008b).

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 able to be reported through the online one-window reporting (OWR) system, which was introduced in 2010 to harmonize the needs of federal and provincial reporting, prevent duplication, and reduce the reporting burden on industry (BC MOE 2011b).

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* (2008b), 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 CAS 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 [California Air Resource Board 2006]) 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 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 (2008b) to join in a capped and regulated carbon market with California and Quebec or pursue other avenues of carbon management.

26.12.1.2 Objective

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

26.12.1.3 Targets

The Greenhouse Gas Management Plan targets are to:

- ensure that reporting is carried out to meet the requirements discussed in Section 0;
- 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 periodically 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 by maximizing vegetation reclamation where possible.

26.12.1.4 Actions to Avoid, Control, and Minimize Effects

26.12.1.4.1 Greenhouse Gas Mitigation Hierarchy: Introduction

There are several ways to mitigate the GHG emissions of a project. The GHG management hierarchy in Figure 26.12-1 illustrates the ideal line of mitigation strategy for GHG emissions, starting with avoidance, then reduction, replacement, enhancement, and finally offsetting 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 Seabridge Gold Inc. (Seabridge, or the Proponent) has committed to 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 via developing additional offset projects.

26.12.1.4.2 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 2009), 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.

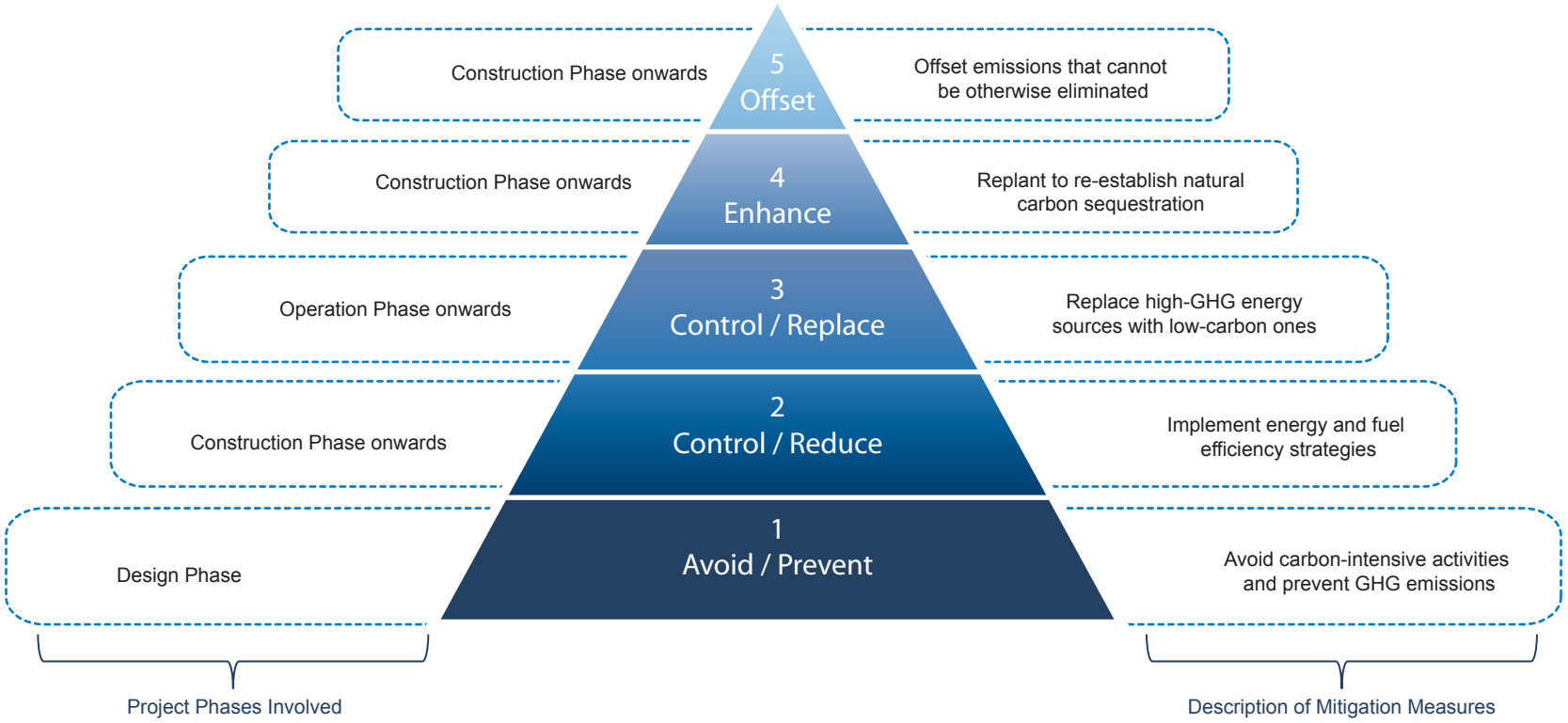


Figure 26.12-1

SEABRIDGE GOLD
KSM PROJECT

The GHG Mitigation Hierarchy

Figure 26.12-1

Rescan
Engineers & Scientists

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.

26.12.1.4.3 Greenhouse Gas Mitigation Hierarchy: Implementation

In an effort to mitigate GHG emissions during the various phases of the KSM Project, Seabridge has already implemented measures that will reduce GHG emissions at the design phase, and plans to implement a variety of other measures to be implemented throughout the Project life. Applying the mitigation measures outlined below will enable the Proponent to work with its upstream and downstream partners toward 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, one of the major Project changes was the switch from open pit to underground mining for the Iron Cap deposit and for 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 TMF and Treaty Process Plant, GHG emissions are anticipated to be similar for each facility regardless of location; however, transport GHG emissions will be higher for sites with longer access routes. As reported on 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 RSFs, and the choice to truck copper-gold concentrate to the closer Port of Stewart, rather than to Prince Rupert. Shorter new road construction also has the co-benefit of reducing effects on other VCs[2], 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 Northwest Transmission Line to the

[2] Valued components: as defined in the Application for Information Requirements for the Project.

Project by about 3% (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.

Construction Phase (Control/Reduce)

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 risks of being subject to energy and fuel cost spikes (Stratos 2009), 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 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;
  - 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 (required in BC now for 1989 to 1993 models weighing more than 8,200 kg) with emission reduction devices;
  - procuring fleets with engines three years old 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;
  - fuel 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 on Coca-Cola haul trucks 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 across the KSM Project lifecycle by including as a procurement criteria that the third-party contractors monitor and report on fuel use and related emissions, as well as follow GHG emission mitigations that are mandated under BC and Canadian 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) and taking reasonable steps to minimize GHG emissions from these sources;
- completing preventive maintenance according to manufacturer specifications to ensure optimum performance of diesel mining equipment and thereby reducing GHG emissions;
- considering, when replacing of 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 to 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 Plan (Section 26.13) to ensure successful reclamation of designated areas and to encourage carbon sequestration. Trees and other plants will be selected based on 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 by 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 be mostly 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 will enhance natural carbon sequestration. Only the Treaty Creek access road and the MTT 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 will 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.

26.12.1.4.4 Summary of Project Greenhouse Gas Mitigation Measures

The primary GHG mitigation measures for the Project can be summarized 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.

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.

26.12.1.5 Monitoring and Reporting

Sources of GHG emissions (e.g., fuel and energy use) will be monitored, and resultant data will be used for GHG assessments and reporting for the Project as per provincial and federal guidelines and legislation, as described in Section 26.12.1.1, as well as included in annual reports.

The Proponent will annually review GHG emissions associated with the Project, determine if any trends are evident, and will assess progress on targets. The need for any actions to correct or improve on-site GHG emission management will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- data showing an increasing trend in GHG emissions (with other factors of production held constant); and
- issues being raised by on-site staff, regulators, or local communities.

Discussions will be initiated to resolve issues, and identified solutions will be implemented and monitored for efficacy.

It is possible that components of the Greenhouse Gas Management Plan may need to be revised over the life of the KSM Project, based on regulatory changes and technological advances. Any modification made to the Greenhouse Gas Management Plan will be reported to regulatory authorities where applicable.

26.12.1.6 Responsible Person

The KSM Project Environmental Manager will oversee GHG management for the Project, delegate responsibility on achieving GHG emissions mitigation targets to appropriate facility or equipment controllers, maintain inspection reports, and provide guidance with the support of a qualified specialist (e.g., energy and/or fuel efficiency, GHG emission mitigation) when required.

26.13 Terrain, Surficial Geology, and Soil Management and Monitoring Plans

The following plans are contained within section 26.13 and are described below:

- Soil Salvage and Handling Plan;
- Erosion Control Plan; and
- the Soil Contamination Prevention Plan.

A number of legislated requirements exist to guide mining proponents on the development of a mine site and on the management of terrain and surface soil disturbance. These regulations include the *Mines Act* (1996j), the *Forest and Range Practices Act* (2002c), the federal *Fisheries Act* (1985c), BC's *Environmental Management Act* (2003), and the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007). Each of these statutes sets up specific regulatory requirements that will be discussed as they relate to terrain, surficial geology,

and soil management and monitoring. Some provisions of the *Nisga'a Final Agreement* (NFA; NLG, Province of BC, and Government of Canada 1998) are also applicable.

Legislation and Standards

BC's *Mines Act* (1996j) provides guidance and approvals for all activities on a mine site, from exploration through to development, production, closure, and reclamation. It also requires project proponents to obtain a permit approving the work system and reclamation program. To obtain this permit a detailed Mine Development Plan and Reclamation Program has to be submitted to the Chief Inspector of BC MEMNG for approval.

Under the *Mines Act* (1996j), the Health, Safety and Reclamation Code (BC MEMPR 2008) requires proponents to provide:

- information on surficial geology, terrain mapping, soil characterization, vegetation, wildlife, and present land use (Chapters 8, 16, 17, and 18);
- plans for salvaging and stockpiling of soils and overburden (Section 26.13.2);
- an erosion control plan (Section 26.13.3); and
- a reclamation plan (Section 27).

Watercourse sedimentation typically results from soil erosion and, while erosion prevention is the focus of various best management practices, currently it is not regulated by law. However, since unpaved roads have potential to contribute significantly to soil erosion, road construction within forested areas is governed in BC by the *Forest and Range Practices Act* (2002c). The Act requires that road construction adheres to codes provided in the Forest Service Road Use Regulation (BC Reg. 70/2004), which focuses extensively on erosion prevention.

Matters related to contamination of the terrestrial habitat are regulated by the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007). These guidelines provide Canada-wide standards for the maximum limits of various toxic substances (e.g., metals, hydrocarbons, and pesticides) in the soil. Similarly, the Contaminated Sites Regulation (BC Reg. 375/96) included in BC's *Environmental Management Act* (2003) lists soil criteria for toxicity to soil invertebrates and plants. These provide numerical standards to define whether a site is contaminated, to determine liability for site remediation, and to assess reclamation success.

A set of detailed mine development and reclamation plans will be submitted at a later date as part of the *Mines Act* Permit application. The following sections outline the general provisions included in these documents in terms of soil salvage and its use in reclamation, erosion control, and prevention of soil contamination and compaction.

26.13.1 Soil Salvage and Handling Plan

26.13.1.1 Objective

The objective of the Soil Salvage and Handling Plan is to retain and preserve suitable soil available for use in mine reclamation.

26.13.1.2 Targets

Targets of the Soil Salvage and Handling Plan include the following:

- preserving adequate volumes of soil for reclamation as specified by the reclamation plan (Chapter 27);
- salvaging soil under appropriate weather conditions;
- establishing erosion control over soil stockpiles in a timely manner;
- transporting salvaged soil to soil stockpile locations within less than two weeks;
- seeding weather permitting soil within one month of being stored at stockpile locations; and
- preventing uncontrolled erosion of stockpiled soil while the soil is being stored.

Specifics of how monitoring will be used to ensure targets are achieved are presented in Table 26.13-1.

26.13.1.3 Actions to Avoid, Control, and Mitigate

Salvaged soils will be used during mine reclamation to facilitate the restoration of functioning ecosystems. To achieve this goal, soils must be salvaged, handled, stored, and transported in a manner that does not result in excessive losses of productivity.

Soil salvage will comply with the following guidelines:

- The operation will be adequately supervised and will follow a predetermined soil salvage plan.
- Duff layer will improve soil quality by increasing organic matter content in the stripped material, while excess vegetation (e.g., large tree limbs, root-balls, and logs) incorporated into the soil would result in degradation of its quality. Consequently, soil salvage will include only fine, easily decomposable organic material.
- Prolonged exposure of bare soil to the elements will be avoided; whenever possible, soil salvage will immediately follow vegetation clearing.
- Soil salvage should not be conducted when soils are too wet or too dry, as working in these conditions can degrade soil quality.
- When possible, mineral coarse fragments larger than 25-cm diameter will be separated during salvaging. This will enable equipment operators to effectively shape the soil stockpile. It will also improve the quality of the soil for use in future reclamation efforts.

Table 26.13-1. Soil Salvage and Reclamation Monitoring Variables, Frequency, and Expected Targets

Monitoring Variables	Monitoring Frequency	Targets
Reconciliation of target soil salvage volumes with soil stockpile volumes	annually	target volumes will be provided in the Reclamation Plan
Number of occurrences of soil salvaging during excessively dry or wet conditions	weekly during stripping operations	no occurrences
Length of time the salvaged soil awaits transportation to stockpile area	weekly during stripping operations	< 2 weeks
Length of time between completion of stockpile construction and seeding with erosion control mix	monthly* during stripping operations	< 1 month
Occurrence of standing water on soil stockpiles	monthly until re-vegetated, then annually	no occurrences
Presence of sheet erosion on soil stockpiles	monthly until re-vegetated, then annually	no occurrences
Presence of rills and gullies on soil stockpiles	monthly until re-vegetated, then annually	no occurrences
Soil stockpile photographic record	annually	representative record
Metal concentration in stockpiled soil that exceeds the Contaminated Sites Regulations (BC Reg. 375/96) guideline limits	every fifth summer	no occurrences

*** seeding will be delayed during frozen conditions**

Soil storage will comply with the following guidelines:

- Soil stockpiles will be located on stable foundations, on level ground where possible, outside of flood plains and riparian areas.
- Stockpile design will incorporate setbacks to ensure materials are not inadvertently displaced outside approved areas.
- Topsoil and overburden will be segregated in separate stockpiles.
- Soil stockpiles will be constructed as soil salvage activities progress. As portions of the stockpile become completed, the slopes will be contoured to ensure stockpile stability, minimize erosion, and to help vegetation establishment.
- Traffic in stockpile areas will be limited to stacking and shaping the stockpiles in an effort to minimize compaction. If required, stockpile areas will be lightly ripped (using a sub-soiler) to mitigate compaction.
- The stockpiles will be surrounded by runoff diversion and collection ditch catchments and shaped in a way that will promote slow, efficient drainage of the slopes.

- Completed portions of soil stockpiles (both slope and top) will be re-vegetated to minimize soil erosion, maintain soil quality, and control weeds. The overburden stockpiles will require fertilizer for vegetation establishment. No further maintenance will be required unless erosion is reported.
- Stockpiles will be accessible and will be marked in the field with permanent signs. Information on stockpile quantity and quality will be recorded.

26.13.1.3.1 Design Criteria

Direct placement of salvaged soil and progressive reclamation helps maintain a healthy environment, increases effectiveness of erosion control, and reduces closure-related capital costs at the cessation of mining activities. Where possible, planning and management strategies employed during mine development and operation will attempt to minimize surficial disturbance and reclaim affected areas early by maximizing direct placement of salvaged material.

26.13.1.3.2 Construction

Mixing surface and subsurface soils during salvaging operations will be avoided, where possible, as excessive mixing of the Ah-horizon (topsoil) with deeper soils can degrade the quality of the topsoil and reduce the productivity of the salvaged material. A designated person will be responsible for determining salvaging depth by visual inspection of the material as it is being salvaged.

Mechanically disturbing excessively wet soils can result in soil compaction. Mechanical disturbance of excessively dry soils can result in wind erosion and destruction of soil aggregates. Where practical, soil salvage scheduling will consider preferred soil moisture content and will occur in moderate weather conditions as soon as possible after vegetation removal to avoid prolonged exposure of bare soils. A significant portion of the Project area is either affected by natural seepage or the water table is near the surface. Soil salvaging operations in these areas should be preferentially scheduled during dry or frozen conditions.

Salvaged soil and overburden will be stockpiled and re-vegetated in a timely manner. Soil stockpiles will be located outside of the general work areas so they do not interfere with construction and/or operation activities or with infrastructure expansion.

26.13.1.3.3 Closure

To retain the quality of the soil during reclamation, the soils will be reapplied in a manner that preserves their value. Compaction will be mitigated by ripping to encourage deeper rooting.

26.13.1.4 Monitoring

An Environmental Effects Monitoring Program will be developed and will complement the management plans. The results of the monitoring program will be used to measure the success of the management strategies and to identify if any additional mitigation is necessary.

The various indicators and their monitoring frequency are specified in Table 26.13-1. When required, corrective management action will be taken promptly.

26.13.1.5 Reporting

Annual reporting of reclamation and environmental monitoring work conducted during construction and operation is required by the *Mines Act* (1996j) as part of the environmental protection program (Sections 10.1.5.[4] and [5] of the Health, Safety and Reclamation Code [BC MEMPR 2008]). Inspection reports will include a description of completed mitigation activities and a log of photographs related to soil salvaging and stockpiling. The monitoring results will be summarized and recorded. The monitoring results and corrective actions will be included in the site documentation management system and will be reported to senior management and regulatory agencies as required.

26.13.1.6 Responsible Person

Designated, trained personnel will oversee the soil salvaging and stockpiling operations, maintain inspection reports, and provide guidance with the support of a qualified soil/ geotechnical specialist, when required.

26.13.2 Erosion Control Plan

While slopes vary substantially across the Project area, the moderate to steep slope classes (26% and higher) occupy approximately 70% of the Project area. Furthermore, approximately 41% of the slopes in the Project area are greater than 50%. Due to the common occurrence of steep slopes, terrain stability and erosion, sedimentation control will be vital during all phases of mine development, operation, and closure. A detailed erosion monitoring program will be implemented to guide surface maintenance and mitigation efforts during mine development, operation, and closure.

26.13.2.1 Objective

The primary objective of the Erosion Control Plan is the control, loss prevention, and minimal degradation of soils due to erosion throughout the Project's life. The following goals are implicit in achieving this primary objective:

- conserving soil quantity and quality in areas that are subject to erosion (i.e., stockpiles and disturbed areas located on slopes);
- minimizing natural drainage disruption along access roads and around mine infrastructure;
- stabilizing exposed erodible materials; and
- reducing or controlling sediment delivery into watercourses.

26.13.2.2 Targets

The targets of the Erosion Control Plan are as follows:

- Minimize erosion in disturbed areas.
- Ensure trained staff and a sufficient supply of erosion control materials are always available.
- Allow no occurrences of un-mitigated erosion to occur in disturbed areas.
- Re-vegetate bare non-rock surfaces within six months of disturbance.

- Prevent erosion of sediment and soil into watercourses.
- Keep records of erosion events, how they were mitigated, and the success of the mitigation.

26.13.2.3 Actions to Avoid, Control, and Mitigate

Vegetation cover plays a vital role in erosion control. Thus, soil and associated vegetation disturbance will be minimized where possible in both areal extent and duration. Areas where vegetation has been temporarily removed (e.g., road shoulders, ditches, and soil stockpiles) will be re-vegetated with an appropriate seed mix as soon as possible. Where required, additional means of soil surface stabilization (e.g., mulch, geo-textiles, or soil binder) will be used to hold the soil in place while the vegetation is established.

Roads will be constructed according to the *Forest Road Engineering Guidebook* (BC MOF 2002a) and will be maintained to ensure low landslide risk and continuous, efficient, controlled water drainage. Road design and construction will include consideration of the following:

- existing slope stability, drainage patterns, and soil types;
- potential impact of proposed structures on streams during and after construction;
- potential for adverse upslope, downslope, and downstream drainage effects;
- confinement of sensitive operations in anticipation of weather and snow melt events;
- proper disposal of slash and debris;
- adequate supply and proper installation of erosion and sedimentation control devices; and
- timely re-vegetation of disturbed slopes.

When the road is no longer required, it will be deactivated according to standards outlined in the *Forest Road Engineering Guidebook* (BC MOF 2002a). This will include, but will not be limited to:

- removing all culverts and bridges;
- contouring potentially unstable road shoulders;
- installing water bars (interceptor dikes);
- ripping the road surface; and
- re-vegetation.

During construction and operation, additional erosion control strategies will include:

- controlling slope erosion by terracing and/or installing fibre logs, geotextiles, erosion control mats, straw, or gravel bags;
- controlling and directing runoff from disturbed areas by grading slopes and ditching;
- minimizing runoff energy by limiting the length and steepness of bare, exposed slopes and by applying appropriate surface drainage techniques (e.g., ditch blocks, ditch surface lining, rip-rap); and

- stabilizing water diversion channels and ditches and protecting channel banks with willow, rocks, gabions, or fibre mats.

Some amount of soil erosion will occur, even with the erosion control strategies outlined above. Therefore, where required, sediment control measures will be implemented to ensure the capture of sediments before they are released to the receiving environment. Sediment control measures include installing and/or constructing:

- silt fences;
- straw bales;
- check dams;
- fabric-covered triangular dikes;
- gravel-filled burlap bags;
- sedimentation ponds; and
- rip-rap along channels and ditches.

Turbidity and total soluble solids will be managed towards meeting the *Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments* (BC MOE 2001a). If required, sources of sediment will be identified and short-term erosion control measures (such as the installation of straw bales) will be implemented until long-term mitigation practices can be established.

26.13.2.3.1 Construction

Development activities will be kept away from hydrologically important features (seepage, springs, rivulets, and open water), if practicable. In areas affected by seepage or where the water table is near the surface, construction activities or soil salvaging operations will preferentially be performed during dry or frozen conditions. Where disturbance of wet areas occurs, measures such as drainage ditches, sediment fences, and erosion cloth will be used to minimize surface erosion. Rip-rap may be used along stream banks. Low ground pressure equipment or other methods may be used to minimize the degree of ground disturbance in areas with sensitive soils.

In addition to the comprehensive baseline data on soils, visual surveys of construction activities will help identify potential sites that require focused attention on erosion and sedimentation. Attention will be given to potential erosion sites, ditch failure, culvert blockage, or outside seepage to reduce the potential of slope/road failure and sediment transport. A communications strategy will be established on the construction site to report concerns to environmental managers.

Stormwater runoff and sediment control measures, including isolation of work areas from surface waters and the use of temporary diversion methods (i.e., lined ditches, flumes, dam-and-pump) will be implemented as required. Sediment traps, geotextile cloth, silt fences, gravel berms, straw bales, check dams, fabric-covered dikes, gravel-filled burlap bags, sumps, ditching/culverting, rip-rap, and other appropriate methods will be used, as required, to prevent sediment from entering waterways. Personnel will be trained in the use of these measures.

Vegetation plays a crucial role in maintaining soil stability. Therefore, stripping of soils or stabilization of surface material should occur as soon as possible following vegetation removal. Disturbed surfaces should be re-vegetated as soon as possible with appropriate vegetation.

Erosion protection measures shall be implemented on soil stockpiles. Stockpiles will be located outside of riparian zones and away from surface water. Silt fences may be used at the toe of stockpiled soils. The stockpiles will be constructed to be stable and the surface will be stabilized using short-term measures such as seeding, mulch, geo-textiles, or a soil binder, and will be re-vegetated with a rapidly establishing erosion control mix for longer periods (greater than six months).

26.13.2.3.2 Operation

Proper installation and maintenance of ditches, including roadside, perimeter, and cross-ditching, will be implemented to control surface runoff and sediment transport. Culverts will be installed following best management practices to avoid erosion to the cut banks, the subgrade, or the road surface. Sediment barriers or trenches will be installed in areas downslope of culverts where there is a potential for erosion.

While works around streams are strictly avoided, required near-stream activities will be designed to maintain bank stability and mitigate or repair any stream bank damage caused by Project activities. All watercourse crossings will be properly constructed, such that natural drainage will be maintained. Water diversion structures will be used to divert sediment-laden water from the work zone to a sediment control area if required.

Roads will be constructed and maintained to minimize erosion. Repetitive off-road vehicle travel can intensify soil compaction and soil erosion. Travel corridors will be clearly demarcated and vehicle travel will be discouraged outside of these areas.

A response plan will be developed detailing sediment and erosion control measures in the event of an unexpected increase in overland runoff or saturation of the work area due to precipitation. Materials such as silt fencing, geotextile lining, and hand-tools, will be available in construction areas near waterways. Personnel will be trained in their use.

If they are no longer required, temporary laydown areas and obsolete travel corridors will be deactivated, ripped, and re-vegetated with an appropriate seed mix. Construction during high precipitation events will be avoided, where possible.

26.13.2.4 Monitoring

An erosion monitoring program will be initiated early during the Project's construction phase. Personnel trained in erosion and sediment control and environmental monitoring will be used for construction projects. Workers will be encouraged to communicate concerns related to erosion and sedimentation, debris or snow jams at stream crossings, and contaminant releases. Notifications will be given immediately to appropriate supervisors (and if appropriate, to senior managers and the regulatory agencies) for incidents in which fish and aquatic habitat could be adversely affected, including erosion and sediment production or release.

Ditches, culverts, and adjacent slopes will be inspected as required, especially after high rainfall or melt events. Identified erosion and sediment concerns, such as blockages, siltation, gullying, or slope failure, will be addressed as soon as possible to protect road infrastructure and the adjacent environment.

Evidence of erosion on disturbed and sparsely vegetated non-rock areas will be assessed; if erosion is observed, affected areas will be treated as soon as possible to avoid acceleration of erosion. Temporary measures, such as straw bales and silt fences, will be checked regularly to ensure that they are functioning properly. These will be replaced or serviced, as required. Long-term measures, such as rip-rap, gabions, and ditches will be installed and monitored at the beginning and end of each season or after high rainfall events to ensure that they are operating properly.

Sampling sites will be located on a map and information including their GPS coordinates, erosion type, intensity, and the extent of the affected area, as well as existing control measures and assessment of their performance, may be documented. Affected sites will be checked regularly for evidence of erosion, particularly after high rainfall events, until erosion is not a concern. Targeted field measurements or sediment sampling may be recommended as required. Monitoring results may be used to trigger an appropriate adaptive management response.

Embankment condition and evidence of sediment transport into watercourses will be assessed along water diversion channels, drainage ditches, ponds, and waterway crossings along roads. The waterbodies adjacent to construction sites will be visually inspected for introduced sediment. Water sampling and/or turbidity testing may also be carried out if discolouration occurs. Regular inspection of areas releasing sediment will be carried out until sediment is no longer released. Information will be documented and reported to the designated person.

The erosion indicators and their monitoring frequency are outlined in Table 26.13-2.

Table 26.13-2. Erosion Monitoring Variables, Frequency, and Expected Targets

Monitoring Variables	Monitoring Frequency	Targets
Supplies of erosion/sedimentation control materials in disturbed areas	monthly	sufficient supply is always locally available
Evidence of non-mitigated erosion or sedimentation occurrences in disturbed areas	monthly or after high rainfall events	no occurrences
Presence of unused, disturbed surfaces (>100 m^2) remaining bare (un-vegetated) for more than six months	beginning and end of each season	no occurrences
Number of incidents of sediment entering waterways	monthly or after high rainfall events	no occurrences
Detailed record of erosion/sedimentation occurrences documented during monitoring of water turbidity	monthly or after high rainfall	record of all erosion occurrences

26.13.2.5 Reporting

Inspection reports will include a description of erosion type, intensity, existing control measures and assessment of their performance, extent of the affected area, undertaken mitigation activities, and a log of dated photographs. The monitoring results and corrective actions will be included in the site documentation management system and will be reported to senior management and regulatory agencies, as required.

26.13.2.6 Responsible Person

Designated, trained personnel will oversee the erosion monitoring program, maintain inspection reports, and provide guidance with the support of a qualified soil/geotechnical specialist when required.

26.13.3 Soil Contamination Prevention Plan

Naturally elevated concentrations of arsenic (As), copper (Cu), molybdenum (Mo), and selenium (Se) exceeding the Contaminated Site Regulation (BC Reg. 375/96) standards for industrial sites have been recorded during baseline studies in several locations near the proposed Mine Site area. Furthermore, the majority of the soils in the Baseline Study Area are strongly acidic (e.g., mean pH was 4.9 for the 0 to 10 cm depth, and up to 5.5 for 30 to 50 cm depth), which significantly enhances metal mobility and toxicity. It is therefore important to control further accumulation of metals in the soil.

26.13.3.1 Objective

The objectives of the Soil Contamination Prevention Plan is to ensure that regulatory obligations are met and that potential impacts to people, property, and the environment that occur as a result of Project operations are minimized. The main objective of the Soil Contamination Prevention Plan is to protect soils from substances that have the potential to exert an adverse effect on soil quality and indirectly affect air, water, and organisms.

26.13.3.2 Targets

Activities associated with Project development and operation will not cause any regulated substances (e.g., metals, hydrocarbons, pesticides, cyanide) to exceed concentration limits listed in the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007) or exceed the Soil Criteria for Toxicity to Soil Invertebrates and Plants listed in the Contaminated Sites Regulation (BC Reg. 375/96) included in BC's *Environmental Management Act* (2003).

Isolation, containment, and careful management of all transported fuels, solvents, and other chemicals will be implemented as per the Spill Prevention and Emergency Response Plan (Section 26.10).

26.13.3.3 Actions to Avoid, Control, and Mitigate

All petroleum products and chemicals will be stored and transported appropriately and in compliance with regulatory requirements. The required WHMIS information will be maintained at appropriate locations.

This plan, the Soil Contamination Prevention Plan (Section 26.13.3), and the Spill Prevention and Emergency Response Plan (Section 26.10) will be refined during Project development. Contaminated soil will be disposed of appropriately off site or will be treated on site through a proper remediation procedure.

Despite the introduction of dust control methods (e.g., dust scrubbing, watering, or dust suppressants), dust generated during ore extraction may migrate to areas surrounding the mine facilities. Dust deposition is not anticipated to adversely affect local soils beyond the 100 m buffers around the Project footprint. However, a monitoring program will be designed and implemented. If metals in soil exceed the Contaminated Sites Regulation (BC Reg. 375/96) criteria for industrial use, the contaminated soil will be disposed appropriately off site or will be treated on site using a suitable remediation procedure.

26.13.3.4 Monitoring

A soil monitoring program will be established early during Project construction to detect potential contaminant accumulations and metal deposition/mobility patterns. The program will involve a number of fixed sites located at various distances from the potential sources of emissions. Location of sampling points will be determined in the permitting phase, likely at established baseline data collection locations, as well as areas where Project activities are anticipated to have the greatest impact on soils. Soil data will be collected in fixed sites located in areas where the levels of dust particle deposition/number of spills are expected to vary substantially (e.g., located near and far from the mining pits, the rock crushing facility, the TMF, and the main transportation corridors). Annual soil sampling and testing will be carried out during construction. After construction, soil sampling intensity, sample locations, and intervals will be adjusted depending on testing results (e.g., statistically significant changes would result in increased sampling frequency/density and vice versa). If during the initial stages of operation there is no statistically significant increase in metals, sampling will be reduced to five-year intervals. If after 20 years of operations there is still no statistically significant increase in soils metals, sampling interval will be increased to every 10 years. Sampling will take place in the late summer when weather conditions are generally most uniform and precipitation is low (Environment Canada 2000).

Soil contamination monitoring will target soil reaction (pH) and substances that:

- are toxic (such as metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons); and
- exert adverse effects on soil properties (such as sodium salts, high levels of hydrocarbons, and elemental sulphur).

The soil contamination indicators and their monitoring frequency are outlined in Table 26.13-3.

Table 26.13-3. Soil Degradation Monitoring Variables, Frequency, and Expected Targets

Monitoring Variables	Monitoring Frequency	Targets
Soil metal concentrations exceeding BC Contaminated Sites Regulation (BC Reg. 375/96) guidelines	annually during construction, later every 5 years	no occurrences
Statistically significant increase in soil metal concentration sustained over last three years	annually during construction, later every 5 years	no occurrences
Occurrence of non-remediated soil contamination with concrete, fuel, oil, reagents, or other chemicals	annually during construction, later every 5 years	no occurrences

26.13.3.5 Reporting

Inspection reports will include a description of contaminates, available preventive measures, assessment of preventive measures effectiveness, size of the affected area, and undertaken mitigation activities. Monitoring results and corrective actions will be included in the site documentation management system and reported to senior management and regulatory agencies as required.

26.13.3.6 Responsible Person

Designated, trained personnel will oversee the soil contamination monitoring program, maintain inspection reports, and provide guidance with the support of a qualified soil specialist, when required.

26.14 Metal Leaching and Acid Rock Drainage Management Plan

The proposed ML/ARD Management Plan will be implemented in the construction, operation, closure, and post-closure phases of the proposed KSM Project to monitor, mitigate, and adaptively manage the potential effects of ML/ARD on surface water quality, groundwater quality, fish and fish habitat, wildlife, and human health.

The ML/ARD Management Plan covers the following deposit and non-deposit geological materials and wastes produced during construction and operation:

- Mine Site deposit rock including pit walls, waste rock, and ore;
- non-deposit rock including bedrock and overburden excavated or exposed during construction of surface diversion channels, tunnels, access roads, borrow areas, quarries, and construction of buildings and laydown areas; and
- tailing.

26.14.1 Legislation and Standards

Whenever significant bedrock or unconsolidated material will be excavated or disturbed in BC, an ML/ARD characterization program must be conducted so that, if necessary, prevention, mitigation, and monitoring plans can be implemented.

The guiding BC provincial and federal principles for ML/ARD prediction and management applicable to long-term environmental management of the proposed KSM Project include:

- The prevention of ML/ARD. Prevention should be achieved through prediction, appropriate design, and effective implementation of appropriate mitigation strategies throughout the life of the proposed Project.
- The demonstration that the proposed mitigation strategies meet the environmental objectives for the proposed Project and are compatible with the proposed Project plan and site conditions.
- The evaluation of ML/ARD potential on a site-specific basis.
- The requirement that water discharge into the receiving environment meets applicable BC provincial and federal objectives.

ML/ARD prediction, prevention, and mitigation in BC are guided by the following documents:

- *Policy for Metal Leaching and Acid Rock Drainage in British Columbia* (BC MEM and BC MELP 1998);
- *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price and Errington 1998); and
- *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009).

26.14.2 Objectives

The objective of the ML/ARD Management Plan is to minimize adverse effects on regional surface water quality, groundwater quality, and other linked valued components (VCs) due to drainage from geologic materials produced or exposed during any phase of the proposed KSM Project.

26.14.3 Targets

Specific targets related to achieving the objective are to:

- achieve compliance with legislation and BC provincial and federal ML/ARD prediction, prevention, and mitigation policies;
- provide general management recommendations to minimize ML/ARD;
- minimize alienation of land and watercourses; and
- achieve receiving environment objectives.

26.14.4 Actions to Avoid, Control, and Mitigate

This section provides recommended management actions to avoid and mitigate adverse effects of ML/ARD. Actions are proposed for the Mine Site area deposit rock, non-deposit rock at both the Mine Site and PTMA, and tailing material.

26.14.4.1 Mine Site Deposit Rock

26.14.4.1.1 Metal Leaching and Acid Rock Drainage Assessment

Potential waste rock and pit wall materials were extensively assessed through four years of baseline studies incorporating over 2,000 acid-base accounting (ABA) tests, 40 waste rock humidity cells, and 17 waste rock field leach barrels (Appendix 10-A). Waste rock and pit wall material is predominantly predicted to be potentially acid generating with the exception of some materials predicted to be not potentially acid generating within the ABA block model codes Sulphurets UP Hazelton, Sulphurets Monzonite, and Mitchell Monzonite. Table 26.14-1 defines the criteria for deposit rock ARD classification. The Net Potential Ratio (NPR) is the ratio of available Total Carbon Neutralization Potential to the Total Sulphur Acid Potential. The laboratory analyses required for ARD classification are outlined in the monitoring section below.

Table 26.14-1. Deposit Rock Acid Rock Drainage Potential Classification

Net Potential Ratio	Paste pH	ARD Potential Classification
≥ 3	> 6	NPAG
< 3	--	PAG
--	< 6	Acid-generating

NPAG = Not potentially acid generating.

26.14.4.1.2 Management Considerations

ML/ARD from Mine Site deposit rock will be managed through a combination of materials handling, monitoring, and mitigation measures; these management strategies are described in the following sections.

Materials Handling

Mine Site waste rock will be permanently stored in two engineered RSFs that are constructed using a bottom-up procedure (Mitchell and McTagg RSFs) or backfilled into the Sulphurets Pit. An ore stockpile will be established between the Mitchell and McTagg RSFs. Waste rock and ore storage locations are upstream of the WSD, and contact water will be routed to the WSF. The storage locations of Mine Site waste rock and ore are presented in Table 26.14-2.

Monitoring

A geochemical inventory of waste rock and ore stored at the Mine Site will allow for validation of ML/ARD predictions developed during the environmental effects assessment process. Rock units to be sampled will be defined by the ABA Block Model, and the number of samples will be determined by the minimum sample number for ARD characterization described by the BC Acid Mine Drainage Task Force (BC MEMPR 1989; MEND 1994). Blast hole chips will be

collected and tested on site for ARD potential (Table 26.14-1) as determined by the Net Potential Ratio (NP/AP) and paste pH.

Table 26.14-2. Mine Site Waste Rock and Ore Storage Locations

Waste Rock (by Deposit)	Mass of Waste Rock (kt)	Storage Location
Kerr Waste Rock	664,993	Sulphurets Pit
Sulphurets Waste Rock	596,482	Mitchell RSF
	239,047	McTagg RSF
Mitchell Waste Rock	981,651	Mitchell RSF
	504,915	McTagg RSF
Iron Cap Waste Rock	1,068	Mitchell RSF
	15,724	McTagg RSF
Ore	Not applicable	Ore stockpile between Mitchell RSF and McTagg RSF

An on-site laboratory will be established to allow for timely ARD characterization and management of waste rock. ARD characterization methods will follow standard practices outlined in ML/ARD guidance documents (Price 2009). Off-site duplicate analyses by a laboratory with personnel who are experienced in ARD characterization will be performed on samples to confirm the reliability of the analytical results during the first six months of operation of the on-site laboratory. If the relative percent difference (RPD) of on-site and off-site analyses exceeds 20%, the reason for the variability will be investigated by reviewing sample identification, calculations, and protocols. Once the precision and accuracy of the on-site laboratory achieves acceptable levels of less than 20% RPD, the frequency of off-site duplicate analysis will decrease to 5%.

The following analyses will be performed at the on-site laboratory:

- paste pH;
- sulphide-sulphur determined by Leco furnace on rock initially leached with hydrochloric acid to remove sulphate; and
- total carbon by Leco furnace.

Sulphide-sulphur concentrations will be used to estimate Acid Potential (AP) and total carbon concentrations will be used to estimate Neutralization Potential (NP).

As deposit materials will not be excavated or handled during a temporary or permanent closure, the on-site laboratory will not be required and will be placed under care and maintenance.

Mitigation

ML/ARD management of Mine Site deposit rock includes control and reduction mitigation measures that are described in the following sections. Table 26.14-3 summarizes the ML/ARD mitigation measures.

Table 26.14-3. Mine Site Deposit Rock Metal Leaching and Acid Rock Drainage Management and Mitigation Measures

Mine Site Management Component	Actions	Construction	Operation	Closure	Post-closure
Pit walls	Pits will be dewatered and the water collected in the WSF		X		
	Kerr and Sulphurets pits will be dewatered post-closure with water being directed to the WSF			X	X
	Mitchell Pit will be allowed to flood at closure, which will reduce surface area of pit walls exposed to oxidation and leaching			X	X
Block cave mines	Mitchell and Iron Cap block cave mines will be dewatered, and the water collected in the WSF or treated directly at the WTP		X		
	Block cave mines will be allowed to flood at closure which will reduce surface area of pit walls exposed to oxidation and leaching			X	X
PAG and acid-generating waste rock	Material will be stored in an appropriate RSF	X	X	X	X
	Contact water from RSFs will be routed to the WSF				
NPAG waste rock	Material may be used for construction	X	X	X	X
Ore stockpiles	Drainage from stockpiles will report to the WSF	X	X		
	Prior to permanent or temporary closure, ore stockpiles will be transported to either the Mitchell OPC or to a permanent RSF		X		

NPAG = not potentially acid generating.

Control

- **Water Management:** Water management is a key component of ML/ARD management for the proposed KSM Project. The main objective is to minimize the amount of non-contact water reporting to the WSF to reduce water treatment requirements. Diversion structures will route non-contact water around the RSFs and WSF. Permanent diversions include the Mitchell Diversion Tunnels and McTagg Twinned Diversion Tunnels and lined surface channels (KCB 2012b). During the operation, closure, and post-closure phases, contact water and seepage from the Mine Site will be routed to the WSF, which will be completed before commencement of mining activities.

- **Waste Segregation:** Waste rock from the Kerr and Sulphurets deposits will be segregated based on ML/ARD potential. Waste rock from the Mitchell and Iron Cap deposits will not be segregated based on ML/ARD potential.
  - **Kerr Deposit:** Waste rock from the Kerr deposit is predicted to have the highest sulphide content and the highest potential for ML/ARD, specifically selenium leaching. During the design phase, Seabridge decided to segregate the Kerr waste rock. Kerr waste rock will be backfilled into the Sulphurets Pit during the operation phase. The waste rock will be backfilled using a bottom-up approach.
  - **Sulphurets Deposit:** Waste rock will be segregated based on ML/ARD potential during pre-stripping and mining of the Sulphurets deposit to obtain construction material for the WSD and RSF basal drains.

    Material from the development of the Sulphurets deposit will be identified as PAG, not potentially acid generating (NPAG), or acid-generating using the ARD classification criteria in Table 26.14-1. Material assessed as PAG or acid-generating will be transported to, and stored in, an RSF. NPAG material will be considered suitable for use in construction.

    In general, segregation of waste rock will be achieved at an operational scale using the following steps:

    1. Blast hole chips will be collected and tested on-site for ARD potential (see Table 26.14-2) as determined by the Net Potential Ratio (NP/AP) and paste pH.
    2. The results will be used by qualified personnel to determine the spatial distribution of material that can be segregated.
    3. Daily mine plans, including the spatial distribution of material to be segregated, will be developed and communicated to equipment operators.
    4. Disposal locations will be monitored to ensure that wastes are transferred to the appropriate facility.
- **Water Treatment**
  - **TWT Facilities:** During the construction phase, local treatment of contact water will occur at various locations to treat drainage from tunnel portals and temporary stockpiles of PAG material. These facilities will remove dissolved metals, suspended solids, and ammonia if required (KCB 2012b).
  - **WSF/WTP:** Water stored in the WSF during the construction, operation, closure, and post-closure phases will be treated at the WTP, a high-density sludge lime-water treatment plant with a treatment capacity of 7.5 m^3/s (KCB 2012b).
  - **Selenium Treatment Plant:** Water from the Sulphurets backfill (Kerr waste rock) will be collected at a basal drain and will be routed to the ion-exchange Selenium Treatment Plant that has a treatment capacity of 0.06 m^3/s. Drainage from the Kerr Pit will be routed by the Selenium Treatment Plant to allow treatment from this flow if required (KCB 2012b). Treated water from the Selenium Treatment Plant will be

routed to the WSF. The spent regenerant from the ion-exchange columns will report to a selenium-reduction stage for elemental selenium precipitation. If required, the plant may be expanded to 0.2 m^3/s by adding more ion exchange columns.

Reduction

- **Flooding:** During the closure and post-closure phases, the Mitchell Pit and Mitchell and Iron Cap block cave mines will be allowed to flood. Flooding will reduce the surface area exposed to oxygen and will decrease rates of sulphide oxidation and metal leaching.
- **Cover:** During the operation phase, a liner will be applied to a portion of each lift of the Sulphurets backfill (Kerr waste rock) to minimize infiltration. The liner will be applied to the outer edge of each bench to a width of 100 m. Sixty metres of the liner will be covered by the subsequent lift.

26.14.4.2 Non-deposit Rock and Overburden

Non-deposit rock includes bedrock and overburden excavated or exposed during construction of surface diversion channels, tunnels, access roads, borrow areas, quarries, buildings, and laydown areas.

26.14.4.2.1 Metal Leaching and Acid Rock Drainage Assessment

The location of proposed access roads, borrow areas, and quarries were sited to avoid areas of high ML/ARD potential, where possible. The ML/ARD potential of non-deposit rock will be assessed prior to use as construction material, and to inform materials handling, monitoring, and mitigation requirements. The ML/ARD potential of the Coulter Creek and Treaty Creek Access corridors and tunnels was assessed for the environmental effects assessment based on available design information (Chapter 10; Appendices 10-A and 10-B). Table 26.14-4 identifies the ML/ARD potential classification criteria. The Net Potential Ratio (NPR) is the ratio of available Total Carbon Neutralization Potential to the Total Sulphur Acid Potential. The laboratory analyses required for ML/ARD classification are outlined in the monitoring section below.

Table 26.14-4. Non-deposit Rock and Overburden Metal Leaching and Acid Rock Drainage Potential Classification

NPR	Paste pH	ARD Potential Classification	Metal Leaching	ML Potential Classification
≥ 3	> 6	NPAG	Less than receiving environment objective	Not Likely
			Greater than receiving environment objective	Likely
< 3	--	PAG	Less than receiving environment objective	Not Likely
			Greater than receiving environment objective	Likely
--	< 6	Acid-generating	Less than receiving environment objective	Not Likely
			Greater than receiving environment objective	Likely

NPR = Net Potential Ratio

26.14.4.2.2 Management Considerations

Prediction, prevention, and management of ML/ARD from non-deposit rock will be managed through a combination of materials handling, monitoring, and mitigation measures; these management strategies are described in the following sections.

Materials Handling

Non-deposit rock may be used for construction at various locations throughout the proposed Project area. Non-deposit rock and overburden material handling will be determined by (1) the suitability as construction material (Table 26.14-5), and (2) the location within or outside of the WSF catchment. The criteria for suitable construction rock are defined in Table 26.14-5.

Table 26.14-5. Construction Suitability of Non-deposit Rock and Overburden

ARD Potential	ML Potential	Suitable for Construction?
NPAG	Likely	Within WSF Catchment
NPAG	Not Likely	Yes
PAG	--	No
Acid-generating	--	No

Table 26.14-6 outlines the materials handling requirements for non-deposit rock and overburden classified as not suitable for construction.

Table 26.14-6. Material Handling Requirements for Non-deposit Rock and Overburden Not Suitable for Construction

Location	Material Handling Requirements
Within WSF Catchment	Material may be left in place or re-handled as required.
Outside of WSF catchment	1) Acid-generating material will be placed on lined pads or hauled to either the RSFs or lined section of the TMF. 2) PAG material will be handled as acid-generating material if feasible and practical. If pad placement is not feasible or not practical, drainage water quality will be monitored to identify potential effects on water quality (see Site-wide Water Quality Monitoring Plan). Additional mitigation or re-handling will occur as required.

Monitoring

A geochemical inventory of non-deposit materials will allow for validation of ML/ARD predictions developed during the environmental effects assessment process and for classification of suitable construction materials. Where an ML/ARD assessment was completed during the environmental effects assessment process (e.g., access roads and tunnels), samples will be collected for sections where an ML/ARD potential of possible or higher was identified. The number of samples for sections of access roads and tunnels with a low ML/ARD potential and for all other non-deposit material will be determined by the minimum sample number for ARD characterization described by the BC Acid Mine Drainage Task Force (BC MEMPR 1989; MEND 1994).

An on-site laboratory will be established to allow for timely ARD characterization and management of waste rock. ARD characterization methods will follow standard practices outlined in ML/ARD guidance documents (Price 2009). Off-site duplicate analyses by a laboratory experienced in ARD characterization will be performed on samples to confirm the reliability of the analytical results during the first six months of operation of the on-site laboratory. If the RPD of on-site and off-site analyses exceeds 20%, the reason for the variability will be investigated by reviewing sample identification, calculations, and protocols. Once the precision and accuracy of the on-site laboratory achieves acceptable levels of less than 20% RPD, the frequency of off-site duplicate analysis will decrease to 5%.

The following analyses will be performed at the on-site laboratory:

- paste pH;
- sulphide-sulphur determined by Leco furnace on rock initially leached with hydrochloric acid to remove sulphate; and
- total carbon by Leco furnace.

Sulphide-sulphur concentrations will be used to estimate Acid Potential (AP) and total carbon concentrations will be used to estimate Neutralization Potential (NP).

Additional ML/ARD characterization will be completed on non-deposit material that will be stored outside of the WSF catchment. The following analyses will be completed at a laboratory experienced in ARD characterization:

- neutralization potential by Sobek and Modified Sobek methods; and
- Shake Flask Extraction (SFE) with analysis of dissolved constituents by ICP methods.

As non-deposit materials will not be excavated or handled during a temporary or permanent closure, the on-site laboratory will not be required and will be placed under care and maintenance.

Mitigation

ML/ARD management of non-deposit rock and overburden includes avoidance, prevention, control, and reduction mitigation measures that are described in Table 26.14-7.

26.14.4.3 Tailing

26.14.4.3.1 Metal Leaching and Acid Rock Drainage Assessment

Tailing includes desulphidized rougher flotation tailing and cleaner sulphide tailing produced through a carbon-in-leach (CIL) process. Desulphidized rougher tailing will be stored in the north or south flotation cells or will be cycloned for use in dam construction while sulphide tailing will be stored in a lined cell.

Table 26.14-7. Non-deposit Rock and Overburden Metal Leaching and Acid Rock Drainage Management and Mitigation Measures

Non-deposit Rock Management Component	Actions	Construction	Operation	Closure	Post-closure
Surface Diversions and Tunnels	During the construction of surface diversions and tunnels, the ML/ARD potential of exposed bedrock will be assessed.	X			
	When exposure of PAG bedrock is unavoidable, the diversion and tunnels will be constructed to minimize the infiltration of diverted water. Lining will also reduce the surface area exposed to water and oxygen, and will reduce rates of sulphide oxidation and metal leaching.	X	X		
	Drainage from tunnel portals and PAG tunnel muck during construction will be treated at TWT facilities.	X			
	Reclamation of the surface water diversions and tunnels will minimize the exposure of the bedrock to water and oxygen in order to minimize ML/ARD.		X	X	X
Buildings and Laydowns	Surface disturbance at building and laydown sites will be assessed for ML/ARD potential.	X	X		
	Buildings and laydowns will be constructed, operated, and reclaimed to minimize bedrock exposure.	X	X	X	X
Access Roads	ML/ARD potential of exposed or disturbed bedrock will be assessed during construction of access roads.	X	X		
	Access road alignments will be assessed for ML/ARD potential and, where practical, alignments will be designed to avoid PAG or acid-generating sections.	X	X		
	Excavated acid-generating or PAG access road material will be stored in a manner that minimizes environmental effects.	X	X	X	X
Borrow Pits	Prior to developing a borrow pit the material will be assessed for ML/ARD potential. Borrow pits classified as PAG will not be developed.	X			
	Borrow pits will be reclaimed when no longer in use.		X	X	X
Quarries	Prior to developing a quarry, the material will be assessed for ML/ARD potential. Quarries classified as PAG will not be developed. If PAG material is identified in an operating quarry, appropriate mitigation will be applied.	X			
	Quarries will be reclaimed when no longer in use.		X	X	X

Extensive geochemical characterization of tailing material has predicted that rougher tailing material will be NPAG and that sulphide tailing material will be PAG (Appendix 10-A). These ML/ARD predictions were incorporated into the design basis for the TMF.

26.14.4.3.2 Management Considerations

Materials Handling

The Treaty Process Plant will process 2.17 Bt of ore for the 51.5 year mine life, yielding a total tailing throughput of 2.16 Bt (removal of 0.5% ore concentrate). The flotation (rougher) tailing represents about 90% of the total tailing by weight, with sulphide tailing comprising the remaining 10%. The flotation (rougher) tailing is classified as NPAG and will be cycloned to produce sand fill for construction of the tailing dams during the summer months. During the summer, the fine cyclone overflow tailing will be discharged along the upstream crest of the tailing dams. The entire flotation (rougher) tailing stream will be discharged along the upstream dam crests during the winter months. The cleaner (sulphide) tailing from the CIL process is a high-sulphide-concentration material and is classified as PAG. This material will be deposited subaqueously in the Centre Cell of the TMF in a separate lined water-covered sulphide containment cell.

Monitoring

A geochemical inventory of tailing material will allow for validation of ML/ARD predictions developed during the environmental effects assessment process. Quarterly composite samples of both rougher and sulphide tailing will be collected and analyzed.

An on-site laboratory will be established to allow for timely ARD characterization and management of tailing material. ARD characterization methods will follow standard practices outlined in ML/ARD guidance documents (Price 2009). Off-site duplicate analyses by a laboratory experienced in ARD characterization will be performed on samples to confirm the reliability of the analytical results during the first six months of operation of the on-site laboratory. If the RPD of on-site and off-site analyses exceeds 20%, the reason of the variability will be investigated by reviewing sample identification, calculations, and protocols. Once the precision and accuracy of the on-site laboratory achieves acceptable levels of less than 20% RPD, the frequency of off-site duplicate analysis will decrease to 5%.

The following analyses will be performed at the on-site laboratory:

- paste pH;
- sulphide-sulphur determined by Leco furnace on rock initially leached with hydrochloric acid to remove sulphate; and
- total carbon by Leco furnace.

Sulphide-sulphur concentrations will be used to estimate AP and total carbon concentrations will be used to estimate NP.

As ore will not be processed during a temporary or permanent closure, the on-site laboratory will not be required and will be placed under care and maintenance.

Mitigation

ML/ARD management of tailing material includes prevention and control mitigation measures that are described in Table 26.14-8.

Table 26.14-8. Tailing Material Metal Leaching and Acid Rock Drainage Management and Mitigation Measures

TMF Management Component	Actions	Construction	Operation	Closure	Post-closure
Flotation (North and South Cells) TMF	Flotation (rougher) tailing will be stored in the flotation cells.		X		
Centre Cell TMF	Cleaner (sulphide) tailing will be subaqueously disposed in the lined CIL Cell.		X		
	Maintain a 3-m water cover during operation.		X		
	Apply a 1-m flotation (rougher) tailing cover and maintain a 5-m water cover after closure.			X	X

Tailing material will be stored in a multi-stage TMF, which will have two flotation tailing cells (North and South), and a separate lined CIL cleaner (sulphide) tailing slurry-containment cell (the Centre Cell).

To minimize sulphide oxidation, acid generation, and metal leaching to levels that do not pose an environmental concern, a water cover will be maintained in the CIL-lined Cell during operation.

At closure, a saturated flotation tailing cover will be placed over the CIL pond deposits, and a 5-m closure water cover will be maintained.

26.14.5 Reporting

Reporting on the ML/ARD materials characterization, sampling and monitoring inventory will be the responsibility of the Environmental Superintendent and delegates. Reports will be submitted to the appropriate regulatory agencies as required. The primary regulatory agencies for ML/ARD are the BC MEMNG enforcing the *Mines Act* (1996j) and the BC Ministry of Environment enforcing the *Environmental Management Act* (2003).

26.14.6 Responsible Persons

Each department head will be accountable for his or her workers, including the Proponent's employees, contractors, and sub-contractors, to ensure that mining waste is handled correctly as per the segregation and management plans described above. Overall responsibility for the management of ML/ARD will belong to the Environmental Superintendent.

26.15 Groundwater Monitoring Plan

26.15.1 Legislation and Standards

The Project will be required to implement a groundwater monitoring plan to satisfy conditions identified in the *Canadian Environmental Assessment Act* (1992a), as specified in the AIR (BC EAO 2011). Groundwater monitoring plans are conditions of the *Mines Act* Permit and the Waste Discharge Permit under the provincial *Environmental Management Act* (2003).

The Groundwater Monitoring Plan is a component of the mitigation and monitoring program that will be implemented to minimize potential adverse effects on the surface water and groundwater environments. To that end, it has been developed to satisfy guidelines and requirements specified in the following legislation:

- *Canada Water Act* (1985a);
- BC *Water Act* (1996n); and
- BC *Water Protection Act* (1996o).

The BC Water Quality Guidelines (BC MOE 2010d) have been used as reference benchmarks for groundwater quality; although these guidelines are established primarily for the surface water environment (e.g., freshwater aquatic life guidelines), they are applicable because the groundwater environment is a cause-effect pathway to surface water quality.

26.15.2 Objective

Objectives of the groundwater monitoring plan include the following:

- to track degradation of groundwater quality arising from seepage of contact water from mine components;
- to track changes in groundwater levels arising from mine components;
- to identify the occurrence of adverse effects on surface water quantity and quality arising from alteration of groundwater conditions; and
- to establish criteria for adaptive management implementation.

Localized adverse effects on groundwater quantity and quality have been predicted, as identified in the groundwater quantity and quality effects assessments (Chapters 11 and 12, respectively). The monitoring plan is an extension of the predictions, whereby action is taken to ensure that adverse effects are not greater than those predicted, and adaptive management is initiated in the event that adverse effects exceed thresholds, which have been established in this plan.

26.15.3 Targets

Monitoring points are planned down-gradient of predicted effects on groundwater quantity and quality. The detection of changes in groundwater conditions at these points would constitute adverse effects that exceed those predicted, as identified in the groundwater quantity and quality effects assessments (Chapters 11 and 12, respectively). Monitoring of background groundwater quality and

levels is also planned, in both the Mine Site and PTMA, at a selection of wells that were installed for the collection of baseline hydrogeological data.

Groundwater Quantity Targets

Targets for groundwater quantity are the established baseline water levels. Occasional divergences from baseline water levels are acceptable. Trends that indicate a statistically significant divergence from baseline water levels would constitute not meeting a target. Alterations of hydraulic gradients, flow directions, and flow rates should be assessed if divergences from baseline water levels occur.

Certain proposed monitoring points have established baseline water levels, including seasonal variability. Baseline water levels are documented in the hydrogeology baseline reports (Appendices 11-A, 11-B, and 11-C). Background water levels will be established at proposed new monitoring points prior to commencement of activity at nearby mine components. Specific monitoring points are identified in Section 26.15.5.

Groundwater Quality Targets

Targets for groundwater quality include the published BC Water Quality Guidelines (BC MOE 2010d) and the established baseline water quality parameters. Where guideline exceedances exist in the baseline data, trends that indicate a statistically significant divergence from baseline would constitute not meeting a target. Where guideline exceedances do not exist in the baseline data, guideline exceedances would constitute not meeting a target. Certain proposed monitoring points have established baseline water quality, including seasonal variability. Baseline water quality is documented in the hydrogeology baseline reports (Appendices 11-A, 11-B, and 11-C). Background water quality will be established at proposed new monitoring points prior to commencement of activity at nearby mine components. Specific monitoring points are identified in Section 26.15.5.

BC Water Quality Guidelines that apply to the groundwater at the KSM Project include those specified for the protection of freshwater aquatic life and those for raw drinking water. Applicable guidelines are presented in Table 26.15-1. These guidelines were current at the time of writing, but are subject to change. Applicable working water quality guidelines have been included where they exist.

26.15.4 Actions to Avoid, Control, and Mitigate

Groundwater Quality

Sources of contamination entering the groundwater environment include seepage of contact water and releases of industrial fluids. Seepage of contact water will be confined to planned waste disposal and contact water management sites, with implementation of the ML/ARD Management Plan (Section 26.14). These include the TMF and the Mitchell Valley upstream of the WSF. Releases of industrial fluids are addressed in the Spill Prevention and Emergency Response Plan (Section 26.10). Both of these plans include specific proposed actions to avoid and control releases.

Table 26.15-1. Groundwater Quality Targets Established for the KSM Project, as Defined in the British Columbia Water Quality Guidelines (2010)

Parameter	Units	Freshwater Aquatic Life	Drinking Water
pH	-	6.5 to 9.0	6.5 to 8.5
Nutrients and Major Anions			
Ammonia	mg/L as N	R	ng
Fluoride (F)	mg/L	Q	1.5
Nitrate	mg/L as N	3	10
Nitrite	mg/L as N	0.02 [S]	1
Sulphate (SO_4)	mg/L	100	500 [U]
Cyanides			
CN (WAD) [A]	mg/L	0.005	ng
CN (Total)	mg/L	ng	ng
Total Metals			
Aluminum (Al)	mg/L	M, W	0.2 [W]
Antimony (Sb)	mg/L	0.02[E]	ng
Arsenic (As)	mg/L	0.005	0.025 [D]
Barium (Ba)	mg/L	5[E]	ng
Beryllium (Be)	mg/L	0.0053[E,T]	ng
Boron (B)	mg/L	1.2	5
Cadmium (Cd)	mg/L	E, F	ng
Calcium (Ca)	mg/L	ng	ng
Chromium (Cr)	mg/L	0.001[E, G]	ng
Cobalt (Co)	mg/L	0.004 T	ng
Copper (Cu)	mg/L	H, T	0.5
Iron (Fe)	mg/L	0.35 [W]	ng
Lead (Pb)	mg/L	J, T	0.05
Lithium (Li)	mg/L	0.014 [E,T]	ng
Magnesium (Mg)	mg/L	ng	ng
Manganese (Mn)	mg/L	L, T	ng
Mercury (Hg)	mg/L	2.0E-5, T	0.001
Molybdenum (Mo)	mg/L	1, T	0.25
Nickel (Ni)	mg/L	0.025-0.150[E, N]	ng
Selenium (Se)	mg/L	0.002	0.01
Silver (Ag)	mg/L	0.0001-0.003[P]	ng
Thallium (Tl)	mg/L	0.0003[E]	ng
Uranium (U)	mg/L	0.3[E]	ng

(continued)

Table 26.15-1. Groundwater Quality Targets Established for the KSM Project, as Defined in the British Columbia Water Quality Guidelines (2010; completed)

Parameter	Units	Freshwater Aquatic Life	Drinking Water
Total Metals (cont'd)			
Vanadium (V)	mg/L	0.006 T	ng
Zinc (Zn)	mg/L	K, T	5

Notes:
Bold/Italic/underlined = exceeds Freshwater Aquatic Life Guideline (BC MOE 2010d).
Shaded = exceeds BC Raw Drinking Water Guideline (BC MOE 2010d).
Outlined = exceeds range of natural variation.
ng = no established guideline.
N/A = Plume concentration not available, not included in TMF surface water quality model.
A Only total CN- concentrations analysed for baseline sampling, and baseline concentrations are very low. Total baseline CN- concentrations assumed to be entirely WAD.
B Measured concentration below detection limit. Average is calculated using half of the detection limit where it exceeded measured concentrations.
C Highest concentration measured in baseline groundwater sampling listed.
D Interim guideline.
E Working water quality guideline, not formally endorsed.
F Cd guideline hardness-dependent: [Cd] = 0.001 * 10^[0.86[log(hardness)] - 3.2} mg/L.
G Cr guideline = 0.0010 mg/L (Cr VI), or 0.0089 (Cr III) which is interim. Most stringent guideline applied.
H Cu guideline hardness-dependent. [Cu] = 2 ug/L for Hardness < 50 mg/L, otherwise [Cu] = 0.04*Hardness in ug/L.
J Pb guideline hardness-dependent. For Hardness<8 mg/L [Pb] = 3 ug/L, otherwise use chronic guideline: [Pb] = 3.31+exp(1.273*ln(Hardness)-4.704) in ug/L.
K Zn guideline hardness-dependent: [Zn] = 7.5 ug/L for Hardness < 90 mg/L, else [Zn] = 7.5+0.75*(Hardness-90) in ug/L.
L Mn guideline hardness-dependent: [Mn] = 0.0044*Hardness+0.54 in mg/L.
M Al guideline pH-dependent: 0.1 mg/L for pH>6.5. For pH<6.5 [Al]=exp(1.209-2.426*pH+0.286*pH2).
N Ni guideline hardness-dependent: [Ni] = 0.025 mg/L at hardness 0-60 mg/L as CaCO3, 0.065mg/L at 60 - 120 mg/L, 0.110 mg/L at 120 - 180 mg/L, 0.150 mg/L at > 180 mg/L.
P Ag guideline hardness-dependent: [Ag] = 0.003 mg/L for >100mg/L, 0.0001mg/L for ≤ 100mg/L.
Q F- guideline hardness-dependent: [F-] = 0.1*(-51.73+92.57*log(Hardness)) in mg/L.
R NH3 guideline temperature- and pH-dependent, as tabulated in BC MOE (2012). Average baseline groundwater temperature assumed (5.0 °C).
S Nitrite guideline higher for chloride concentrations greater than 2 mg/L.
T Chronic exposure guideline. Acute guidelines listed only were chronic guidelines have not been established.
U Aesthetic guideline only.
V Guidelines apply specifically to dissolved component. Unless specified otherwise, guidelines for metals apply to total concentrations.
W Guideline specified for dissolved component.

Certain design features have been established specifically to minimize seepage from contact water management sites. These include:

- **seepage collection ponds** – used to capture groundwater flow down-gradient of the WSD and TMF dams;
- **seepage cut-off walls (grout curtains)** – used to reduce permeability below the WSF, TMF dams, and seepage collection dams;
- **seepage collection tunnels** – used to capture groundwater flow below the WSD; and
- **CIL TMF Centre Cell** – used to store fine PAG tailing, where higher concentrations of metals and lower pH are expected. The CIL Cell is located in the centre of the TMF, where hydraulic gradients in the subsurface are lowest, resulting in slower transport in the

groundwater upon contact. The design also includes a low-permeability liner, which will reduce seepage rates and delay contact.

Groundwater Quantity

No measures are planned for the avoidance, control, or mitigation of effects on groundwater quantity. Measures used to mitigate effects on groundwater quality have adverse effects on groundwater quantity, because they reduce seepage contributions to the down-gradient environment. Effects on groundwater quantity are predicted to be local in extent without mitigation measures, primarily due to the containment provided by the steep hydraulic gradients in the valleys where the mine components are proposed.

26.15.4.1 Monitoring

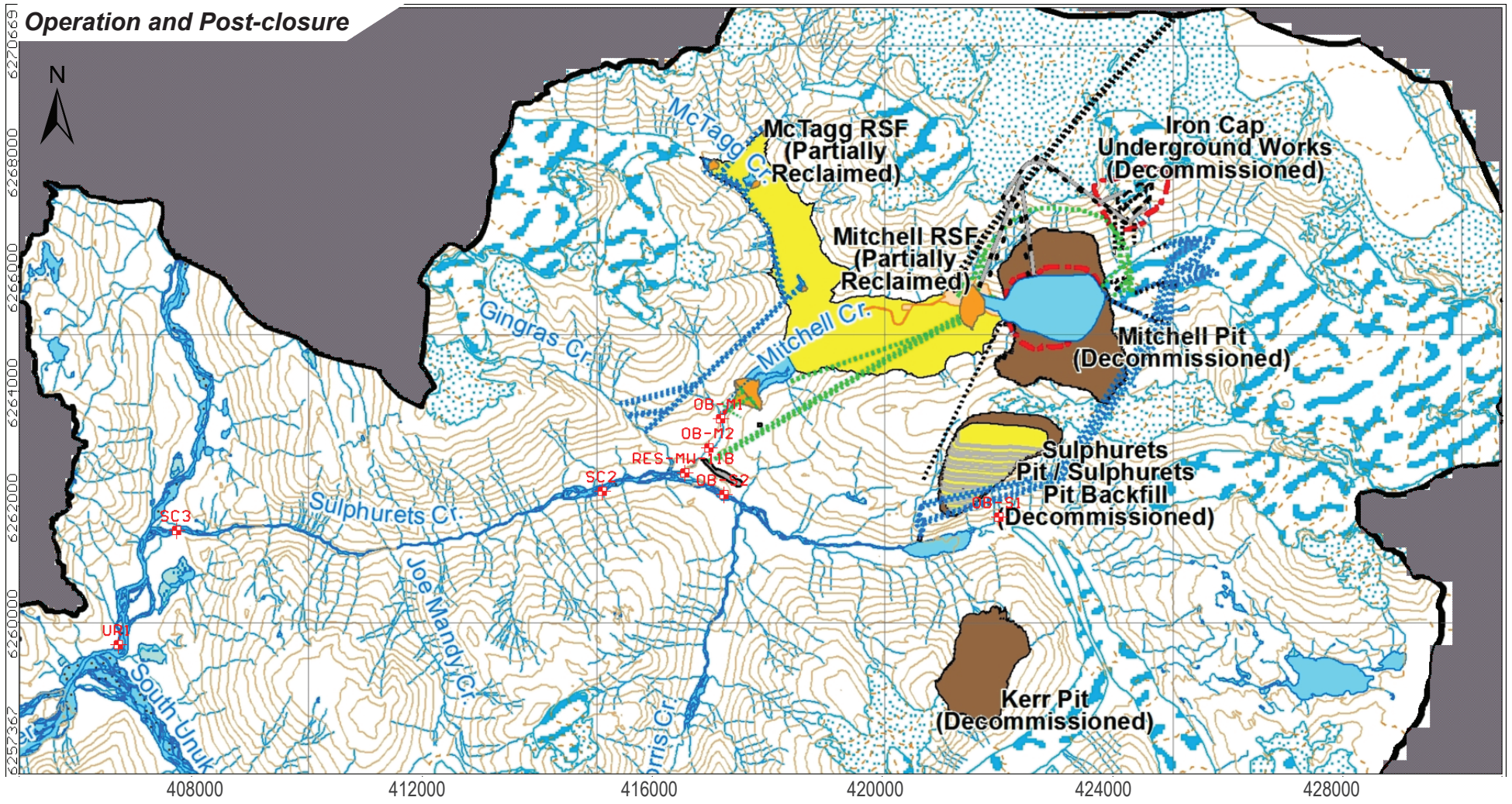
The proposed groundwater monitoring network includes existing and proposed wells in the Mine Site and PTMA. Eight wells are proposed in both the Mine Site and PTMA for tracking the degradation of groundwater quality arising from seepage of contact water from mine components. Multilevel sampling wells can be installed (one in alluvium, one in shallow bedrock) at each site. Additionally, existing wells that are located outside the mine footprints and that are anticipated not to be affected by the future mining activities will be used to monitor background water quality and levels in the Mine Site (well RES-MW-14) and PTMA (well RES-MW-03).

Monitoring activities will include groundwater level measurements and groundwater quality sampling. Water samples will be analyzed at an environmental laboratory for analytes included in the BC Water Quality Guidelines, as listed in Table 26.15-1. Data will be analyzed for guideline exceedances and trends that diverge from baseline conditions.

Groundwater monitoring locations were identified based on the predictive groundwater flow and solute transport results that formed the foundation of the groundwater effects assessments. Certain locations where there is uncertainty in the solute transport results were identified. Figures 26.15-1 and 26.15-2 show the proposed locations of down-stream monitoring sites in the Mine Site and PTMA, respectively. Proposed background monitoring wells, which were also used for baseline groundwater data collection, are shown in Figures 11.1-1 and 11.1-2 (Chapter 11). Table 26.15-2 identifies the rationale for their inclusion in the monitoring network. Predicted concentrations (base case simulation results) at planned monitoring wells are presented in Figures 26.15-3 and 26.15-4 for the Mine Site and PTMA, respectively. Predicted concentrations arising in the event of operation and early closure are provided for the PTMA, whereby the TMF only attains final stage 1 construction prior to mine closure.

Wells are planned along drainage pathways down-gradient of mine components with predicted contact water seepage, including the WSF and TMF. There is no contact water seepage predicted for the Sulphurets Pit, because it will be de-watered. However, worst-case scenario modelling indicates that flow paths may pass through the unsaturated waste rock backfill and report to Sulphurets Lake. A monitoring well is proposed down-gradient of Sulphurets Pit because of its proximity to Sulphurets Lake and because of recognized uncertainty in the modelling results.

Monitoring will commence at particular wells when up-gradient mine components become active. Specific wells and the timing that monitoring will be active are listed in Table 26.15-2.



Legend

- Observation Well (SC2)
- Underground Conveyor
- Diversion Tunnel
- Collection Tunnel
- Tunnel
- Surface Disturbance
- Dam
- Pond
- Pit & Pit Lake
- Rock Storage Facility
- Underground Footprint
- Water Treatment Plant
- Ore Preparation Complex
- Glacier
- Icefield
- Creek/River/Lake
- Inactive Cells

Figure 26.15-1

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Groundwater Monitoring Locations in the Mine Site

Figure 26.15-1

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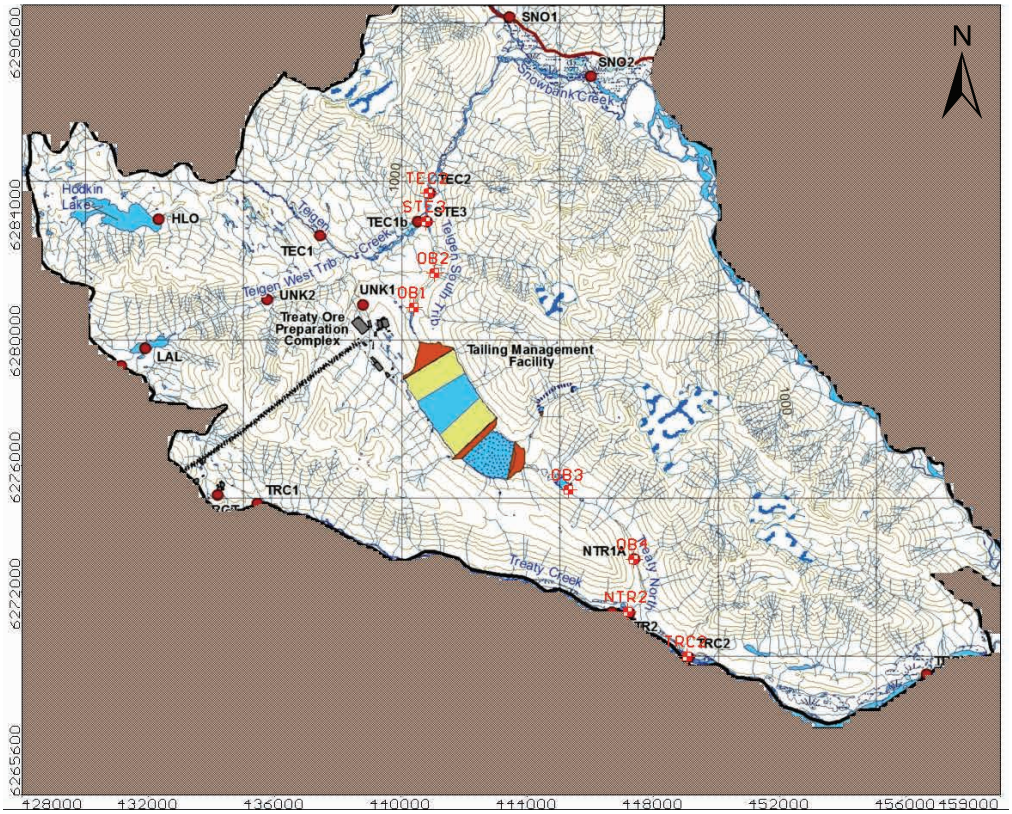
Table 26.15-2. Proposed Monitoring Well Locations and Rationales

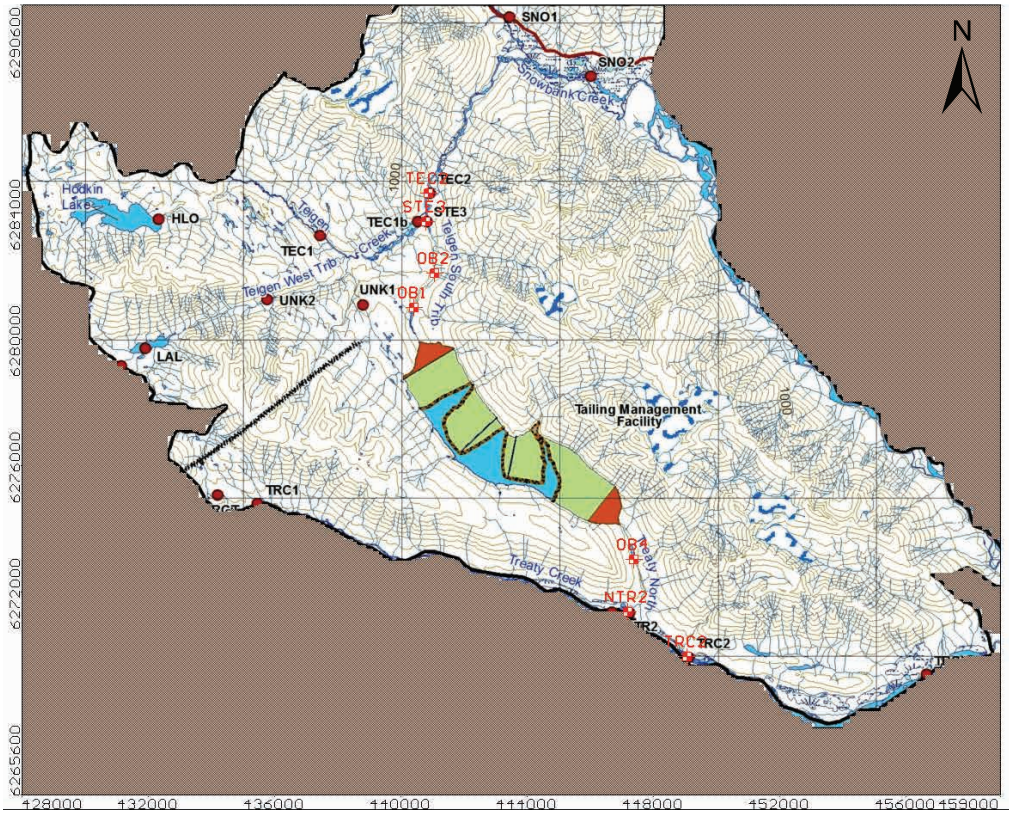
Well ID	Existing (Y/N)	Active timeframes: Construction	Operation	Closure	Post-closure	Location	Rationale for monitoring
Mine Site							
MW-11B	Y	X	X	X	X	Confluence of Mitchell and Sulphurets creeks	Assess presence of contact groundwater emanating from Mine Site, hydraulic gradient into Surface water.
OB-M1	N	X	X	X	X	Mitchell Creek downstream of the WSF seepage collection dam, within 10 m of dam downstream foot	Assess presence of contact groundwater emanating from WSF pond, hydraulic gradient into Mitchell Creek.
OB-M2	N	X	X	X	X	Mitchell Creek downstream of the WSF seepage recovery dam, half-way to mouth	Assess presence of contact groundwater emanating from WSF pond, hydraulic gradient along Mitchell Valley downstream of dam.
OB-S1	N	X	X	X	X	Northeast of Sulphurets Lake, down-gradient of planned Sulphurets Pit	Assess presence of contact groundwater emanating from Sulphurets Pit, hydraulic gradient into Sulphurets Lake.
OB-S2	N	X	X	X	X	Sulphurets Creek up gradient of Mitchell Creek mouth	Assess presence of contact groundwater emanating from WSF, due to presence of karst in carbonate bedrock.
SC2	N	X	X	X	X	Lower Sulphurets Creek, downstream of Mitchell Creek mouth	Assess presence of contact groundwater emanating from Mine Site, hydraulic gradient into Sulphurets Creek. A most distant monitoring point established in response to uncertainty arising for worst case simulation results for seepage of contact water from WSF (refer to Chapter 12).
SC3	N	To be determined				Lower Sulphurets Creek near confluence with Unuk River	Assess presence of contact groundwater emanating from the Mine Site. Commence monitoring only if tailing water is detected at monitoring wells up-gradient.
UR1	N	To be determined				Sulphurets Creek at mouth	Assess presence of contact water emanating from Mine Site and hydraulic gradient into Sulphurets Creek. Commence monitoring only if contact water is detected at monitoring wells up-gradient.
Processing and Tailing Management Area							
OB-1	N		X	X	X	South Teigen Tributary down-gradient of North seepage collection dam (within 10 m of toe)	Assess presence of contact groundwater emanating from TMF North Cell immediately down-gradient, hydraulic gradient into South Teigen Tributary.
OB-2			X	X	X	South Teigen Tributary at intermediate distance between North seepage recovery dam and mouth	Assess presence of contact groundwater emanating from TMF North Cell at intermediate distance down-gradient, hydraulic gradient into South Teigen Tributary.
STE3	N		X	X	X	Mouth of South Teigen Tributary	Assess presence of contact groundwater emanating from TMF North Cell at a distance down-gradient, hydraulic gradient into South Teigen Tributary.
TEC2	N	To be determined				Teigen Creek downstream of South Teigen Tributary mouth	Assess presence of contact water emanating from TMF North Cell at a distance down-gradient in parent catchment basin. Commence monitoring only if tailing water is detected at monitoring wells up-gradient.
OB-3	N		X [A]			Down-gradient (within 10 m of toe) of Saddle seepage collection dam	Assess presence of contact groundwater emanating from TMF CIL (Centre) Cell immediately down-gradient during operation years 1 to 25 (TMF stage 1). Monitor hydraulic gradient into North Treaty Tributary.
OB-4	N		X [A]	X	X	Down-gradient of Southeast seepage collection dam (within 10 m of toe)	Assess presence of contact groundwater emanating from TMF South Cell immediately down-gradient, hydraulic gradient into North Treaty Tributary.
NTR2	N		X	X	X	Mouth of North Treaty Tributary	Assess presence of contact groundwater emanating from TMF and South cells (stages 2 and beyond) immediately down-gradient, hydraulic gradient into North Treaty Tributary.
TRC2	N	To be determined				Treaty Creek downstream of North Treaty Tributary mouth	Assess presence of contact water emanating from TMF South Cell at a distance down-gradient in parent catchment basin. Commence monitoring only if tailing water is detected at monitoring wells up-gradient.

Notes:
X = Water level measurement and water sampling will be conducted during this phase of the Project at the corresponding well.
Y = Yes, N = No
A OB-3 will be actively monitored up to Year 25, during stage 1 of the TMF design. OB-4 will be active from Year 25 onward, when the North Cell will be built and receiving tailing.

a) Operation and Early Closure Monitoring



b) Operation and Post-closure Monitoring



Legend

- OB1 Monitoring Wells
- STE3 Surface Water Quality Monitoring Station
- Plant Site
- Tailing Dam
- Tailing Pond
- Tailing Cells
- CIL Cell
- Seepage Collection Dam and Pond
- Conveyor Tunnel
- Diversion Tunnel
- Glacier
- Creek/River/Lake
- Wetland
- Inactive Cells

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Groundwater Monitoring Locations in the Processing and Tailing Management Area

Figure 26.15-2

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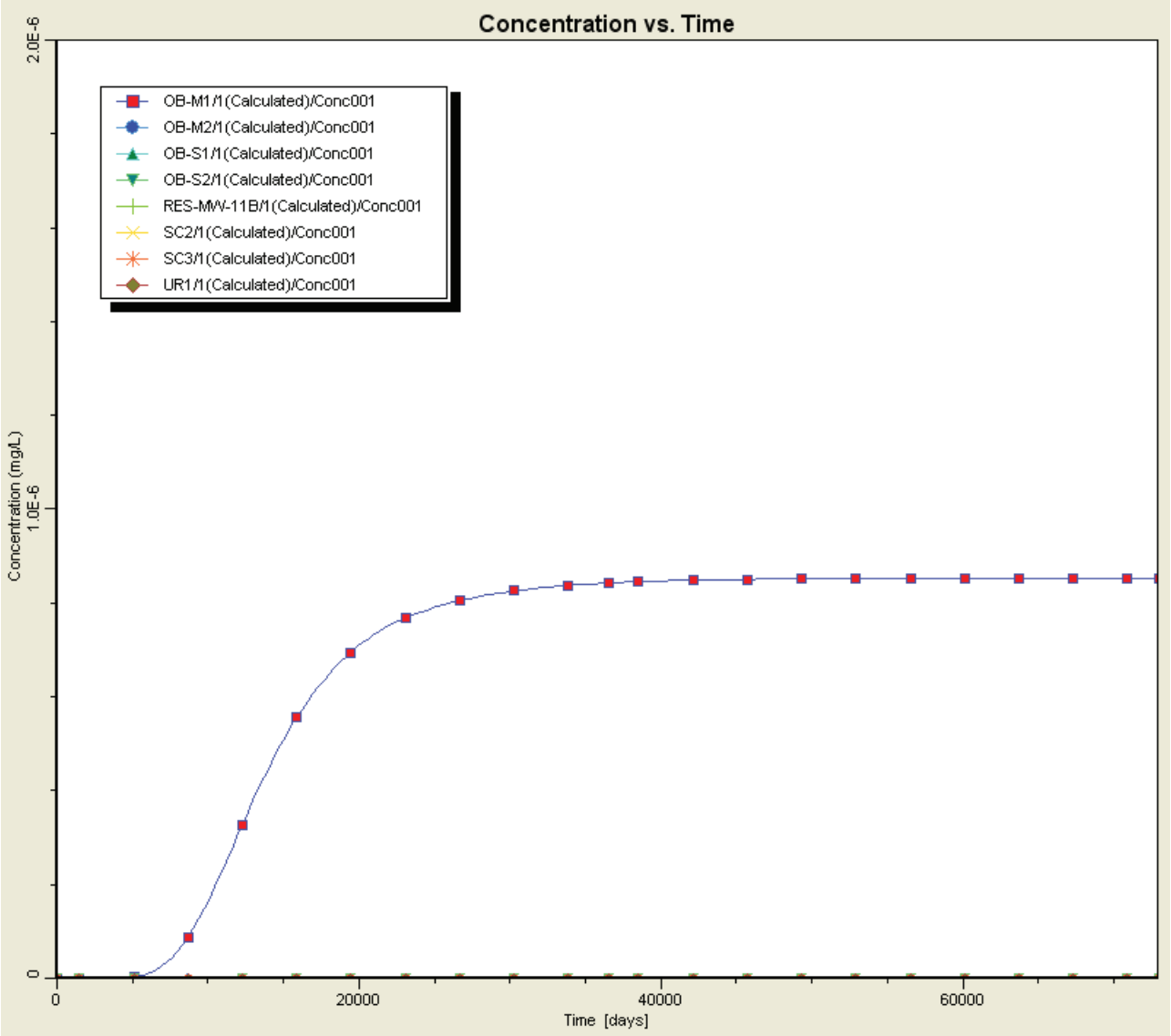
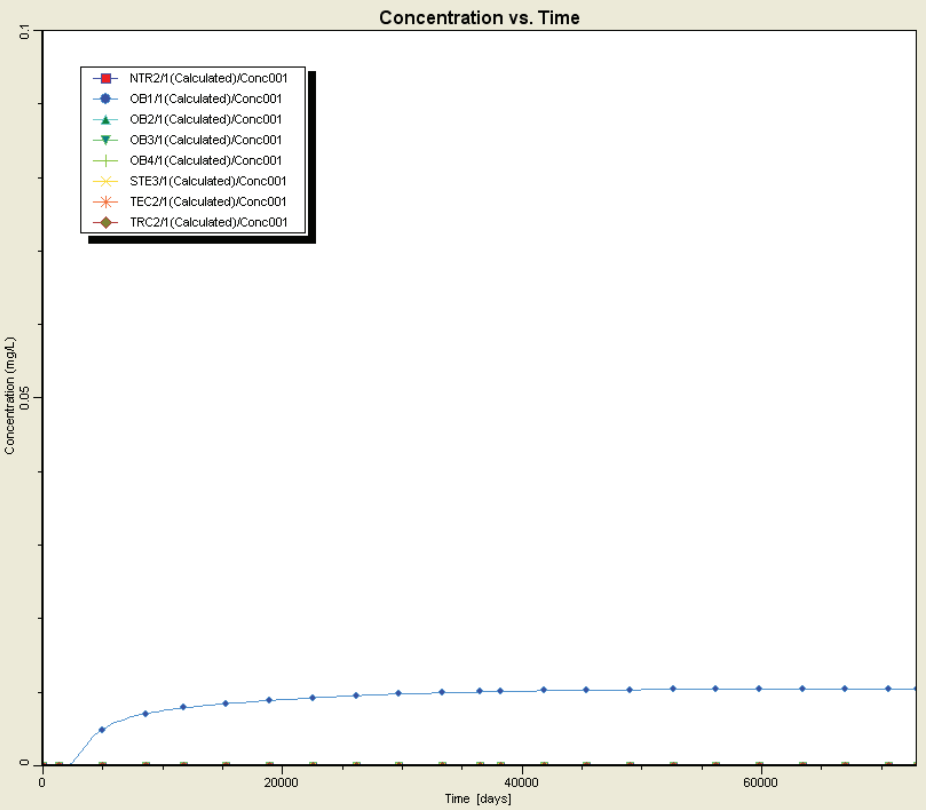
Operation and Post-closure



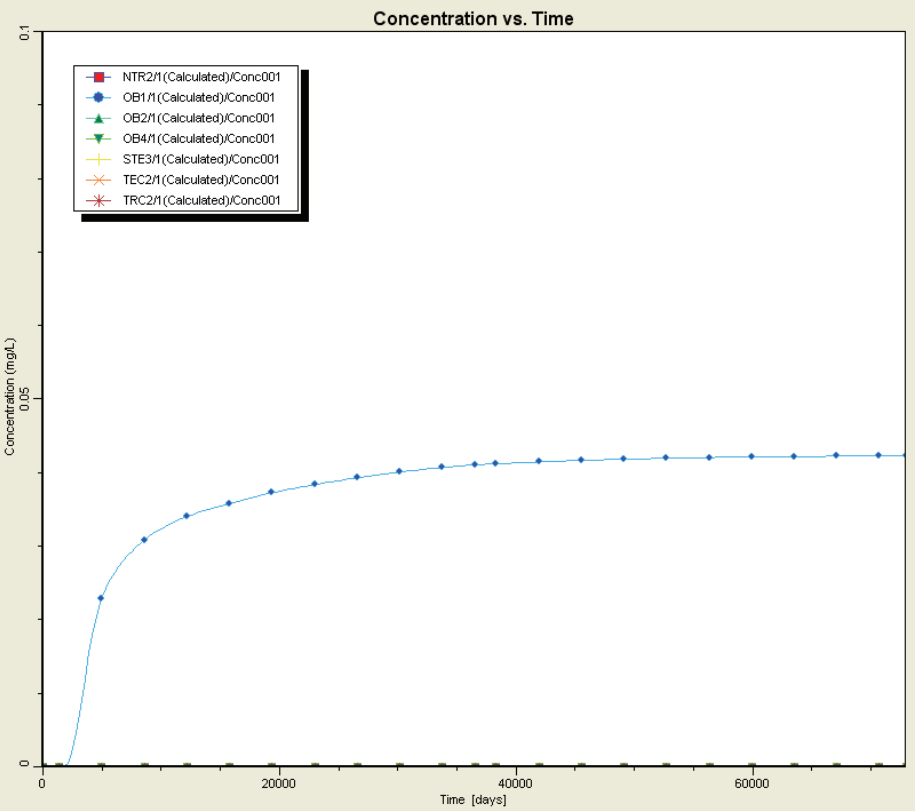
Predicted Concentrations at Long-term Monitoring Wells in the Mine Site

Figure 26.15-3

Operation and Early Closure Monitoring



Operation and Post-closure Monitoring



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Predicted Concentrations at Long-term Monitoring Wells in the Processing and Tailing Management Area

Figure 26.15-4

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Water level measurements and sample collection will be conducted at least seasonally (four times annually at approximately three-month intervals) at active wells during the construction, operation, and closure phases. Monitoring frequency will increase to bi-monthly if water quantity or quality targets are not being met at a particular well. During the post-closure phase, a progressive reduction in groundwater monitoring will occur, contingent upon water quality and quantity parameters meeting targets. For the first five years of the post-closure phase, monitoring will be conducted seasonally. Bi-annual measurements will be conducted for years 6 to 10, followed by annual measurements during the post-closure monitoring period, as required by regulators.

Monitoring will be conducted by a trained technician familiar with groundwater level measurement and sampling methods. Methods will be in accordance with guidance provided by the BC Ministry of Environment (2012), including quality assurance and quality control protocol.

26.15.5 Adaptive Management

If groundwater quantity or quality targets are not being met and there is a clear link between mine activities and changing groundwater conditions, then an adaptive management strategy will be implemented. Professional hydrogeologists will be consulted to determine the most appropriate adaptive management strategy. Seepage control mechanisms, such as additional seepage collection dams, pumping wells, or remediation mechanisms, such as permeable reactive barriers, are examples of strategies that may be considered to account for un-predicted exceedances of groundwater quality targets. Drainage pipes or aquifer recharge wells (depending whether water levels are higher or lower than baseline conditions) are examples of strategies that may be considered to account for unpredicted exceedances of groundwater quantity targets.

The groundwater effects assessment included possible worst-case scenario modelling to account for uncertainty in the base case (expected) simulations. Worst-case predicted changes to groundwater levels, flow directions, flow rates, and hydraulic gradients are discussed in the effects assessment. Worst-case plume extents and worst-case magnitude of day lighting of contact water in receiving streams are discussed in the effects assessment. Worst-case groundwater modelling was also a component of the iterative design process, whereby design measures were added to mine components where they contributed to lessening effects on groundwater quality. Proposed monitoring locations are downstream of predicted effects. Therefore, the detection of water quality or quantity parameters that do not meet targets at the selected monitoring sites is unlikely.

26.15.6 Reporting

Groundwater monitoring results will be provided to regulators annually as part of the Annual Reclamation Report. These results will include the following:

- all collected data, including dates, locations, laboratory results, and water level measurements;
- methodologies used for data collection and analysis, including quality control and quality assurance measures;

- comparisons between measurements and targets; and
- an assessment of the performance of mitigation measures.

A qualified hydrogeologist will be responsible for analysis and reporting.

26.16 Glacier Monitoring Plan

26.16.1 Objective

The KSM Project is located in the glacierized Boundary Ranges of the northern Coast Mountains. The rugged topography, high elevations, proximity to the ocean, and location in relation to a robust winter storm track combine to create conditions that support the growth of large alpine glaciers and ice fields. The ultimate boundaries of the proposed Mitchell Pit extend under the current terminus of Mitchell Glacier. Assuming glacial recession rates remain constant, it is anticipated that the glacier terminus will be upslope of the proposed Mitchell Pit location by the time construction begins. McTagg Glacier is also within the Mine Site area. Monitoring of both glaciers will be important for water management activities throughout the life of the Project.

The KSM Project Glacier Monitoring Program was initiated in 2008 to provide information on the rates of down-wasting and retreat of Mitchell Glacier, seasonal and annual mass balance estimates, and flow velocities (for additional details on the KSM Project Glacier Monitoring Program refer to Appendix 13-C). Nearby glaciers were catalogued, and hypsometries were generated for 12 glaciers that are located upstream or proximal to proposed development. The main objective of the Glacier Monitoring Plan is:

- to continue to conduct mass balance measurements, surface velocity measurements, and glacier terminus mapping at Mitchell Glacier and McTagg Glacier (which is composed of McTagg East and McTagg South and West Glaciers).

26.16.2 Targets

The target of the monitoring program is to continue the Glacier Monitoring Program that was initiated in 2008.

26.16.3 Monitoring

The program is comprised of three main components:

1. Glacier Delineation;
2. Glacier Mass Balance; and
3. Glacier Dynamics.

Glacier Delineations

For purposes of glacier delineation, a DGPS survey of the terminus position for Mitchell and McTagg glaciers should be carried out. This information can be coupled with a digital elevation model (DEM) of the Mitchell Glacier to generate glacier hypsometry (i.e., distribution of surface area by elevation).

Glacier Mass Balance

Elevation exerts an important control on accumulation and ablation processes, due to the dependence of both temperature and precipitation on elevation. Snow accumulation is generally greatest at high elevations due to orographic enhancement and the frontal dynamics of weather systems in the area. Melt is generally greatest at low elevations due to warmer temperatures and the earlier exposure of glacier ice after melting of the winter snowpack: glacier ice absorbs more than twice as much solar radiation as fresh snow, resulting in enhanced melt rates. While variations in accumulation and ablation will occur in horizontal directions, a monitoring network that exploits their dependence on elevation is sufficient to describe the majority of the spatial variability in mass balance.

The glaciological method has historically been used for determining the mass balance of Mitchell Glacier and McTagg Glacier, this method involves measuring the accumulation of snow during the winter and the change in snow depths and ice surface heights over the summer. As Mitchell Glacier is an elongated valley glacier where mass balance is primarily controlled by elevation, monitoring locations were distributed along the vertical mid-line of the glacier. A glaciological year runs from October to September of the following year, and the mass balance year from October 2012 to September 2013, for example, is referred to as the 2013 balance year.

At any point on the glacier, the specific net mass balance (b_n) is the sum of the winter accumulation (b_w) and summer ablation (b_s, negative by convention), all with units of metres of water equivalent (m w.e.):

$$b_n = b_w + b_s \qquad [1]$$

Point mass balance observations are denoted by a lower-case b. Winter accumulation is affected by avalanching, wind redistribution, changes in precipitation type (rain versus snow), and orographic enhancement. Accumulation can thus exhibit a high spatial variability, with the majority of the variability due to elevation. Summer ablation is determined primarily by air temperature and absorbed solar radiation. Spatial patterns of melt are dominated by the decrease in temperature with elevation, as well as variations in radiation absorption related to shading, albedo, surface slope, and aspect. Initial distributions of snow can also play a large role; before ice melt can begin, the snow cover must be completely removed, and the high reflectivity (albedo) of snow reduces the absorption of solar radiation.

Winter balances are calculated through observations of snow depth (d_s) and snow density (ρ_s), from which a snow water equivalent (SWE, in m) can be calculated:

$$b_w = d_s \times \rho_s / \rho_w \qquad [2]$$

where ρ_w is the density of water (1.000 kg/m^3).

Field observations of snow depth and density should be collected in April. Snow pits should be excavated between the terminus and the upper basins and snow densities continuously sampled throughout the entire depth of each pit and integrated to determine the total snow water equivalent (SWE) at each pit location. Snow densities below 2 m should be measured with a Federal Snow Tube (or similar device). As density varies with snow depth, a function describing

the relationship between depth and density was determined so that snow density could be estimated over the entire glacier surface.

Snow depths should also be probed at numerous locations in the upper basins of each glacier. Generally, between three and six depth measurements should be made at each monitoring location, and the average snow depth computed. A relation between elevation and snow depth can then be determined based on these field observations in order to estimate snow depth over the entire glacier surface.

With established relations between (1) snow depth and elevation and (2) snow depth and density, winter balance b_w can be estimated over the glacier surface from Equation [2] and the DEMs of each glacier. The glacier averaged winter balance B_w can then be calculated by integrating the estimated specific winter balance for each DEM grid cell, and dividing by the total area of the glacier (A):

$$B_w = \frac{1}{A}\int b_w \qquad [3]$$

Summer ablation is the combined loss of both snow and ice during the melt season, which typically lasts from May to September. Snow melt (M_s) is calculated by subtracting the observed end-of-summer SWE from the observed winter balance (b_w) at a given location. If the ice surface has been exposed, $M_s = b_w$. Above the end-of-summer snowline, $M_s < b_w$, and observations of end-of-summer snow depth and density are required to estimate the remaining SWE. Ice melt (M_i) is measured using stakes (referred to as ablation stakes) that are drilled into the ice. The base of the stake remains fixed relative to changes in the height of the surface (Figure 26.16-1). Total ice melt (in m w.e.) is calculated by converting the depth of ice melt (Δd_i in m) to water equivalence following:

$$M_i = \Delta d_i \frac{\rho_i}{\rho_w} \qquad [4]$$

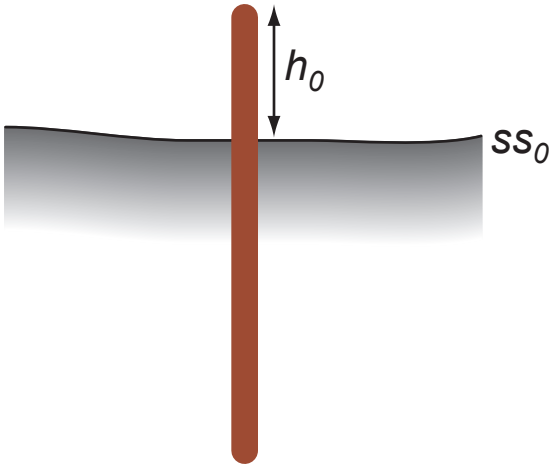
where ρ_i is the density of ice (900 kg/m^3).

The summer balance (bs) at a specific point can then be calculated by:

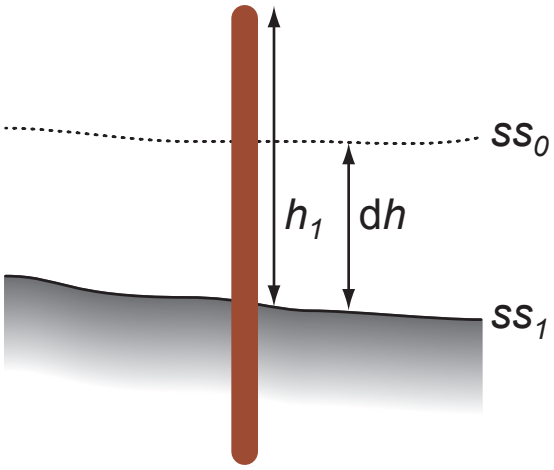
$$b_s = M_s + M_i \qquad [5]$$

Glacier-averaged summer mass balance (Bs) can be calculated by integrating the specific summer mass balance estimated for each DEM grid cell and dividing by the total area A, as in Equation [3].

Mass balance values estimated for each grid cell (in m w.e.) can be multiplied by the area of each grid cell (20 by 20 m) to calculate a volume (in m^3 w.e.). Volumes for b_w, b_s, and b_n in each grid cell were then summed over the entire glacier and divided by the total area of the glacier to obtain the glacier-averaged mass balance. Although the total glacier mass balance is frequently expressed as a volume, the glacier-averaged mass balance is more intuitive, and it allows for comparisons between glaciers and time periods.



1. When the ablation stake is installed, its intial height (h_0) above the end-of-summer surface (ss_0) is measured.



2. On subsequent visits, the new height of the stake (h_1) is measured, allowing for the calculation of net surface lowering (dh = h_1 - h_0). The stake will then be redrilled, and a new intial height above the surface will be recorded.

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Use of Ablation Stakes in Measuring Summer Mass Balance

Figure 26.16-1

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Glacier Dynamics

A primary safety concern in heavily glacierized terrain is the possibility of rapid glacial advances, such as surges (where velocities are orders of magnitude greater than normal velocities), that could affect infrastructure located near glacier termini. The factors contributing to alpine glacier surges are complex: glacier bed topography, subsurface hydrological drainage characteristics, and antecedent mass balance conditions are all contributing factors (Raymond 1987), but these parameters are difficult or impossible to measure. Surging glaciers are also not limited to a particular geographic region: they have been identified in Alaska, the Yukon, and northwest BC, as well as in the Arctic, South America, and the Himalayas (Benn and Evans 1998).

Surface features that are indicative of surge-type glaciers include heavy crevassing, intense folding visible at the surface and looped medial moraines (Copland, Sharp, and Dowdeswell 2003). Other investigators have suggested that long glaciers with low slope angles have a higher probability of being surge-type glaciers in comparison with short glaciers, which will generally have a greater slope angle (Clarke 1991). These generalizations are useful in the context of examining the potential for glacier surges in the KSM Project region, but cannot be considered as rules. In order to quantify the rate of retreat or ablation of a glacier within the Mine Site, the following methods should be used:

- annual differential GPS (DGPS) surveys of the terminus;
- annual DGPS surveys of the ablation stake network;
- field-based evidence for glacier flow; and
- TRIM data analysis.

Using a sampling interval of one second, location coordinates will be recorded as a surveyor walks along the glacier terminus margins. Safety concerns, including collapsing ice cliffs, limited the extent to which the terminus was mapped in all years, but the data collected provide a benchmark for future terminus mapping and comparison. To reduce some of the uncertainty introduced by the safety concerns, a rangefinder can be used to determine the distance to the glacier snout where it was unsafe to walk immediately along the terminus.

To estimate glacier flow velocities, the locations of ablation stakes were surveyed after initial installation in July and September of each year. The DGPS unit can be operated for approximately one minute at each stake using a sampling interval of one second, yielding approximately 60 points for each site.

The DGPS data collected in the field should then be post-processed and corrected using an off-site base station. From the corrected data at each stake, an average location can be calculated. The change in stake position (in the easting and northing directions, in metres) can be calculated by subtracting.

26.16.4 Responsible Persons

The KSM Project Environmental Manager or other designated person will be responsible for ensuring water monitoring reporting for the Project, overseeing the water monitoring operations,

maintaining inspection and maintenance reports, and providing guidance on any changes or needs of the program, with the support of a qualified specialist, when required.

26.16.5 Reporting

A report will be submitted to the Proponent on an annual basis.

26.17 Water Management Plan

Water is a key component in the mining process in that it is required for, and affected by, mining activity. Over the life of a mine, waterbodies can by temporarily diverted, created, or drawn upon to allow mining activity to occur. Additionally, water acts as a transport medium for potential contaminants to be introduced to the receiving environment. Therefore, water must be managed for a variety of reasons including compliance with operation permits, smooth and uninterrupted operation of the mine, and minimization of effects on water quality and quantity in the receiving environment.

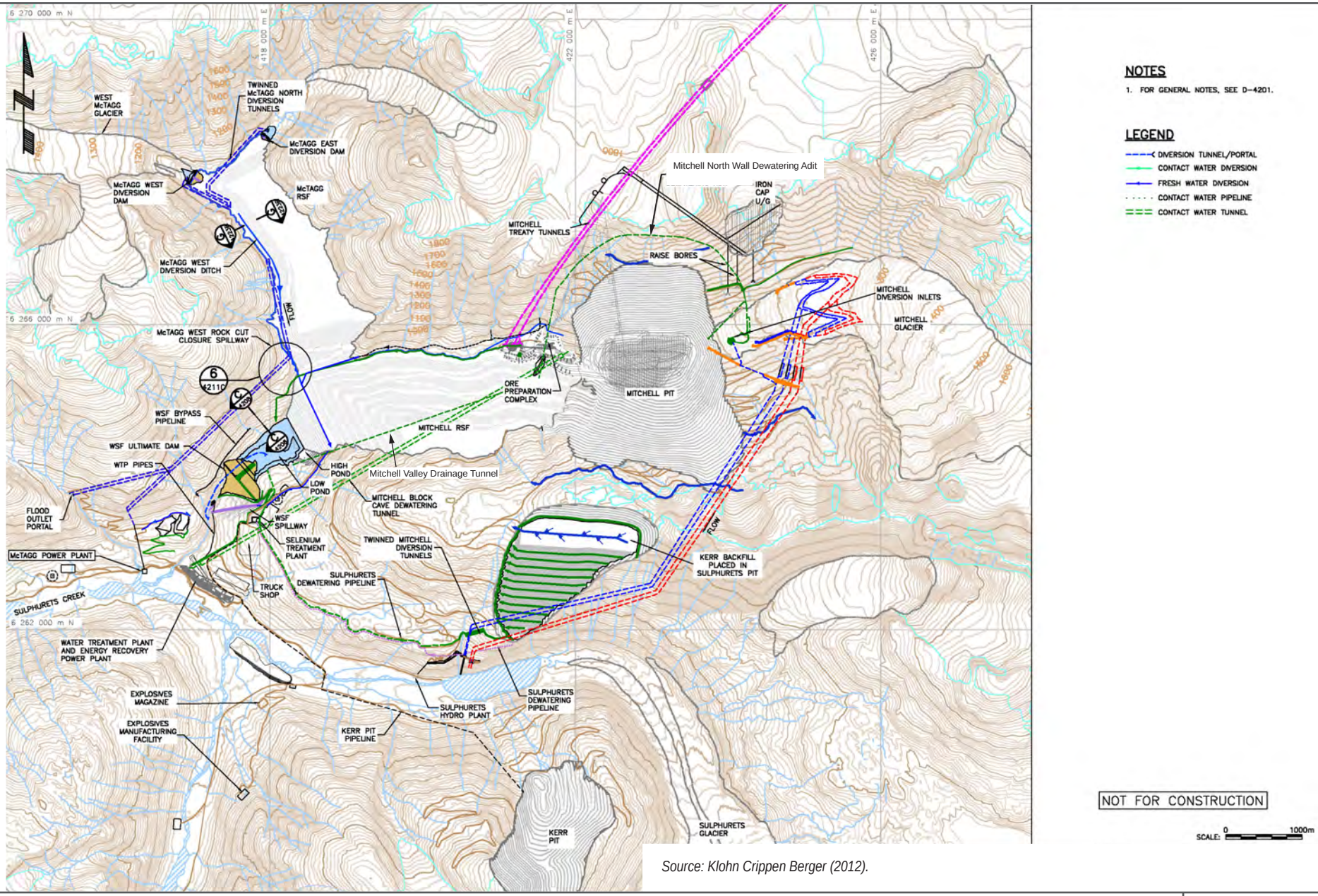
As such, the Proponent is committed to a comprehensive Water Management Plan that applies to all mining activities undertaken during all phases of the KSM Project. The main objective of the Water Management Plan is to regulate the movement of water in and around the area of the Project in order to ensure long-term environmental protection.

26.17.1 Water Management Philosophy

The proposed KSM Project is located in a glaciated area that experiences high annual precipitation. Rain, snow, and water discharged from nearby ice fields and glaciers have been incorporated into the design of the proposed mine. The Project requires large volumes of non-contact water to be diverted to facilitate mining and to minimize environmental impacts. The Project will result in substantial localized changes to water quantity, and minimal changes to downstream locations (see Chapter 13 for more detail). Localized changes and effects can be minimized by avoiding the creation of contact water, and through the management of non-contact water, erosion, and sedimentation through diversions and mitigation.

An overview of water management infrastructure layouts and catchment areas within the Mine Site and PTMA are shown in Figures 26.17-1 and 26.17-2. Details of the development of the Project water management in five-year increments are presented in Appendices 4-N and 4-AA.

Process and structure design details, including water balance models, were developed by Klohn Crippen Berger Ltd. and are presented in the documents, *2012 Geotechnical Design of Rock Storage Facilities and Water Management* (Appendix 4-J) and *2012 Engineering Design Update of Tailing Management Facility* (Appendix 4-AC). An overview of the water balance for the Project's major water storage facilities is provided in the Water Management Plan. The surface water management plan includes a discussion of erosion and sediment control BMPs with a focus on runoff management and sediment control; erosion control is described in greater detail in the Erosion Control Plan (Section 26.13.3).



Source: Klohn Crippen Berger (2012).

Figure 26.17-1

Mine Site Ultimate Water Management Plan

Figure 26.17-1

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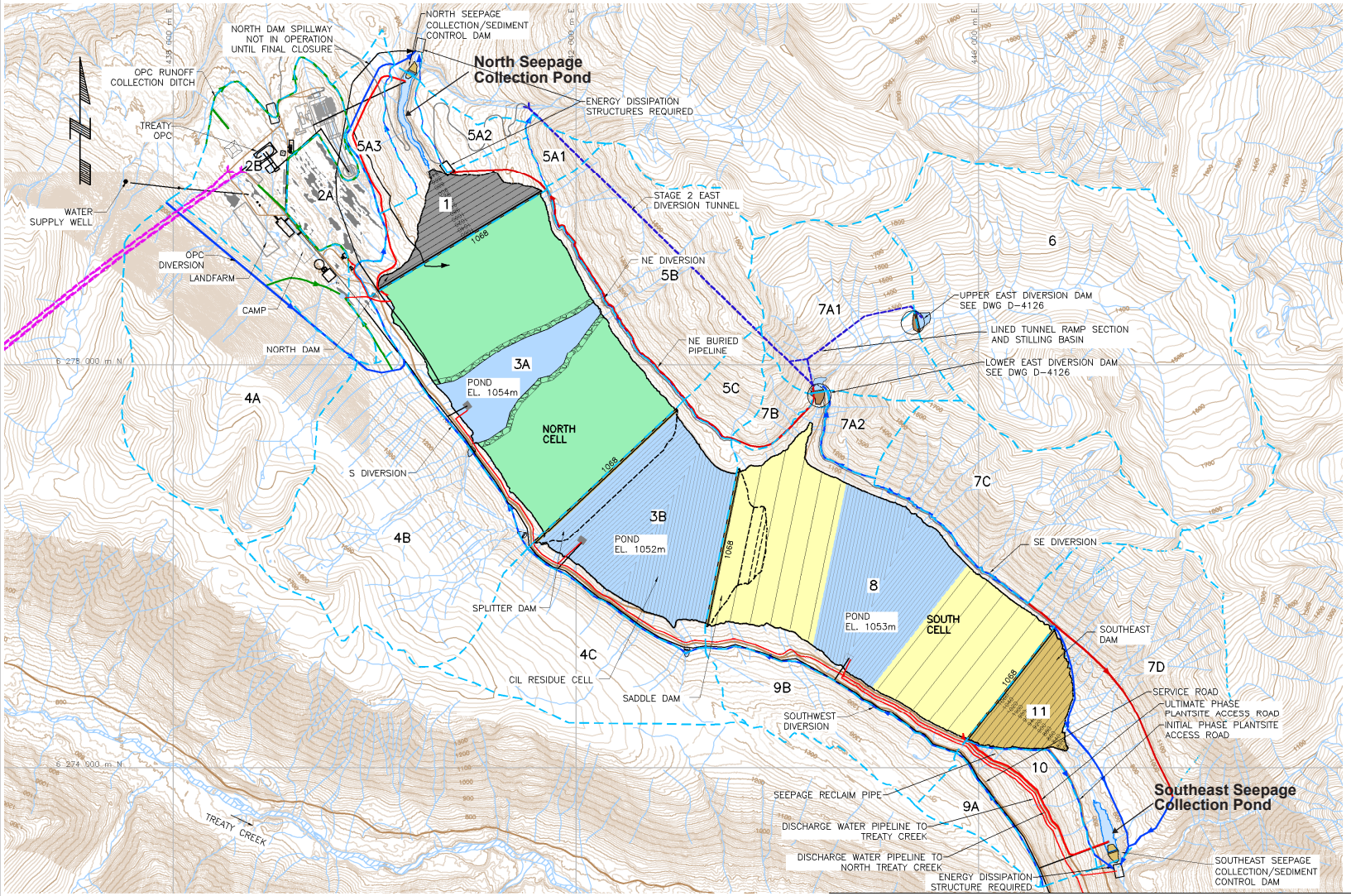

TMF/CIL CATCHMENT AREAS

CATCHMENT	AREA (ha)
1	156.4
2A	96.4
2B	249.6
3A	546.8
3B	283.1
4A	503.4
4B	487.9
4C	272.9
5A1	26.0
5A2	44.2
5A3	64.9
5B	307.6
5C	49.6
6	874.1
7A1	262.9
7A2	53.8
7B	31.9
7C	341.7
7D	346.3
8	650.7
9A	52.9
9B	154.6
10	98.7
11	112.6

LEGEND

- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CONTACT WATER DIVERSION
- NORTH DAM SPILLWAY
- CATCHMENT BOUNDARY
- FRESH WATER DIVERSION
- PIPELINE
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL
- NORTH AND SADDLE DAMS
- RECLAIMED DAM SLOPE
- TAILING
- RECLAIMED TAILING SURFACE
- TAILING POND
- RIPRAP
- RECLAIM BARGE

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. DATUM: NAD83 UTM ZONE 9.

NOT FOR CONSTRUCTION

SCALE: 0 1000m

Source: Klohn Crippen Berger (2012).

Figure 26.17-2

SEABRIDGE GOLD
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Processing and Tailing Management Area
Ultimate Water Management Plan

Figure 26.17-2

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A separate, more detailed Environmental Effects Monitoring Plan will also be developed in consultation with regulators and in compliance with the MMER (SOR/2002-222) and provincial discharge limits as a requirement of the permits and licences under which the KSM Project will operate. This Water Management Plan provides an overview of the surface water management and monitoring program that will be implemented for the Project.

26.17.2 Objectives and Targets

26.17.2.1 Objectives

The objectives of the management plan are to provide a basis for management of surface water on site including:

- diverting non-contact water around the Mine Site and PTMA;
- protecting ecologically sensitive areas and resources and avoiding harmful impacts to aquatic life and wildlife habitat;
- providing and retaining water for mine operation;
- defining required environmental control structures; and
- collecting and treating contact water from the Mine Site to meet discharge requirements prior to release to the receiving environment.

26.17.2.2 Targets

The targets intended to optimize the Water Management Plan to achieve surface water objectives include:

- minimizing the production of contact water by implementation of best management practices (BMPs) and water diversion measures;
- collecting and treating contact water where required in order to meet applicable water quality standards; and
- implementing and maintaining an on-site monitoring and control system to regulate surface water quantity and quality.

26.17.3 Legislation and Standards

The Water Management plan has been developed to satisfy guidelines and requirements specified in the following legislation:

- BC *Mines Act* (1996);
- *Fisheries Act* (1985);
- *Canada Water Act* (1985a);
- BC *Water Act* (1996n); and
- BC *Water Protection Act* (1996o).

26.17.3.1 British Columbia *Mines Act*

BC's *Mines Act* (1996) provides guidance and approvals for all activities on the Mine Site, from exploration to development, production, closure, and reclamation. It also requires the Proponent to obtain a permit approving work system and reclamation.

26.17.3.2 Health, Safety and Reclamation Code for Mines in British Columbia

The Health, Safety and Reclamation Code (BC MEMPR 2008) is empowered through the *Mines Act* (1996) and requires the proponent to provide:

- designs and details for water management structures, water storage, and water treatment facilities;
- an OMS manual that is prepared and provided to an inspector and to all employees involved in the operation of a major dam or major impoundment, prior to commissioning. The manual shall be revised regularly during operation, decommissioning and closure of the structure (Section 10.5.2 of the Health, Safety and Reclamation Code);
- the source, use, and water balance for any water required in the operation;
- an overall site water balance;
- a plan for erosion control and sediment retention; and
- a reclamation plan (Chapter 27).

26.17.3.3 Fisheries Act

Information requirements for review under the Fish Habitat Protection Provisions of the *Fisheries Act* (1985) include descriptions of measures that will be taken to avoid or minimize any effects on the aquatic environment, shoreline, or riparian areas during Project development or its subsequent operation. The *Fisheries Act* (1985) also regulates the discharge of harmful substances into fish habitat and imposes reporting requirements in case such a discharge occurs.

26.17.3.3.1 Metal Mining Effluent Regulations

Environmental monitoring and surveillance programs of the WSF and TMF effluent discharges are further requirements of the federal Metal Mining Effluent Regulations (MMER; SOR/2002-222) pursuant to the *Fisheries Act*.

26.17.3.4 Canadian Environmental Protection Act

The *Canadian Environmental Protection Act* (1999) regulates the release of toxic substances into the environment, as well as disposal and movement of hazardous wastes. Storage of petroleum products is regulated by the Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (SOR/92-267) associated with the *Canadian Environmental Protection Act* (1999).

26.17.4 Actions to Avoid, Control, and Mitigate

A variety of diversion, collection, and treatment structures will be developed to manage surface water for the Mine Site and PTMA. Surface water management activities will consist of non-contact water diversion and contact water collection and treatment. By minimizing the

amount of contact water that is produced on the Project site, surface water diversion reduces the volume of water that must be treated. Additionally, surface water diversion decreases the potential for erosion and sediment production by limiting the volume of water that enters a work area. The following section describes the general water management measures that will be used during all phases of the Project.

26.17.4.1 Construction

Water management and erosion and sediment control measures will be implemented soon after Project approvals and before pre-production mining. Specific construction-related water management measures associated with the Mine Site include:

- Baseline data on soils, terrain, and surface water quantity will be used along with visual surveys of construction activities to identify potential sites that require focused attention and specific plans for water management. Vulnerable sites, such as locations of potential ditch failures or culvert blockages, will be identified in advance, and risks in these areas will be addressed by site-specific contingency plans.
- Where feasible, development activities will be kept away from hydrologically important features (seepage sites, springs, rivulets, and open water). In areas affected by seepage or where the water table is near the surface, construction activities or soil salvaging operations will preferentially be performed during dry or frozen conditions.
- Erosion and sediment control BMPs will be implemented. These include isolation of work areas from surface waters, the use of temporary diversion methods (e.g., lined ditches, flumes, and dam-and-pump), and proper use of sediment traps, geotextile cloth, silt fences, gravel berms, and straw bales in order to mitigate and control erosion and sediment.
- Non-contact water drainages interrupted by mine infrastructure will be rerouted into existing stream courses using water diversion ditches, pipelines, or tunnels.
- Perimeter diversion ditches, armoured with rip-rap on steep slopes to prevent erosion and bank slumping, will be installed to catch and transport all runoff from the Mine Site and associated work areas to vegetated swales, sediment basins, or water treatment facilities, such that no sediment-laden water (i.e., contact water) directly reaches a watercourse. Perimeter sediment collection will be established as a first step to site construction.
- Seepage collection ditches will be constructed downslope of Project infrastructure as necessary to route seepage to water treatment facilities.
- Small-scale runoff collection and treatment measures may be used locally (e.g., sediment fences around the perimeter of stockpiles, sediment pools at culvert inlets).
- Where sediment ponds are required to treat large volumes of contact water, specifications will be designed by an engineer and will adhere to the BC *Guidance for Assessing the Design, Size, and Operation of Sedimentation Ponds Used in Mining* (BC MOE 2001b). Criteria taken into consideration will include local soil type, contributing drainage area, desired sediment removal efficiency, inflow volume and velocity during a design storm event, and Project duration from initial soil disturbance to final stabilization.

- Where instream work is required, cofferdams and/or diversion pipelines or tunnels will be used to temporarily divert water around the construction zone while maintaining flow downstream. Isolation of instream work sites will help to prevent the introduction of sediment or contaminants to the receiving environment.
- Near-stream and instream work will be preferentially conducted during periods of low flow at areas of stable substrates. In cases where low stream flows and optimum instream work periods do not coincide with fish timing windows for construction, the Proponent will apply for a variance from the fish timing windows.
- Areas of disturbance at stream crossing sites will be minimized in order to retain as much vegetation as possible in the riparian zone above and below the crossing point.
- Where possible, stream crossing structures will be designed to span the entire width of the stream channel, pass 100-year flood events, provide natural substrates for fish, allow for fish migration where applicable, allow for passage of vessels where designated a navigable water under the *Navigable Waters Protection Act* (1985g), and prevent sediments from entering streams.
- When draining of wetted areas occurs, measures will be taken to ensure that the process does not cause erosion of downslope stream banks or terrestrial areas.
- Environmental monitoring and supervision of protection measures will be ongoing through the construction phase.
- Machinery will arrive on site in a clean condition and will be maintained free of fluid leaks. An emergency spill kit will be kept at each construction site in case of fluid leaks or spills.
- Fuels, solvents, and other chemicals used during construction will be isolated, contained, and carefully managed. Bulk fuel will be stored well away from streams, in high capacity double contained steel tanks with barriers to protect them from vehicles. Secondary containment will have the capacity to accommodate 110% of the volume of the largest vessel in the area. Further information on storage of fuels can be found in the Spill Prevention and Emergency Response Plan in Section 26.10.
- Explosives for construction will be stored during non-working hours in secure areas accessible by authorized staff only. During operation, the Explosives Manufacturing Facility will have collection sumps for site water, and diversion ditches will be constructed to catch and contain any contaminated runoff from the area before it can migrate to surface drainages. Further information on explosives management can be found in Section 26.8.
- The MTT NPAG rock (estimated 70%) and (PAG rock (estimated 30%) will be stored in appropriate rock storage facilities with water treatment facilities as required. Tunnel water will be pumped to settling ponds and water treatment facilities for settling suspended solids and removing metals.
- Communication procedures will be established between field staff and environmental managers to facilitate timely reporting of any incident or concern during the construction process. Construction personnel will be required to communicate any concerns including

erosion and sediment production, debris or snow jams at stream crossings and ditches, and contaminant releases. Further information on communications can be found in the Construction Management Plan, Section 26.2.

The water management and sediment control methods described above will be used in conjunction with the Erosion Control Plan (Section 26.13.2).

26.17.4.2 Operation

In addition to the water management measures described in the section above, the following specific measures will be implemented during site operation:

- Water management and sediment control structures, such as ditches, pools, swales, and ponds, will be regularly inspected and maintained. Maintenance procedures will include prompt attention to potential erosion sites, ditch or culvert failure, culvert blockage, or outside seepage because such problems could lead to structure failure and sediment transport. Maintenance will also include routine removal of accumulated sediment from ditches and retention structures. The sediment removed will be used as fill or disposed of in stockpiles.
- Camp sewage will be treated, and discharged in accordance with the Municipal Sewage Regulation (BC Reg. 97/2012) or the Sewerage System Regulation (BC Reg. 326/2004) in a manner that does not impair the receiving environment. Further information on the disposal of sewage can be found in the Domestic and Industrial Waste Management Plans in Section 26.6.
- Contingency plans will be established proactively for emergency situations (e.g., storm events, ditch blockage). These plans will detail response actions to be taken in the event of an unexpected increase in overland runoff or saturation of the work areas due to precipitation. Emergency spill clean-up kits will be readily available and clearly marked at all work sites.
- Notifications will be immediately given to environmental staff, senior managers, and regulatory agencies as appropriate for any incident in which water quality could be adversely affected.

26.17.4.3 Closure and Post-closure

Water treatment structures and facilities that are not being used for closure and post-closure activities will require reclamation. Guidelines for closure and reclamation include:

- Similar erosion and sediment control BMPs as those used during the construction and operation phases will be used during closure activities that require ground disturbance, especially the use of perimeter/diversion ditches.
- Upon closure, camps and other sites that are no longer required will be decommissioned and dismantled and their sites will be re-graded, stabilized, and seeded to re-vegetate and revert to wildlife habitat. Reclaimed sites will be monitored routinely until vegetative cover is established and land use objectives are met.

- When no longer needed, temporary sediment control ponds will be completely dewatered, and retained sediment will be buried or, if suitable, reclaimed. Alternately, if the pond site is not located in an active floodplain, sediments may be stabilized with a cap of coarse material. After sediment removal or capping, the pond site will be re-contoured to conform as much as possible to the surrounding topography, followed by topsoil application and re-vegetation if appropriate for the site.

Monitoring and reporting will continue during closure and post-closure, as described in Sections 26.17.7 to 26.17.9, until land use objectives are met.

26.17.5 Mine Site

Water management structures and facilities will be constructed to separate contact water for treatment and to route non-contact water around the Mine Site to the environment. The main objective is to minimize the amount of non-contact water reporting to the WSF to reduce water treatment requirements.

26.17.5.1 Changes to Flow Pathways and Drainage Areas

Expected changes to sub-catchment areas within the Mine Site for multiple stages of the mine life are shown below in Figures 26.17-3 to 26.17-8. Changes to flow pathways and drainage areas are discussed in more detail in Chapter 13.

26.17.5.2 Water Balance

A water balance model for the Mine Site was developed using GoldSim by Klohn Crippen Berger Ltd. (KCB; see Appendix XI of Appendix 4-J). A key objective of the water balance was to determine operating storage requirements for the WSF and determine maximum required and average water treatment rates. Rescan further developed the model to contain parameters for the receiving environment (results in Chapters 13 and 14).

26.17.5.2.1 Pumped Flows and Downstream Flow Rates

Pumped flow rates from the WTP into Sulphurets Creek and subsequently the Unuk River were estimated for different climatic conditions. Scenarios for 1-in-200 dry, 1-in-200 wet, and an average year were produced. In order to manage pumping rates from the WTP, hydrometric monitoring stations will be located on the Sulphurets Creek and the Unuk River.

Figures 26.17-9 to 26.17-14 shows an estimate of stream flows for the three scenarios in Sulphurets Creek and the Unuk River, discharge from the WTP are also presented.

26.17.5.3 Mine Site and Associated Infrastructure: Avoidance, Control, and Mitigation

Mining will be conducted at an average rate of 130,000 tpd over the 51.5-year life of mine by open pit mining in the Mitchell, Sulphurets, and Kerr pits and underground block caving in the Mitchell and Iron Cap deposits. The pits and underground developments will lie within the drainages of Sulphurets and Mitchell creeks. Ore will be crushed at the Mine Site at a rate of 130,000 tpd and will be transported to the Treaty OPC via a conveyor in one side of the twinned 23-km long MTT.

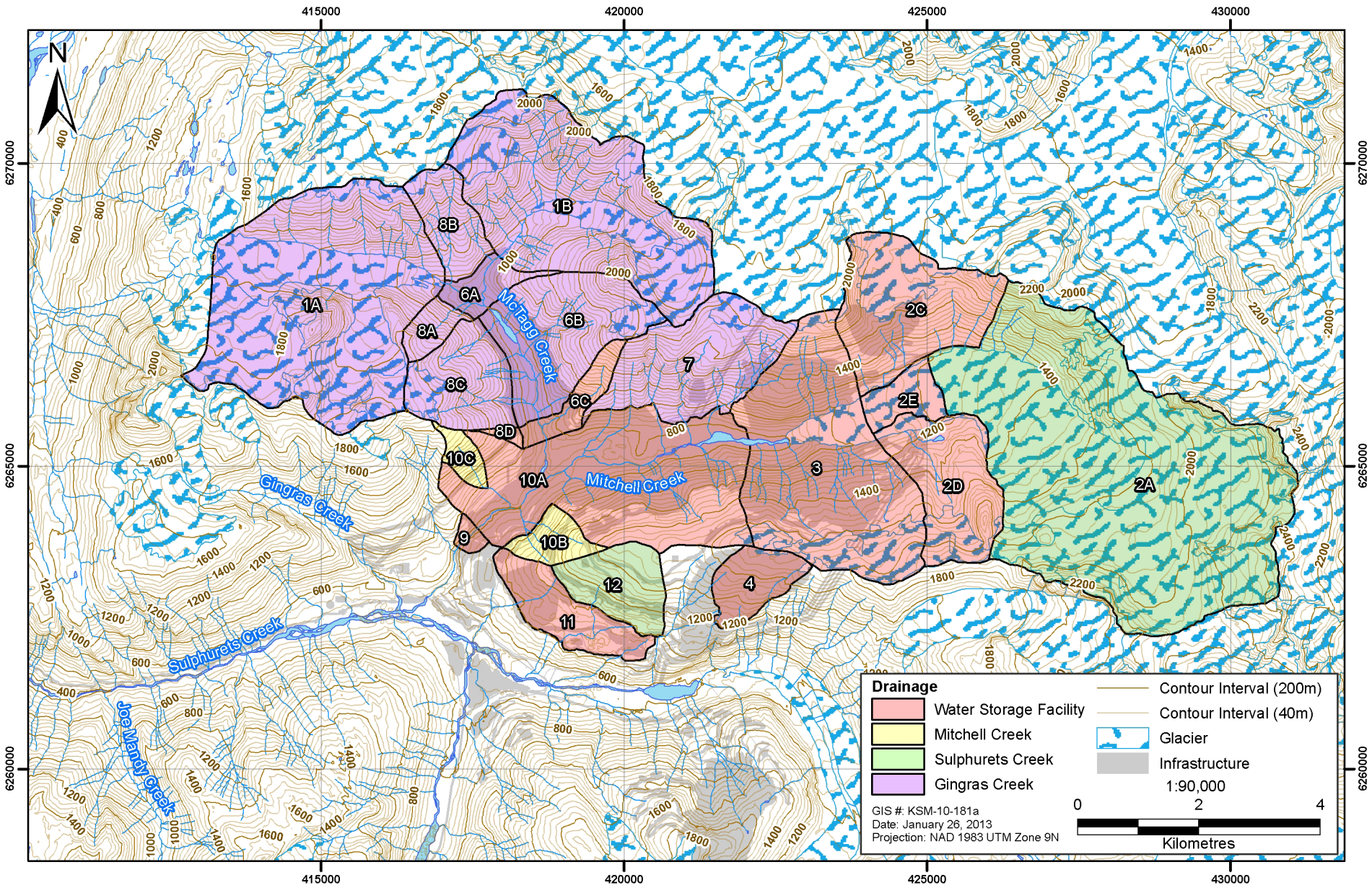

Figure 26.17-3

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area during Years 0 to 10 of Operation

Figure 26.17-3

Rescan
Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-181b April 1, 2013

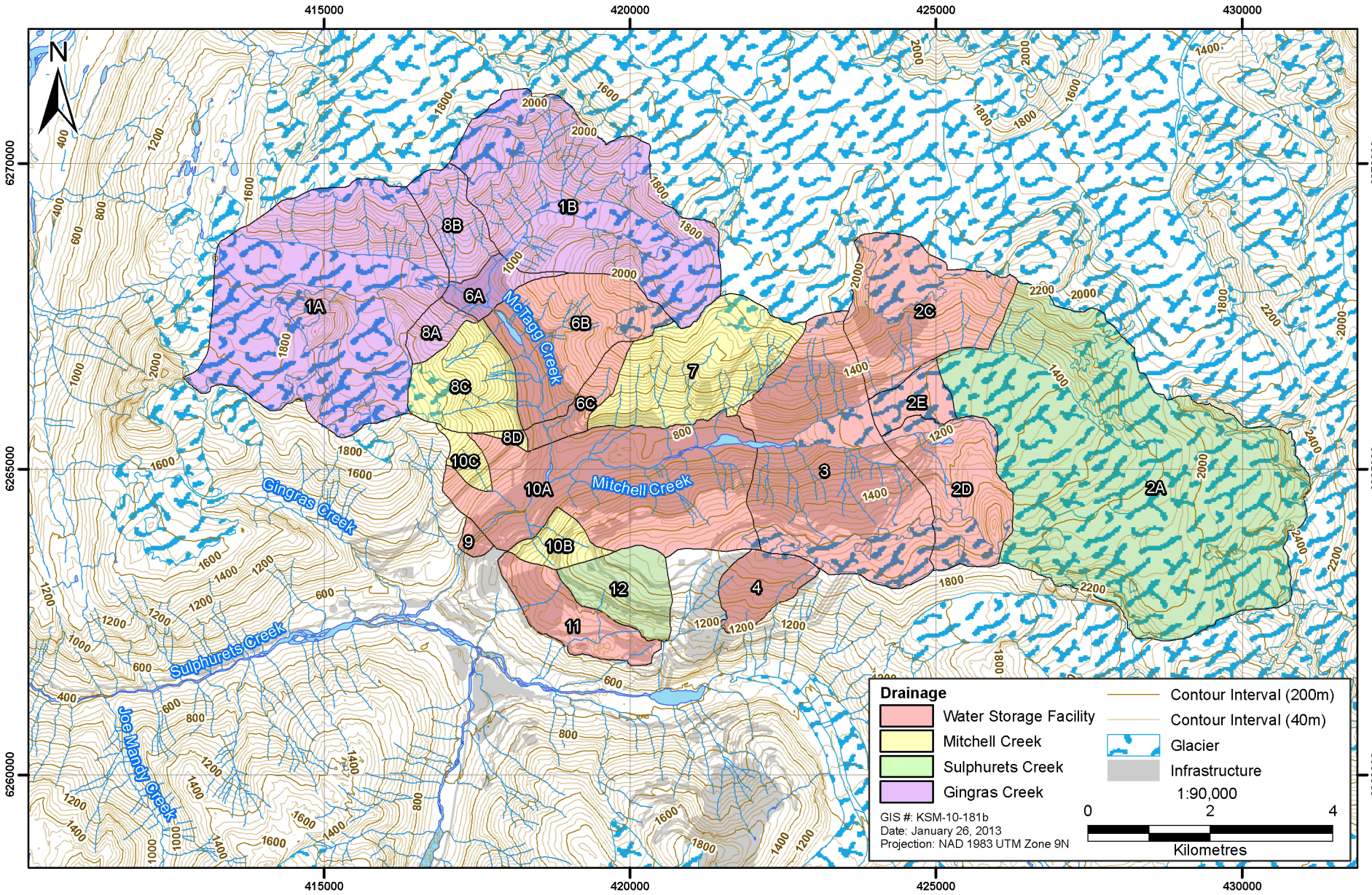

Figure 26.17-4

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area during Years 10 to 25 of Operation

Figure 26.17-4

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Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-181c February 6, 2013

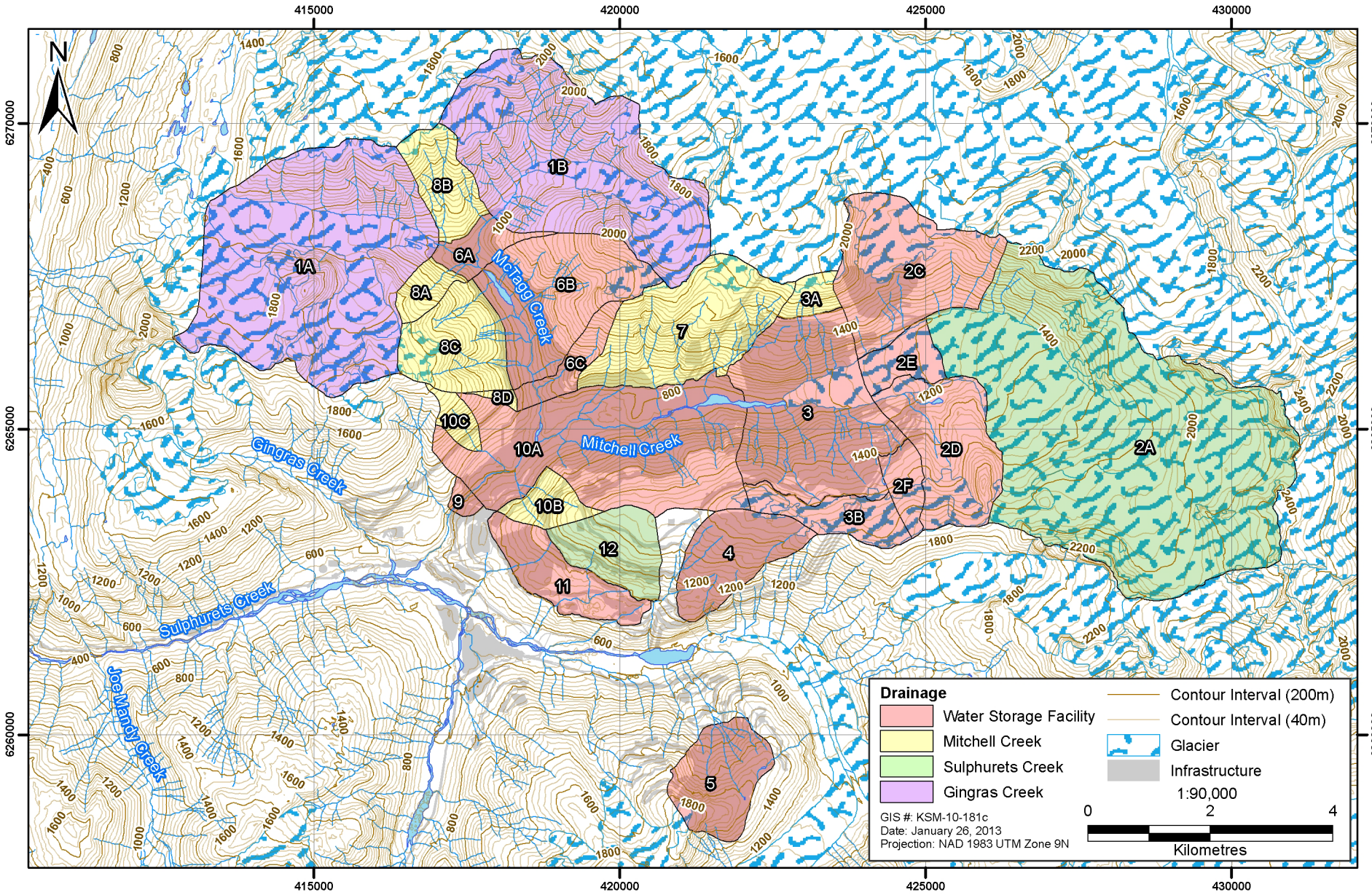

Figure 26.17-5

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area during Years 26 to 30 of Operation

Figure 26.17-5

Rescan
Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-181d February 6, 2013

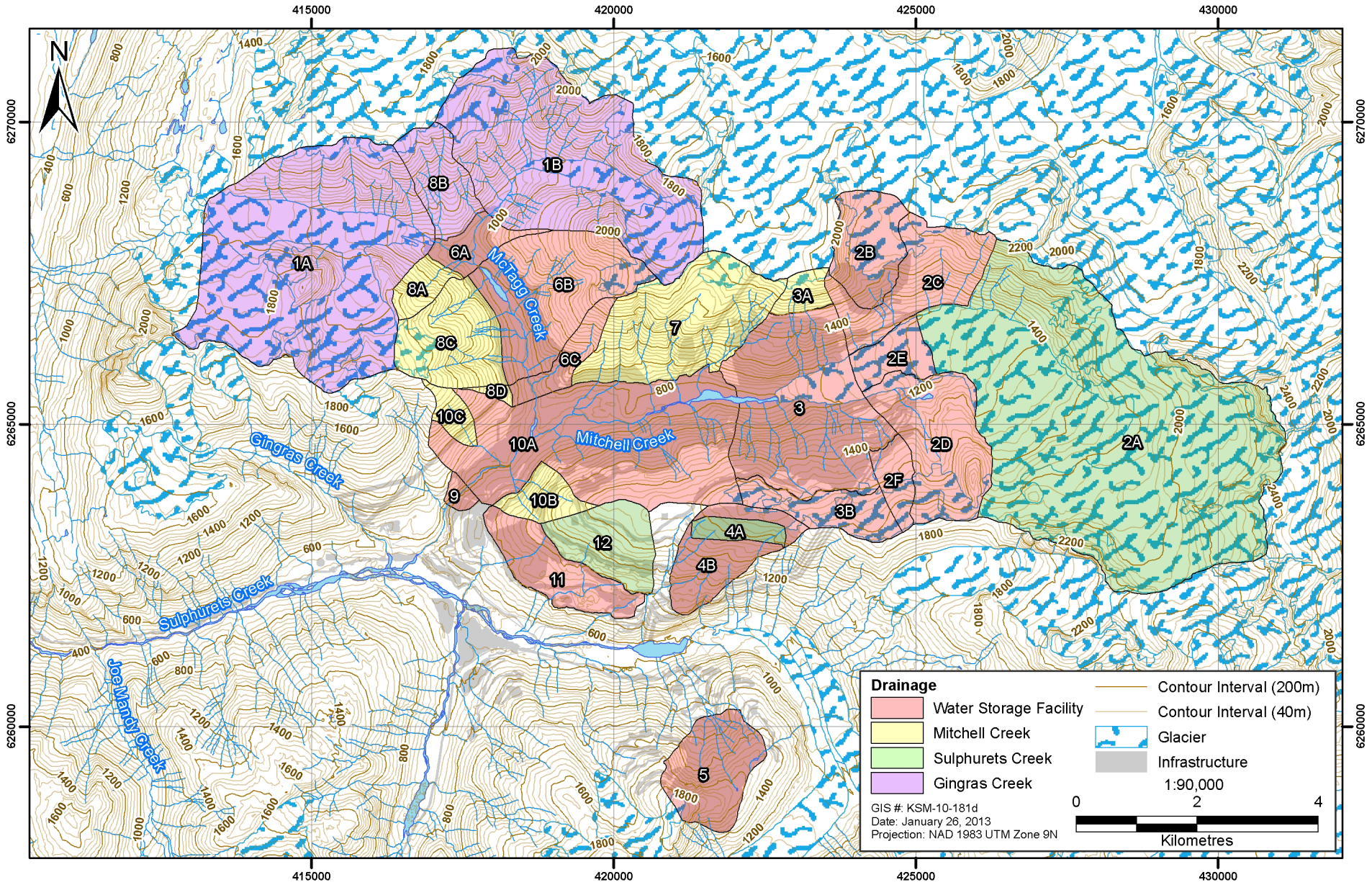

Figure 26.17-6

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area during Years 30 to 51 of Operation

Figure 26.17-6

Rescan
Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-181e January 29, 2013

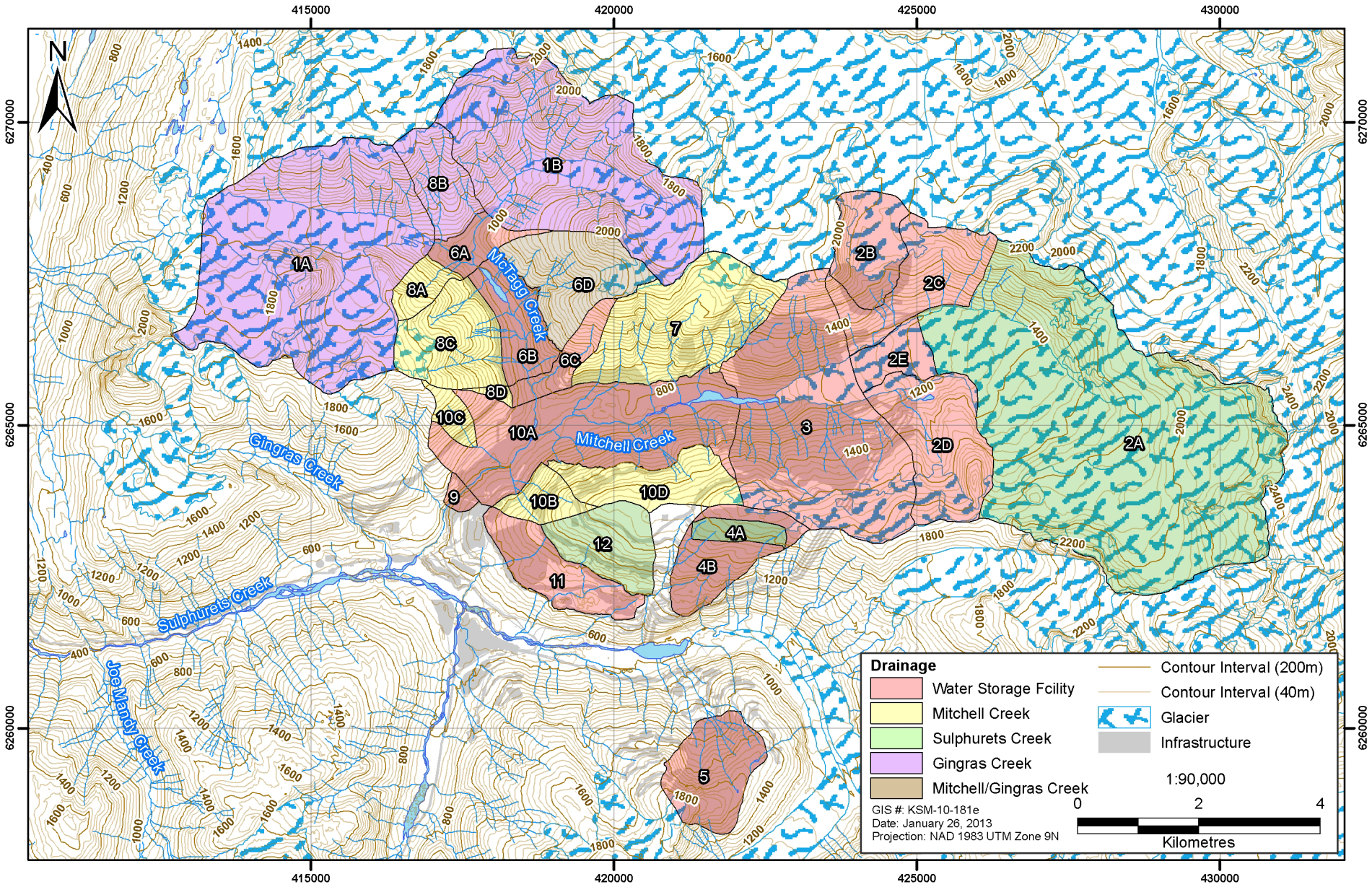

Figure 26.17-7

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area during Years 51 to 56 of Operation

Figure 26.17-7

Rescan
Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-181f April 1, 2013

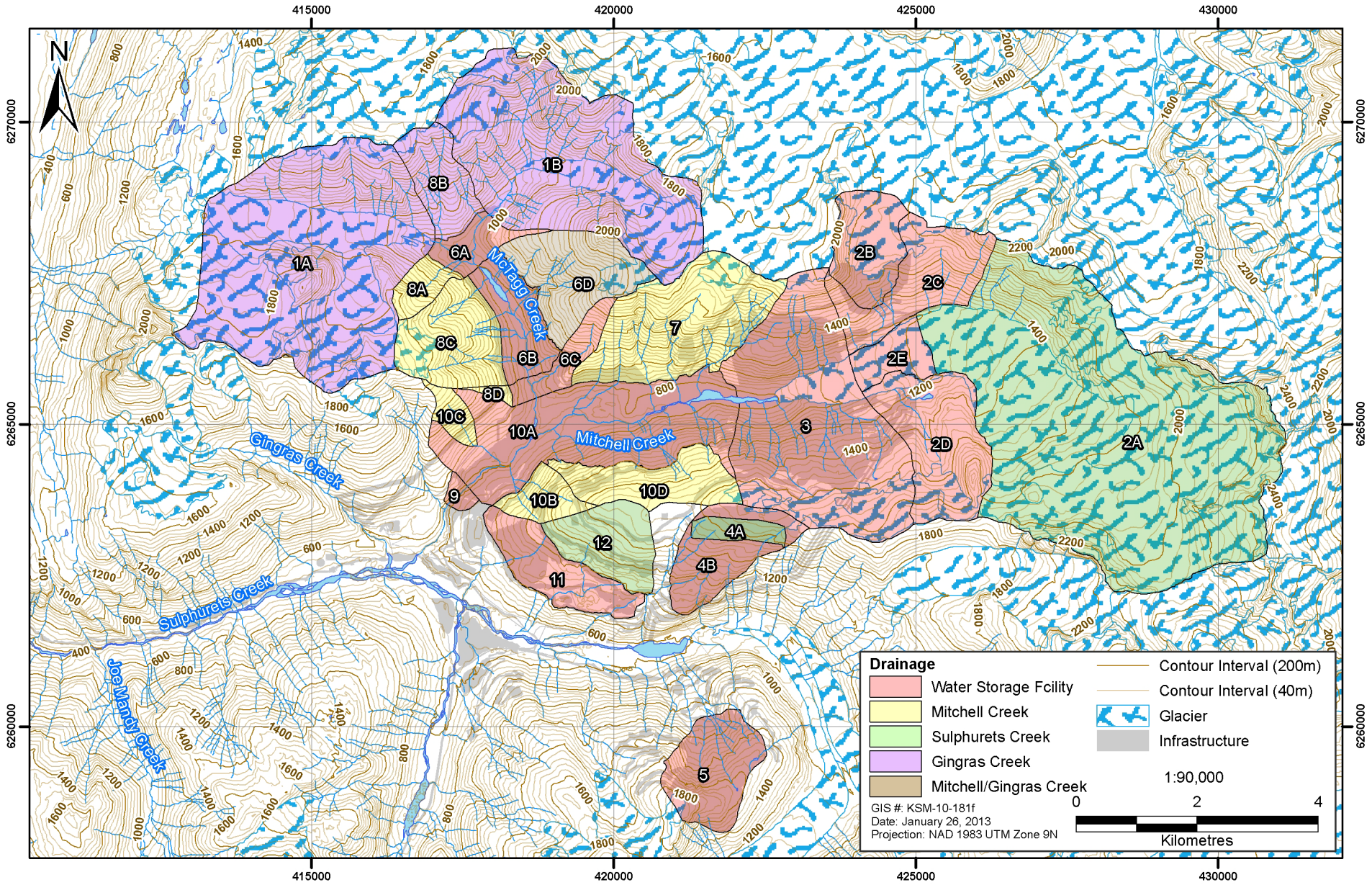

Figure 26.17-8

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of Mine Site Area after 57 Years of Operation

Figure 26.17-8

Rescan
Engineers & Scientists

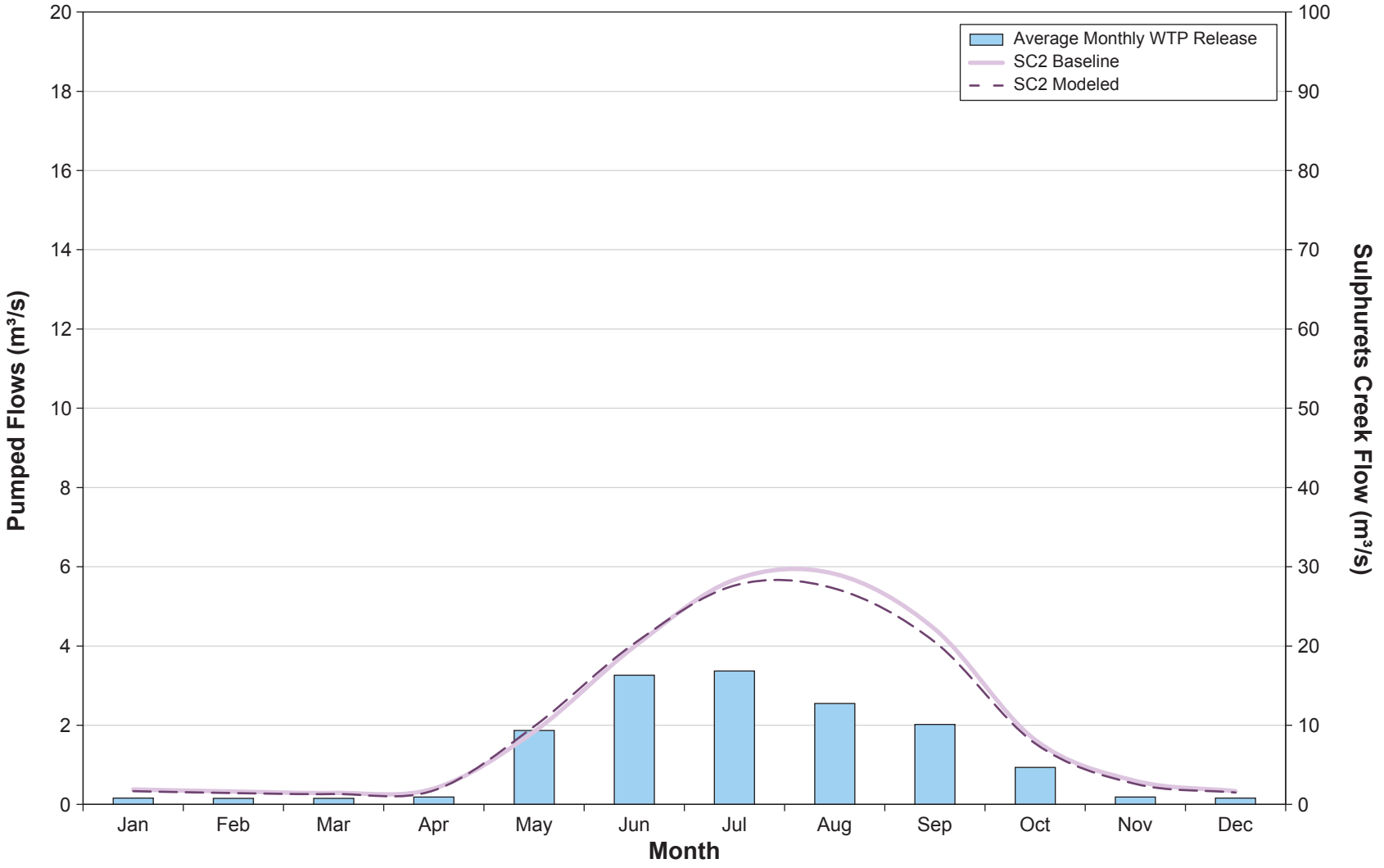

Figure 26.17-9

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within Sulpurets Creek for a 1 in 200 Dry Year

Figure 26.17-9

Rescan™ Engineers & Scientists

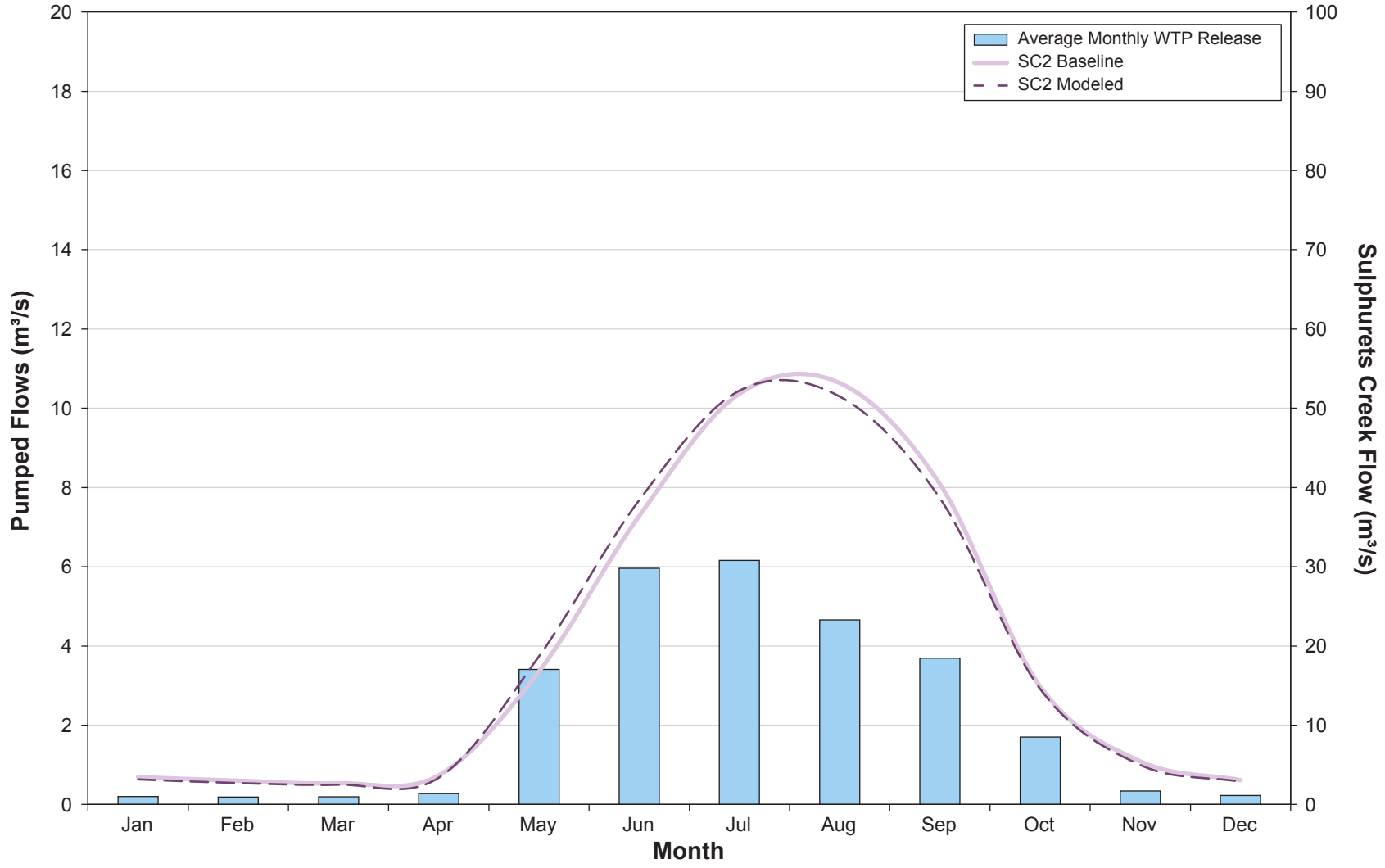

Figure 26.17-10

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within Sulphurets Creek for an Average Year

Figure 26.17-10

Rescan™ Engineers & Scientists

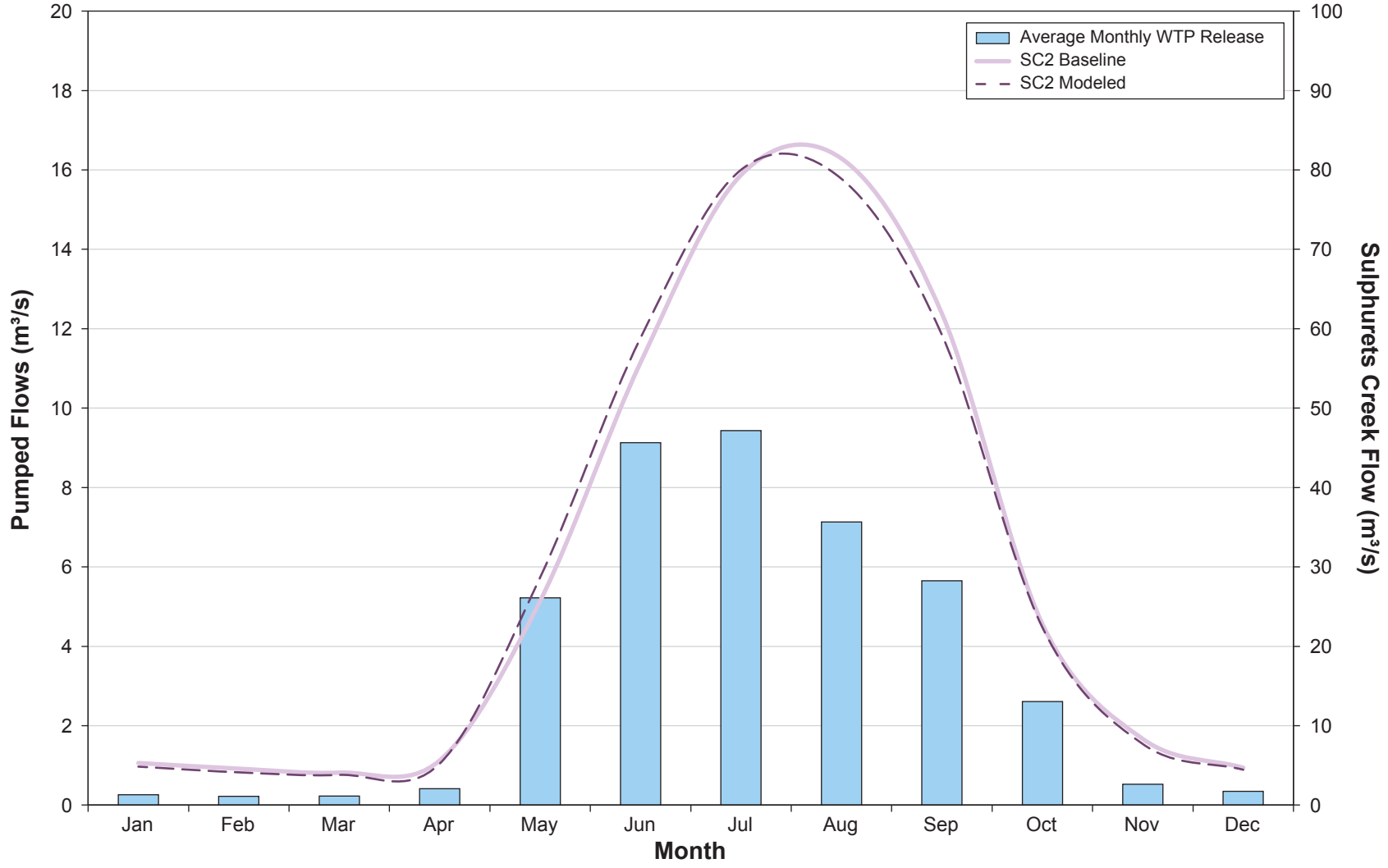

Figure 26.17-11

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within Sulphurets Creek for a 1 in 200 Wet Year

Figure 26.17-11

Rescan™ Engineers & Scientists

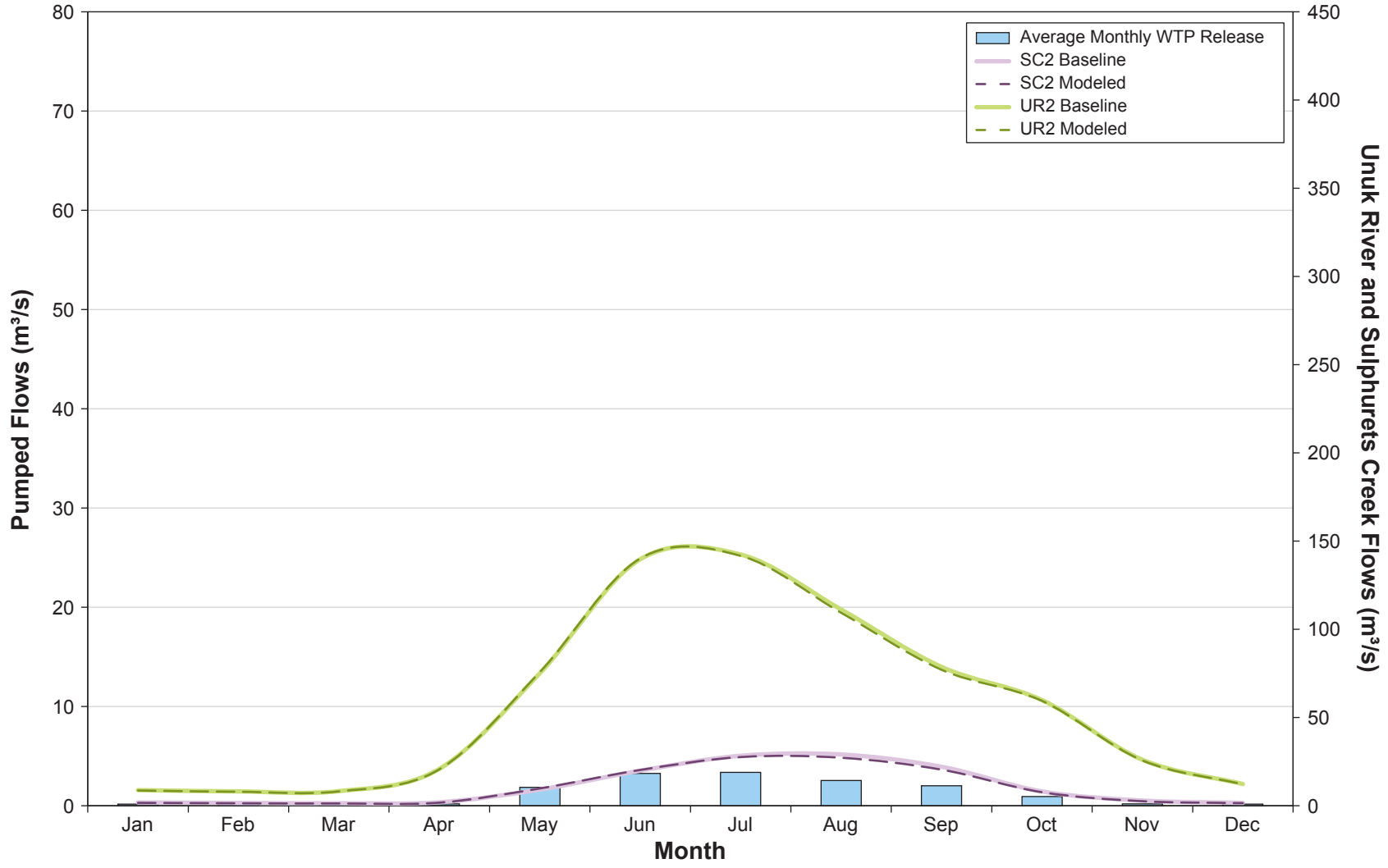

Figure 26.17-12

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within the Unuk River and Sulpurets Creek for a 1 in 200 Dry Year

Figure 26.17-12

Rescan™ Engineers & Scientists

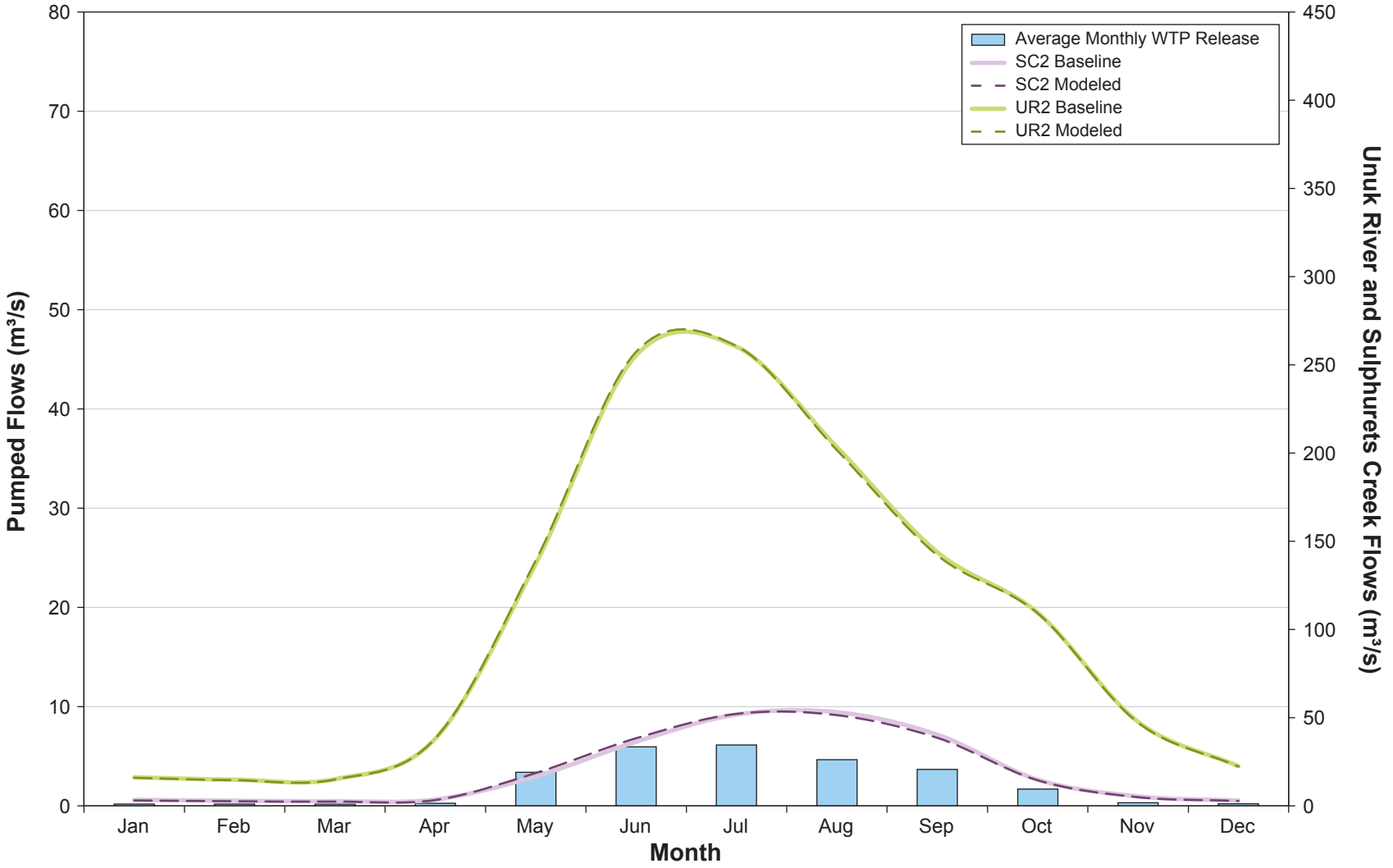

Figure 26.17-13

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within the Unuk River and Sulphurets Creek for an Average Year

Figure 26.17-13

Rescan™ Engineers & Scientists

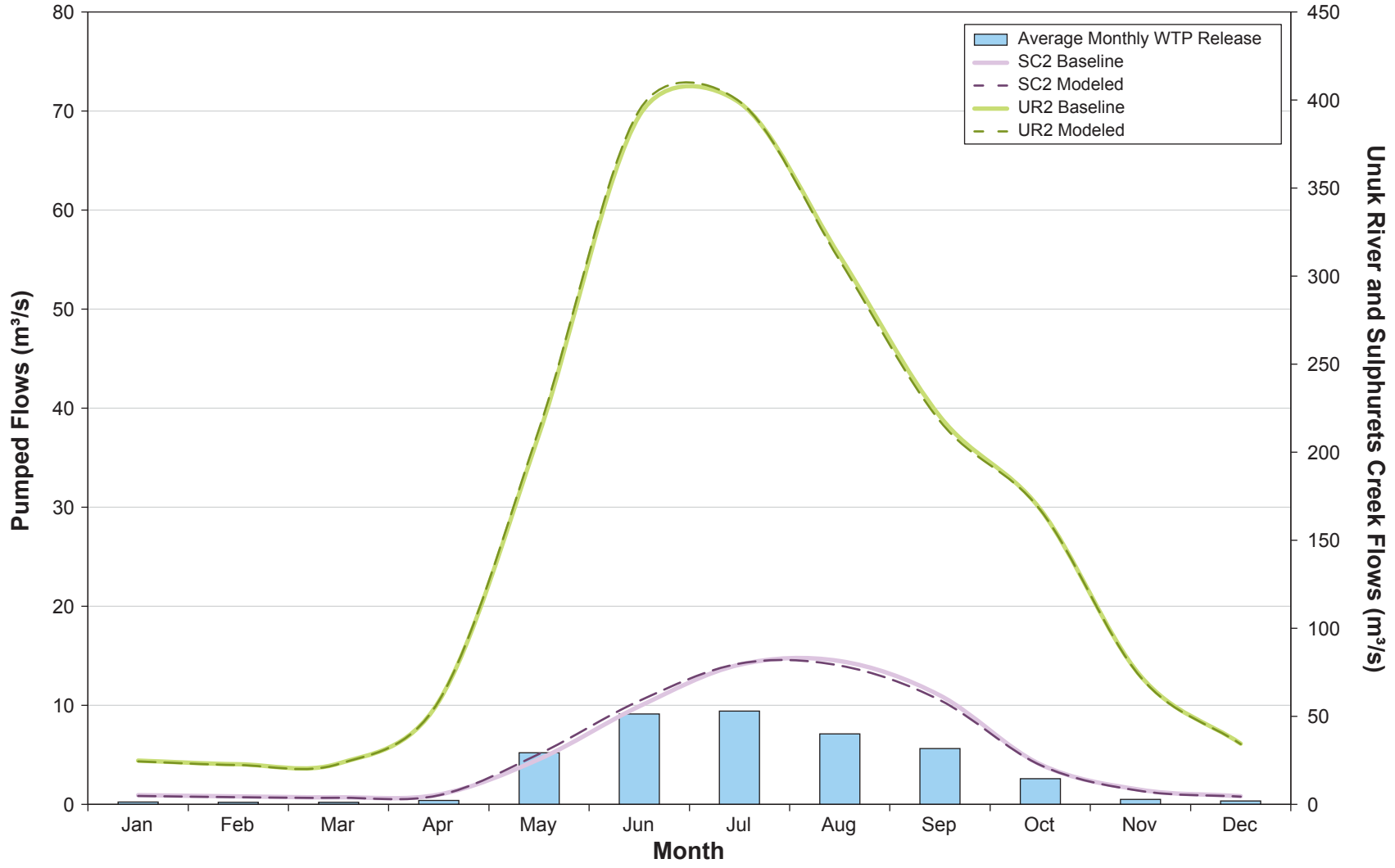

Figure 26.17-14

SEABRIDGE GOLD
KSM PROJECT

Baseline and Predicted Flows within the Unuk River and Sulphurets Creek for a 1 in 200 Wet Year

Figure 26.17-14

Rescan™ Engineers & Scientists

An extensive system of water management facilities will be constructed and maintained throughout the life of the Project to divert non-contact water away from disturbed areas and to collect water that has contacted disturbed areas (contact water) for treatments before release to the environment (for additional details see Chapter 4). The primary water management structures and facilities for the Mine Site include:

- the WSF, consisting of the WSD, the WSD construction diversion tunnel and cofferdam, the WSF seepage dam, the WTP, WSD pumps and housing, and HDPE lined steel penstocks;
- Mitchell and McTagg RSFs non-contact and contact diversion ditches, pipelines, and channels;
- the Mitchell Diversion Tunnels and McTagg Twinned Diversion Tunnels;
- the Mitchell Pit north wall dewatering adits;
- the Mitchell Valley Drainage Tunnel;
- Mitchell underground drainage tunnels;
- secondary diversion ditches and pipelines constructed in the Mine Site during operation to reduce contact water volumes and to direct open pit contact water and discharge from pit dewatering wells to the WSF;
- TWT facilities (construction phase only);
- closure channels (closure and post-closure phases only); and
- erosion and sediment control measures for the facilities listed above.

A primary objective of water management in the Mine Site is to minimize non-contact water reporting to the WSF to reduce water treatment requirements.

A secondary objective is to limit the flow of sediment to the WSF. During the construction phase, temporary sediment control structures will be required until the WSF is commissioned. Sediment control will be required during operation both to limit flow of sediment to the WSF, and to maintain channel design dimensions. Sediment controls will include ditches, sumps, silt fences, stilling basins, etc., as required to limit discharge of sediment and control erosion. Primary sediment control structures will be installed on the Mitchell and McTagg RSFs. The WSF will serve as secondary sediment control structure for the Project, and intermediate ponds will be required to facilitate sediment cleanout. Most mining activities will be upstream of the WSF.

Diversions will route non-contact runoff, glacial meltwater, and streams around the RSFs and WSF, and include permanent structures such as the Mitchell and McTagg diversion tunnels. Lined surface channels within the mine catchment areas will route local precipitation and slope runoff away from the RSFs and pits.

Main inflows into the WSF and WTP include, in no particular order:

- precipitation on open water in the WSF and WSF seepage dam impoundments;

- overland runoff in the WSF and WSF seepage dam catchments;
- runoff and infiltration from Mitchell and McTagg RSFs and Sulphurets laydown area;
- runoff and groundwater seepage from Mitchell, Kerr, and Sulphurets pit catchments;
- runoff from Mitchell Glacier north and south valley slopes where natural waters are in contact with mineralization upstream of the Mitchell diversion infiltration gallery;
- infiltration from surface and groundwater into the Mitchell and Iron Cap underground block caving operations (Iron Cap water will go directly to the WSF, not to the WTP);
- leakage from Mitchell Glacier and McTagg Glacier inlets to diversion tunnels, and diversion channels;
- seepage from the MTT;
- dewatering of the open pits and underground block caving; and
- water discharged from the Selenium Treatment Plant.

Outflows or losses from the WSF and WTP include:

- evaporation from open water in the WSF; and
- water discharged from the WTP.

26.17.5.3.1 Design Criteria

Detailed design criteria for structures within the Mine Site can be found in Appendix 4-J. A specific reference to that Appendix is provided below for structures relevant to the Water Management Plan.

- Mitchell and McTagg Rock Storage Facilities Underdrains – Section 9.7;
- Mitchell Diversion Tunnel and McTagg Twinned Diversion Tunnel – Section 9.2 to 9.4;
- Surface Water Diversions – Section 9.5;
- Sulphurets Laydown Areas and Sulphurets and Kerr Pits' Contact Water Collection Systems – Section 9.6; and
- WSF, WSD, Water Storage Facility Seepage Dam, and WTP – Section 8.

Water management associated with the Mitchell and Iron Cap block cave mines can be found in Chapter 4, Sections 4.5.1.3 and 4.5.1.6.

26.17.5.3.2 Construction

During construction, drainage from tunnel portals and temporary stockpiles of PAG tunnel muck (located near the tunnel portals) will be treated using TWT facilities at each location. TWT facilities will be located at the following sites:

- the WTP (treating runoff from the truck shop, WSF seepage collection dam, and WSD area);
- the MTDTs outlet (tunnels driven from south end or outlet only);

- the MDTs inlets, southwest of the Mitchell Glacier toe (treating MDT tunnels drainage and PAG muck runoff tunnel drainage);
- the MTT Mitchell process plant portal at west end (treating MTT drainage, PAG muck runoff, and PAG runoff from PAG road cuts in the Mitchell OPC);
- the MDTs outlets in Sulphurets Creek Valley (treating MDTs muck and tunnel drainage);
- the Treaty Saddle portal on the MTT alignment (treating tunnel muck if PAG and MTT drainage);
- the MTT process plant portal at the northeast end (Treaty OPC; treating tunnel muck if PAG and MTT drainage); and
- the WSD construction diversion tunnel, upstream end (treating tunnel muck and tunnel drainage).

Prefabricated, containerized, TWT facilities will remove dissolved metals and suspended solids, and will include ammonia control if required for residue from explosives use. Facilities will include tanks, agitators, lime dosing, and three treatment/settling ponds. Further details on the design and construction of these treatment facilities are included in Appendix 4-P, *Temporary Water Treatment Plants for Construction*.

Where PAG tunnel rock is excavated during tunnels development, it will be stockpiled on lined pads near the portals. The TWT facilities will be located preferentially downslope of the lined PAG pads. Where the muck pads are located outside the Mitchell or McTagg valleys, once the WTP is operating, PAG tunnel muck will be evaluated, assessed, and options for disposal will be considered, foremost being hauling the PAG material to the RSFs for disposal. For eastern sections of the MTT, PAG rock will be hauled to the lined section of the TMF for storage. Water management procedures for the TMF are described in Section 26.17.6.

Sediment control during construction is described in Section 26.17.4.1. Erosion and sediment control BMPs will be implemented. These include isolation of work areas from surface waters, the use of temporary diversion methods (e.g., lined ditches, flumes, and dam-and-pump), and proper use of sediment traps, geotextile cloth, silt fences, gravel berms, and straw bales in order to mitigate and control erosion and sediment.

As described in that section, baseline data on soils, terrain, and surface water quantity will be used along with visual surveys of construction activities to identify potential sites that require focused attention and specific plans for water management. Vulnerable sites, such as locations of potential ditch failures or culvert blockages, will be identified in advance, and risks in these areas will be addressed by site-specific contingency plans.

If necessary, to protect vulnerable sites, temporary sediment ponds will be constructed as a secondary form of sediment control. The sediment ponds will be augmented by automated total suspended solids (TSS) treatment facilities (flocculent dosing systems) if additional treatment is required to protect the receiving environment and meet permit requirements.

26.17.5.3.3 Operation

Before Year 5, contact water from mineralization upstream of the Mitchell Pit will be routed through the Mitchell Valley Drainage Tunnel to the WSF for treatment via a rock channel cut in north of the starter pit. After Year 5, mineralized water from upstream of the Mitchell Pit will be diverted around the pit by the Mitchell Pit north wall dewatering adit. The Mitchell Valley Drainage Tunnel will pass around the north side of the Mitchell Pit. The adit will also accept drainage from vertical pit dewatering wells.

During part of the open pit phase (between Year 5 and Year 29), the Mitchell Creek Valley will be blocked by the land-bridge and ore stockpile. While the valley is blocked, freshwater runoff from the valley slope above the ore stockpile will pass over the ore stockpile and land-bridge on a surface diversion. Flow from the Mitchell Valley north slope above the Mitchell OPC will be routed through pipes under these obstructions.

Additional, independent redundancy against water flow into Mitchell Pit or the underground works caused by MDT diversion failure or by failure of the subglacial inlets will be provided by connections at the surface inlets to both the Mitchell Pit north wall dewatering adit and the MDT. A system of gates, weirs, and stoplogs will provide control of water paths and control of alternate emergency-only routings for drainage around the pit and underground works.

During the open pit phase, storm flows from the Upper Mitchell Creek Valley, North Mitchell Glacier slope, and South Mitchell Glacier above the 200-year peak flow capacity of the Mitchell Pit north wall dewatering adit will be either directed to the open pit or discharged to the MDT. During this phase, the dewatering adit will discharge into the Mitchell Valley Drainage Tunnel to handle additional discharge from Mitchell Pit area. This tunnel is an extension of the Mitchell Pit north wall dewatering adit that routes contact water directly to the WSF.

In Year 26, when development of underground mining commences at the Mitchell Block Cave Mine, two additional Mitchell diversion tunnels will be constructed in parallel to the existing twin MDTs to increase the capacity to convey the 1,000-year peak flow. These additional tunnels will enter service in about Year 26 when block caving commences. The additional diversion tunnel capacity will protect the underground developments from extreme flood events. Additionally, during underground phases a lined contact water channel will be provided on the surface in Mitchell Creek Valley. This channel will drain to the WSF.

McTagg Glacier water will be diverted to Gingras Creek by a system of twinned diversion tunnels, called the McTagg Twinned Diversion Tunnels. The McTagg diversion works will be constructed in three stages to accommodate the increased footprint of the McTagg RSF. Stage 1 will be in service from years -2 to 10; the inlet is located at 688 m, approximately 900 m upstream of the confluence of McTagg Creek with Mitchell Creek. Stage 2, between years 10 and 15, the dam and inlet is located at 807 m in the McTagg Valley downstream of the confluence of the east and west forks of McTagg Creek. Subsequent inlets will be established at higher elevations in the McTagg Creek Valley as the valley is gradually filled by the McTagg RSF. Stage 3 is required by Year 15, and will include two inlet dams, with East McTagg at 920 m and West McTagg at 914 m. A perimeter closure channel will be established around the

north and west edges of the McTagg RSF at these elevations. The tunnel outlets in Gingras Creek will be used to generate hydroelectric power for the Project.

As the McTagg RSF rises over time, lined diversion ditches and diversion pipelines will be constructed on the perimeter of the RSF against the west wall of the McTagg Valley, across the RSF and around the east side of the WSF in a rock cut channel upslope of the access road. This channel will route non-contact valley slope runoff into Mitchell Creek downstream of the WSF. These surface diversions are designed to route the 200-year event.

A lined diversion channel for non-contact freshwater will be raised in stages above the north edge of the Mitchell RSF. This channel will be raised on the ore stockpile perimeter until the ore stockpile reaches its ultimate height. North Slope non-contact water from slopes east of the ore stockpile will be directed into a buried pipeline running under the ore stockpile and under the land-bridge between the Mitchell and McTagg RSFs. Initially, the surface channel and this pipeline will discharge into the MTDT inlet. In later years of operation, the channel and pipeline will discharge into a freshwater diversion channel crossing the Mitchell RSF downstream of the land bridge.

The Kerr deposit is higher in selenium than the other KSM Project deposits. As a result, mine rock from the Kerr Pit will be conveyed and placed as backfill in the mined-out Sulphurets Pit. The backfilled Kerr waste rock will be covered and drainage will be collected for selenium removal by a dedicated selenium ion exchange treatment plant, which will discharge to the WSF. The Selenium Treatment Plant design report is located in Appendix 4-V. The Sulphurets Pit will be dewatered by a pipeline leading past the Selenium Treatment Plant and on to the WSF, allowing treatment as required. The Kerr Pit will be dewatered by a pressure pipeline directing drainage from the pit to the WSF.

During the operation phase, seepage and contact surface runoff from the Mine Site, the Mitchell and McTagg RSFs, and the Sulphurets laydown area will be directed to the WSF for treatment at the WTP. Dewatered sludge from the water treatment process will be trucked from the WTP site to the Mitchell OPC and added to the ore at the crusher. The sludge will pass through the milling process and will ultimately be disposed of in the TMF. Details of sludge volume, storage, and transport are described in the Project Description (Chapter 4).

26.17.5.3.4 Closure and Post-closure

Avoidance and mitigation measures to manage water during the deactivation and closure of the Mine Site will be similar to those used during the construction phase. Mine Site closure will be staged for purposes of water management.

The WSF and WTP will continue to operate into the future until water quality meets discharge requirements. The WSD and associated facilities will be subject to ongoing monitoring and maintenance to ensure dam safety. The difference in height between the normal flow discharge pipe and the WSD spillway crest will provide storage to attenuate and retain storm floods in the pit lake. Under the CDA's *Dam Safety Guidelines*, the WSF reservoir spillway is required to safely route the inflow design flood, defined as two-thirds of the difference between the magnitudes of the 1,000-year flood and the PMF, without dam overtopping or significant

damage to the spillway structure (CDA 2007). However, as a conservative design choice, the WSF spillway has been designed to pass the PMF.

Upon cessation of mining activities, the MDT and MTDT will continue to direct non-contact water around the Mine Site and RSFs. Closure channels located on the RSFs will provide additional capacity for routing non-contact runoff to Mitchell Creek downstream of the WSD. Design of the closure channels considers that the MDT and MTDT could be subject to blockages or failures, therefore requiring that the closure channels have capacity for diversion flows in addition to runoff flows. However, it is planned that the MDT and MTDT will be maintained for generation of hydropower in the event of BC Hydro grid power failures.

At closure, Mitchell Pit will be flooded to reduce the area of pit wall rock exposed to oxidation and potential acid generation. To accelerate the flooding of the pit and underground works, the gates in the MDT will be temporarily partially closed. Once the pit lake is filled, approximately after five years, the diversion tunnels will be fully re-opened to divert all non-contact water. Drainage from the pit lake will be treated as contact water and will be routed to the WSF via a surface channel. After closure, if for some reason all of the MDTs fail, flow from Mitchell Glacier could be routed through Mitchell Pit Lake and over the flooded underground workings.

Closure of the Kerr and the backfilled Sulphurets pits will include ongoing drainage by gravity to the Selenium Treatment Plant and WSF. The geometry of the Kerr and Sulphurets pits is not favourable for closure flooding. As a result, only a small amount of water will be collected in each during storm events, sufficient to attenuate peaks from the storm runoff. Normally flows from these pits will drain directly into the dewatering pipelines. A closure pipeline will be maintained from Kerr Pit to the WSF until water quality at Kerr is adequate for direct discharge into Sulphurets Creek.

Closure of the Iron Cap Underground Works will result in mine drainage reporting to the Mitchell Pit Lake by gravity through the ventilation adits. These tunnels will lead from the lower levels of the Iron Cap Underground Works to three portals situated above Mitchell Glacier.

Upon mine closure, the Mitchell and McTagg hydroelectric plants will remain in operation, generating more power than required to operate the treatment plant, and generating income to offset treatment costs. Continued operation of the hydroelectric plants will also provide the benefit of a locally produced backup power supply for the WTP, increasing reliability of the power supply to the plant.

The MTT will remain open after closure to provide access to the Mine Site and to keep the tunnel power cables in operation to allow for the sale of surplus power to the provincial grid.

26.17.6 Processing and Tailing Management Area

Water management in the PTMA is focus and the construction of diversion channels to control and divert water in the PTMA catchment area to either South Teigen Creek or North Treaty Creek.

26.17.6.1 Changes to Flow Pathways and Drainage Areas

Expected changes to subcatchment areas within the PTMA are presented in Figures 26.17-15 to 26.17-20 for multiple stages of the mine life. Changes to flow pathways and drainage areas are discussed in more detail in Chapter 13.

26.17.6.2 Water Balance

26.17.6.2.1 Pumped Flows and Downstream Flow Rates

Pumped flow rates heading into Treaty and North Treaty creeks were estimated for different climatic conditions. Scenarios for 1-in-200 dry, 1-in-200 wet, and an average year were produced. In order to manage pumping rates from the TMF, hydrometric stations will be located on South Teigen, North Treaty, and Treaty creeks.

Figures 26.17-21 to 26.17-26 show the estimates of potential changes to stream flow in Treaty and North Treaty creeks due to pumped flows originating from the TMF.

26.17.6.3 Processing and Tailing Management Area: Avoidance, Control, and Mitigation

After primary crushing at the Mitchell OPC near the deposits, ore will be transported from the Mine Site to the PTMA by the MTT. The PTMA includes the eastern portals of the MTT, the Treaty OPC, and the TMF. The Treaty OPC is adjacent to the TMF. Grinding and flotation of the ore will take place at the Treaty OPC, producing tailing (90% of the total). Further processing of sulphide-enriched material (10% of the total) will be done through a leaching process, producing a CIL tailing.

The TMF is designed to store 2.3 Bt of tailing, stored in three cells, staged over the 51.5-year mine life. Flotation tailing will be deposited in the North Cell from years 0 to 25 and in the South Cell from years 26 to 51.5. The CIL tailing will be in contact with cyanide during processing and will be stored in a separate, fully lined CIL or Centre Cell located between the North and South cells. The Centre Cell will be operated over the 51.5-year mine life.

The TMF is divided into cells to separate the CIL tailing from the flotation tailing, to manage flows from the East Catchment, to minimize surplus water in the TMF, and to allow progressive reclamation of the North Cell during operation of the South Cell.

Scheduled development stages of the TMF are categorized as follows:

- **Stage 1 (Years 1 to 24) –** operation of the North Cell to its ultimate capacity;
- **Stage 2 (Years 25 to 29) –** closure of the North Cell;
- **Stage 3 (Years 30 to 51.5) –** operation of the South Cell to its ultimate capacity;
- **Stage 4 (Years 51.5 to 55) –** closure; and
- **Stage 5 (Years 56 to 60) –** permanent facility closure.

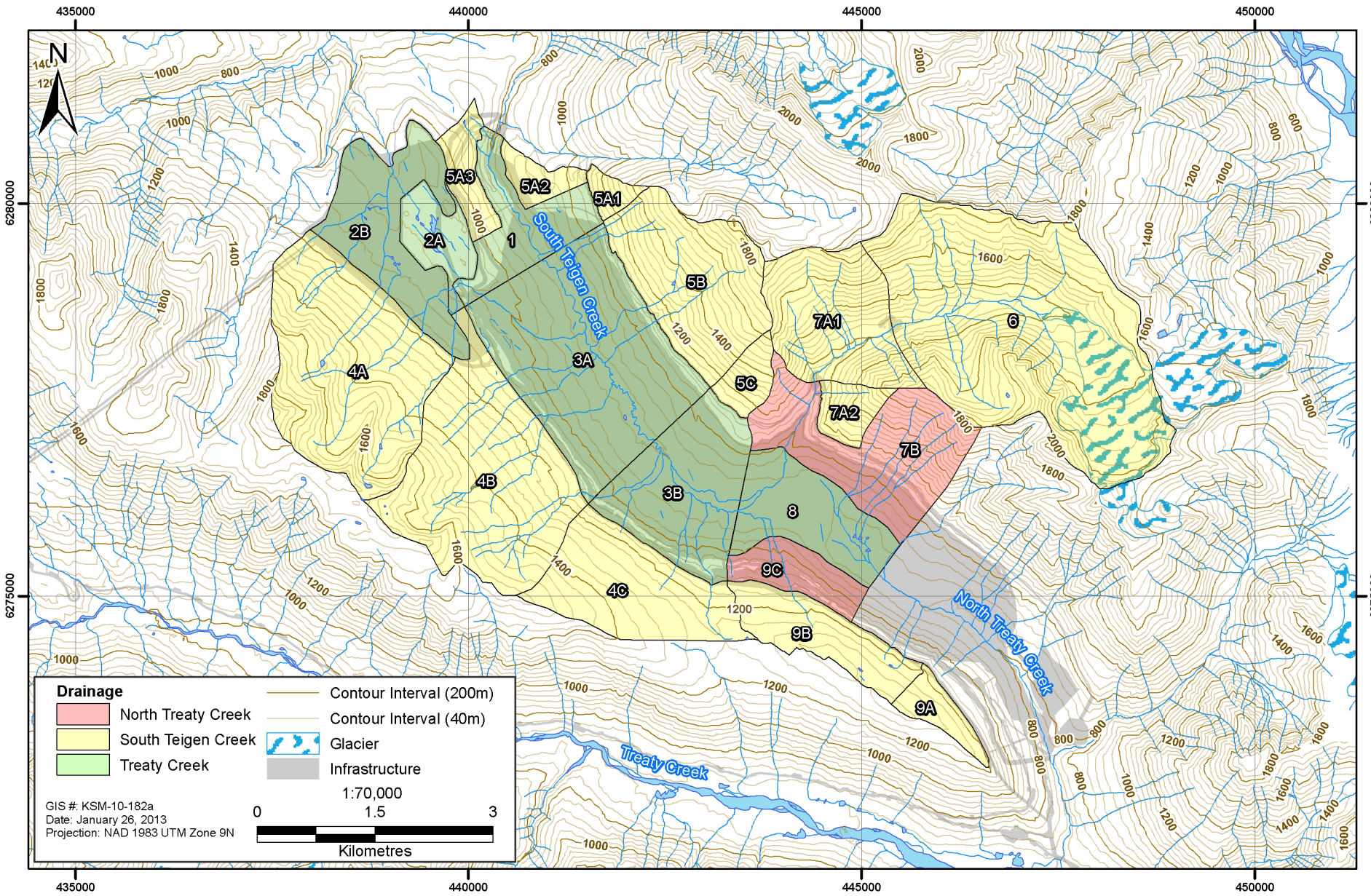

Figure 26.17-15

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA during Years 0 to 24 of Operation

Figure 26.17-15

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PROJECT # 0868-022-23 GIS No. KSM-10-182b February 6, 2013

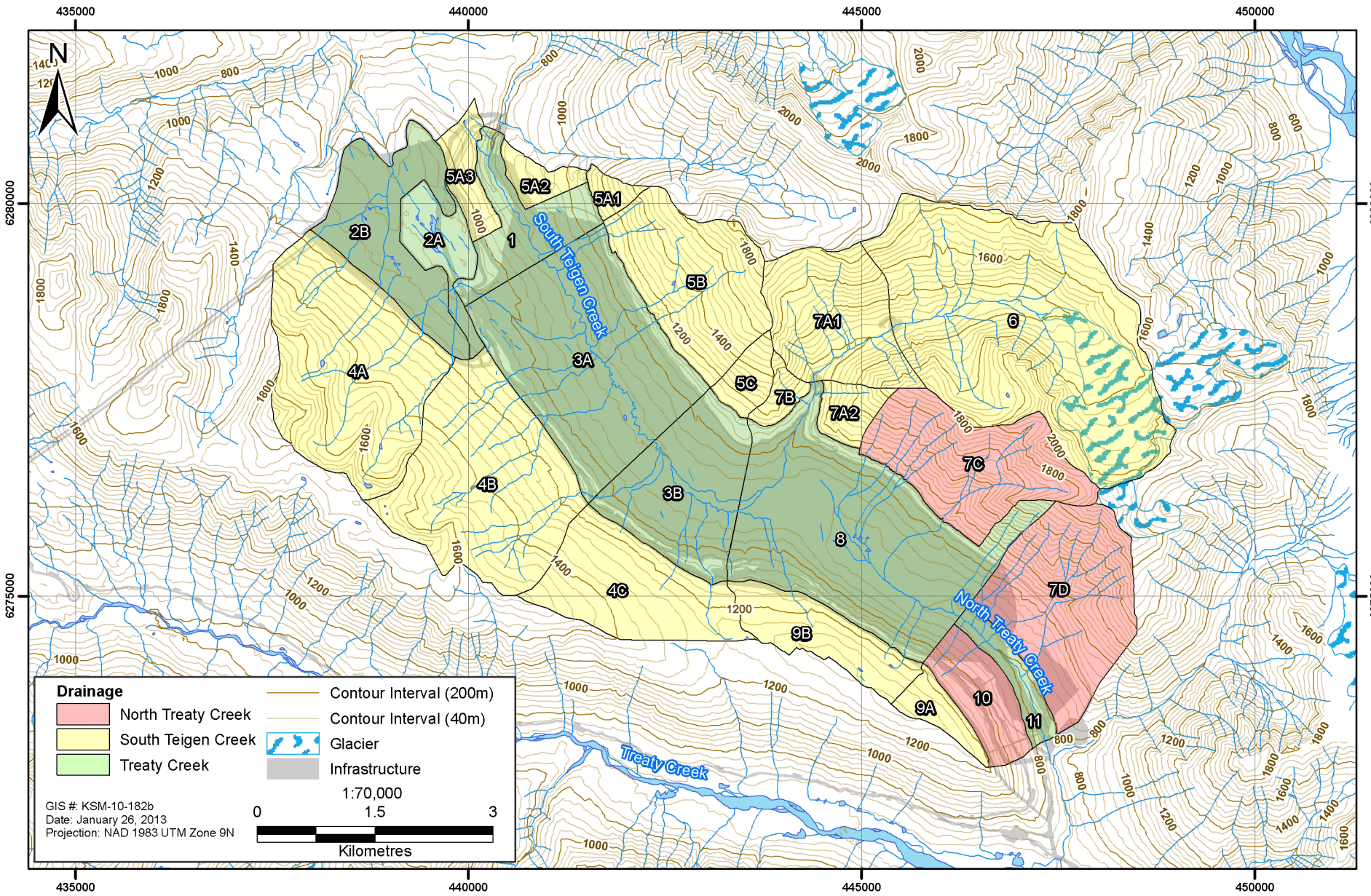

Figure 26.17-16

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA during Years 25 to 30 of Operation

Figure 26.17-16

Rescan
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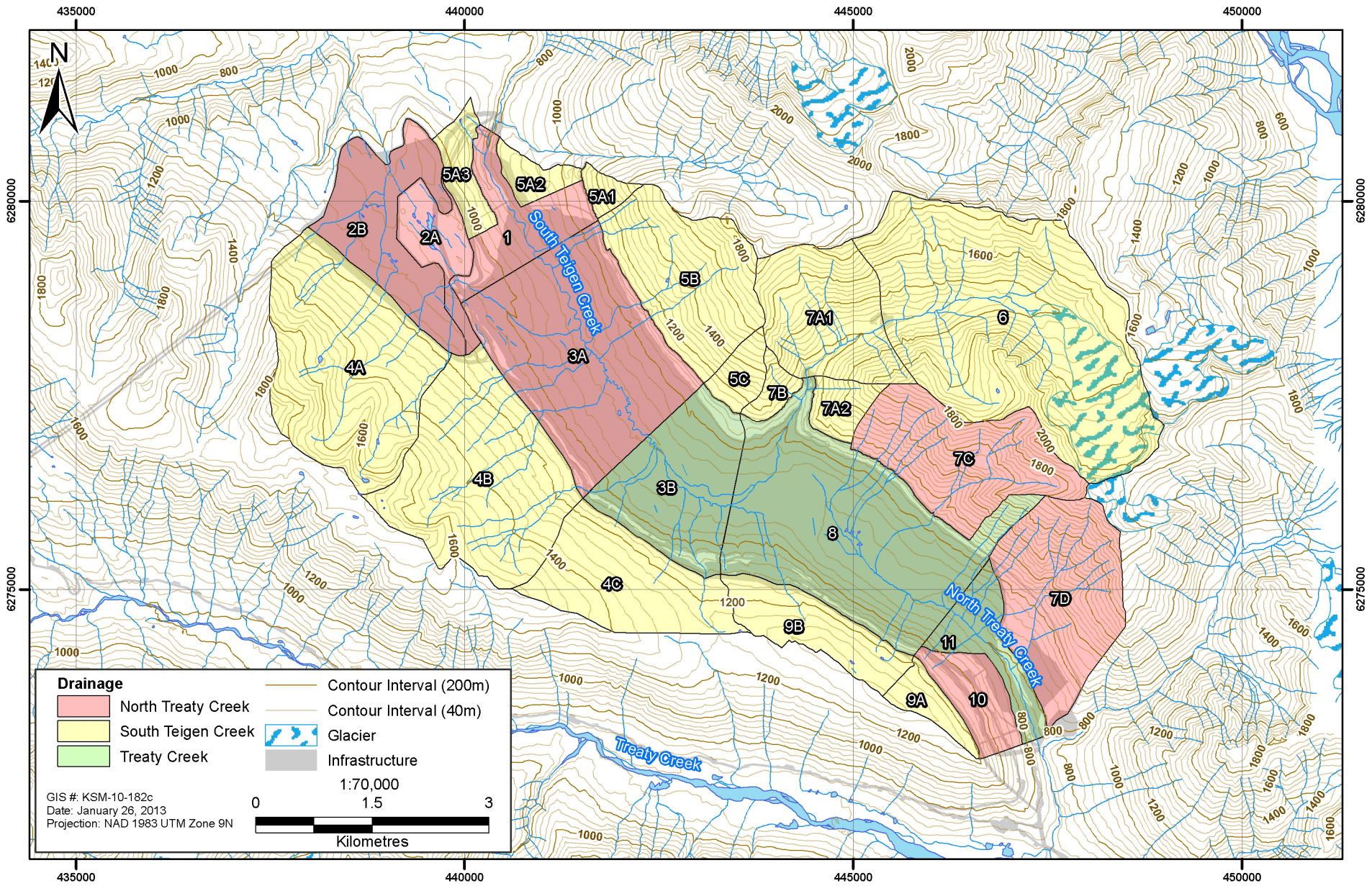

Figure 26.17-17

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA during Years 30 to 45 of Operation

Figure 26.17-17

Rescan
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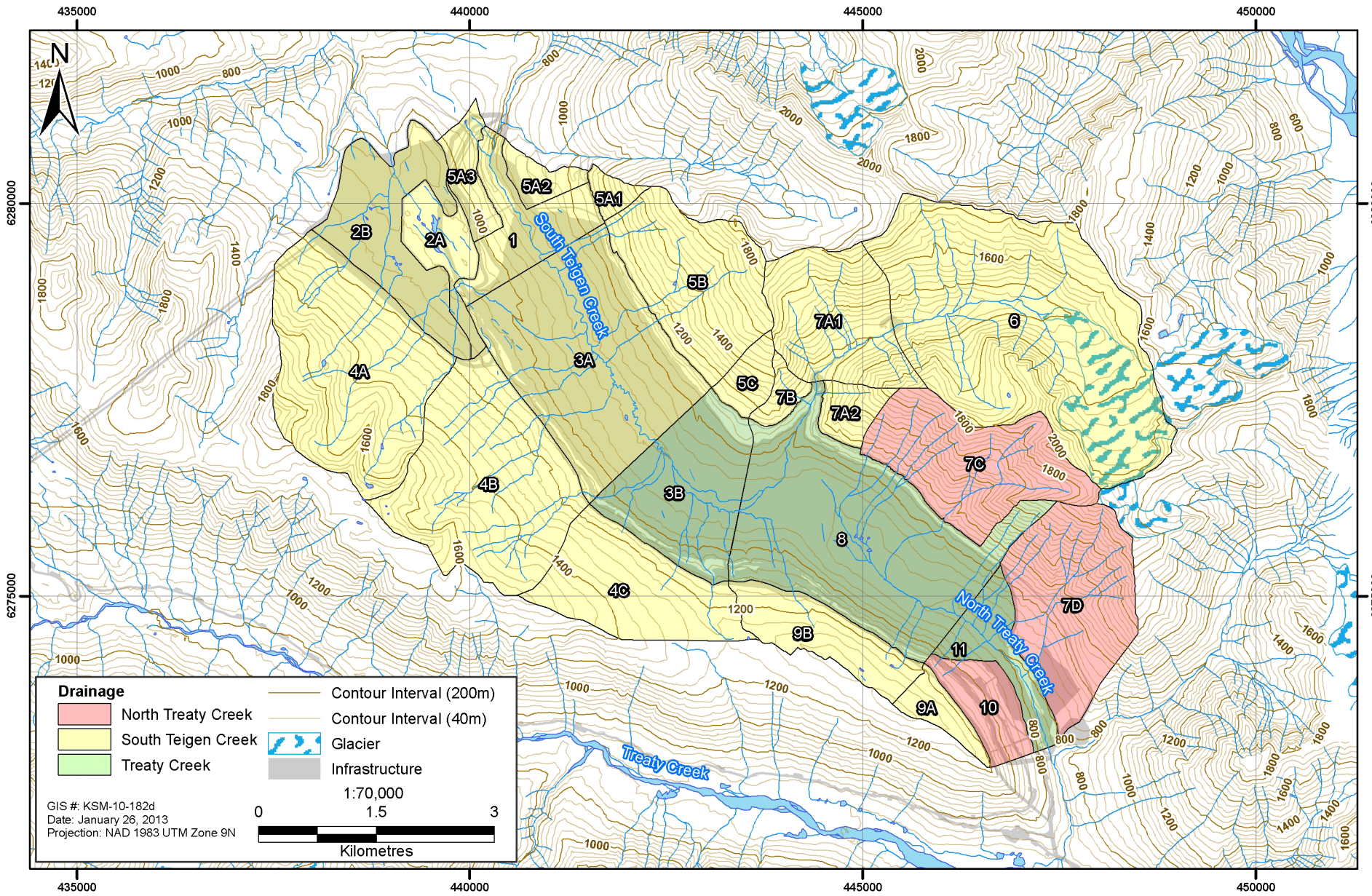

Figure 26.17-18

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA during Years 45 to 51 of Operation

Figure 26.17-18

Rescan
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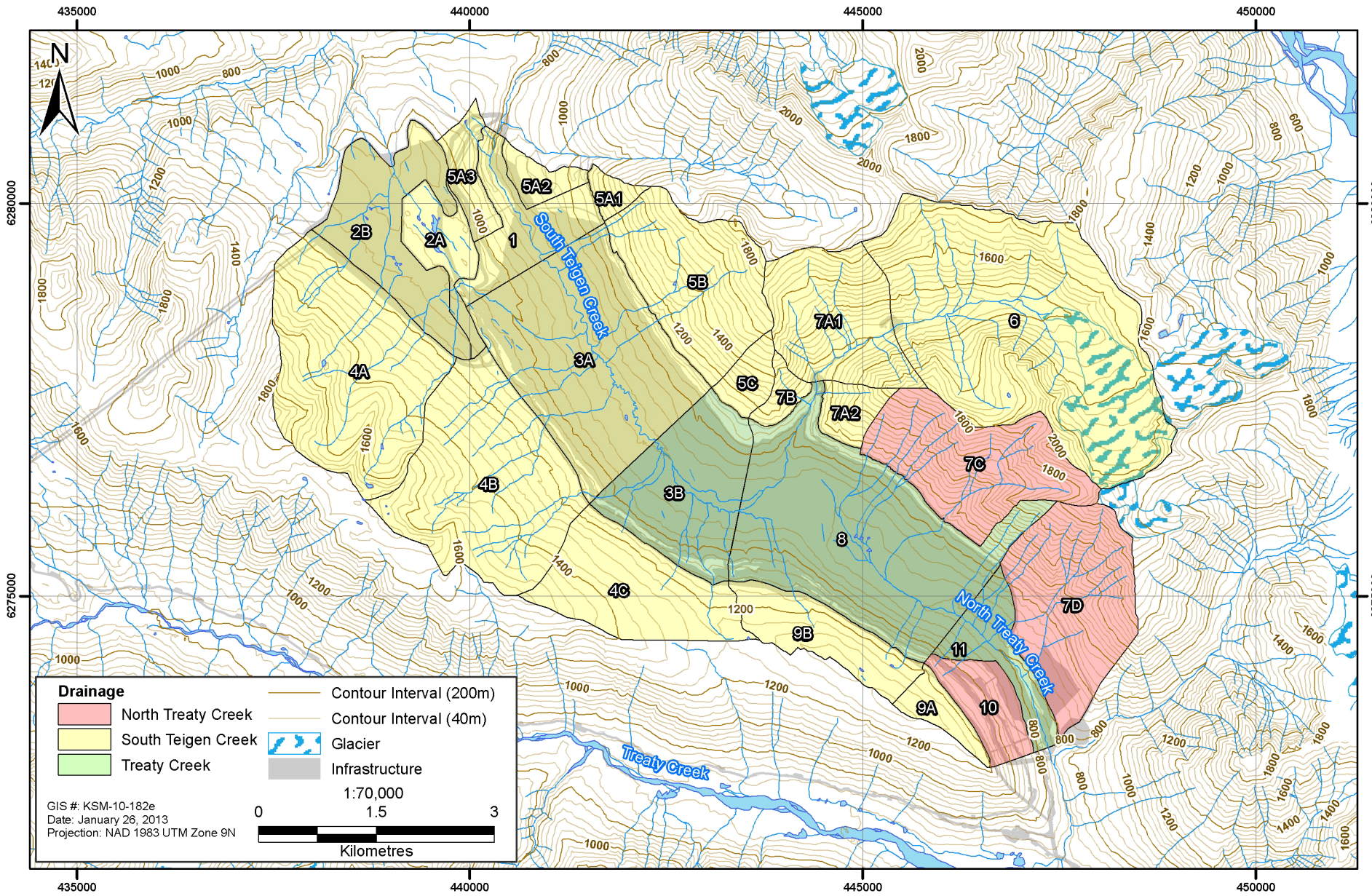

Figure 26.17-19

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA during Years 51 to 56 of Operation

Figure 26.17-19

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Engineers & Scientists

PROJECT # 0868-022-23 GIS No. KSM-10-182f February 6, 2013

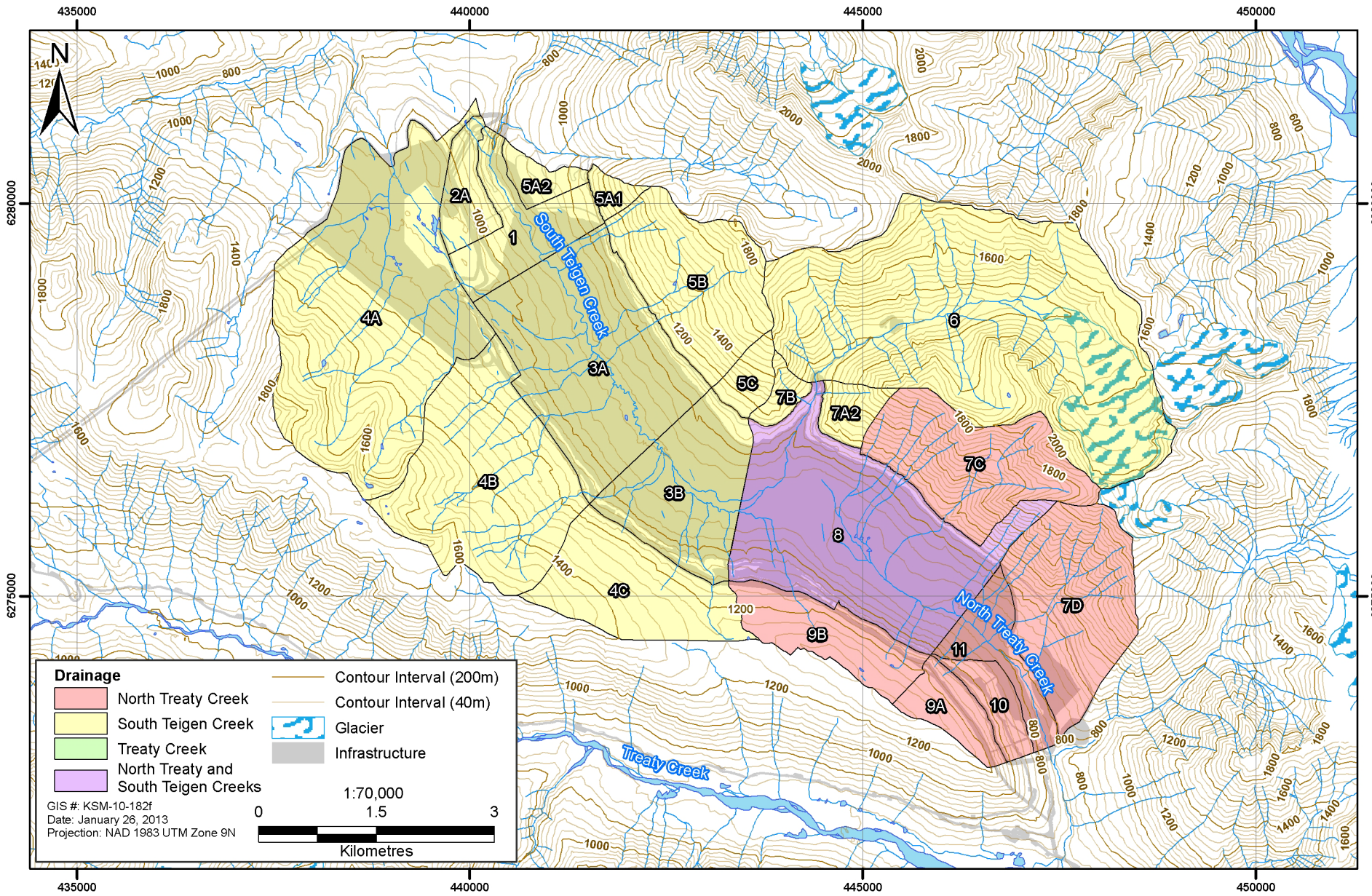

Figure 26.17-20

SEABRIDGE GOLD
KSM PROJECT

Subcatchments of PTMA after 57 Years of Operation

Figure 26.17-20

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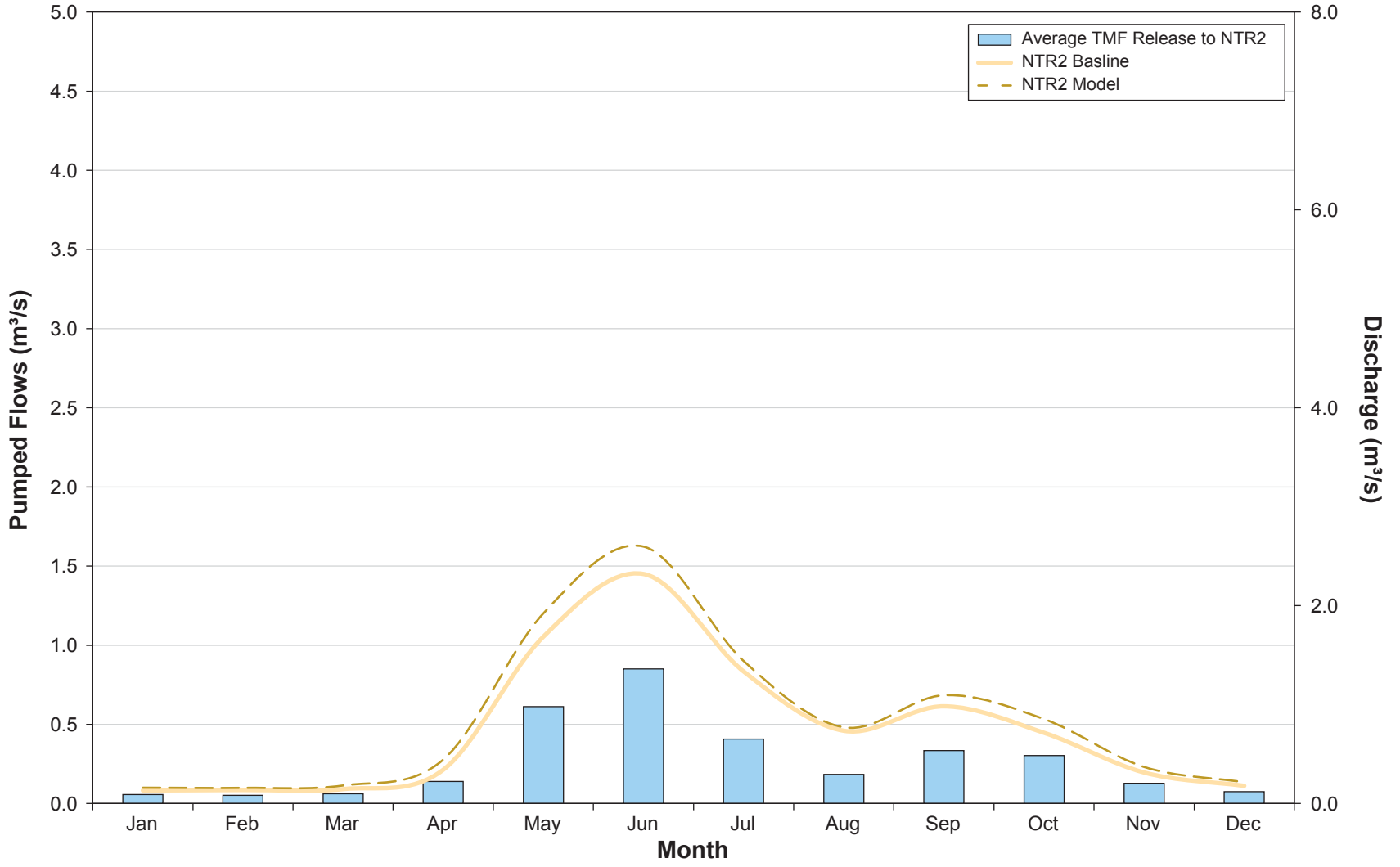

Figure 26.17-21

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within North Treaty Creek for a 1 in 200 Dry Year

Figure 26.17-21

Rescan™ Engineers & Scientists

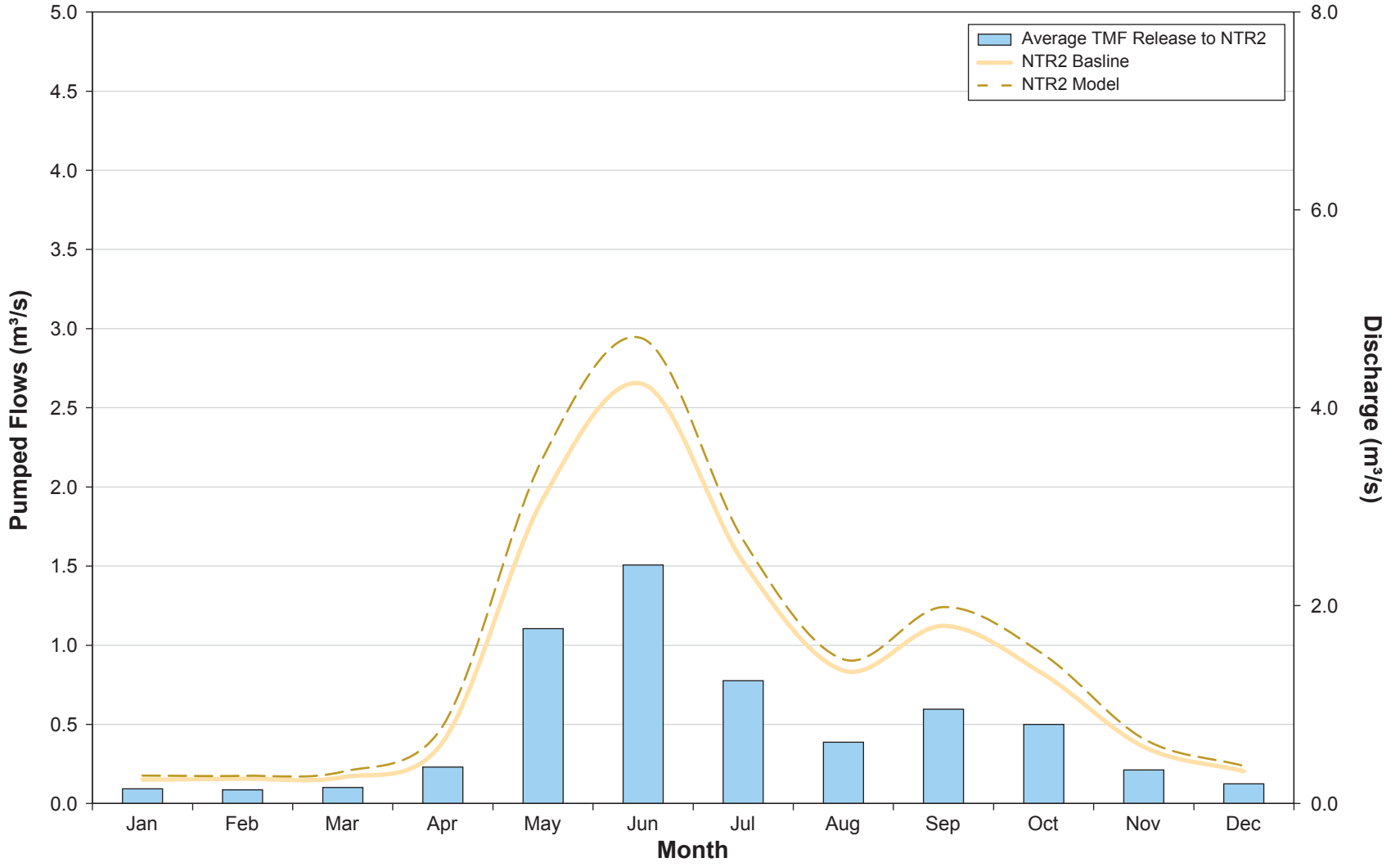

Figure 26.17-22

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within North Treaty Creek for an Average Year

Figure 26.17-22

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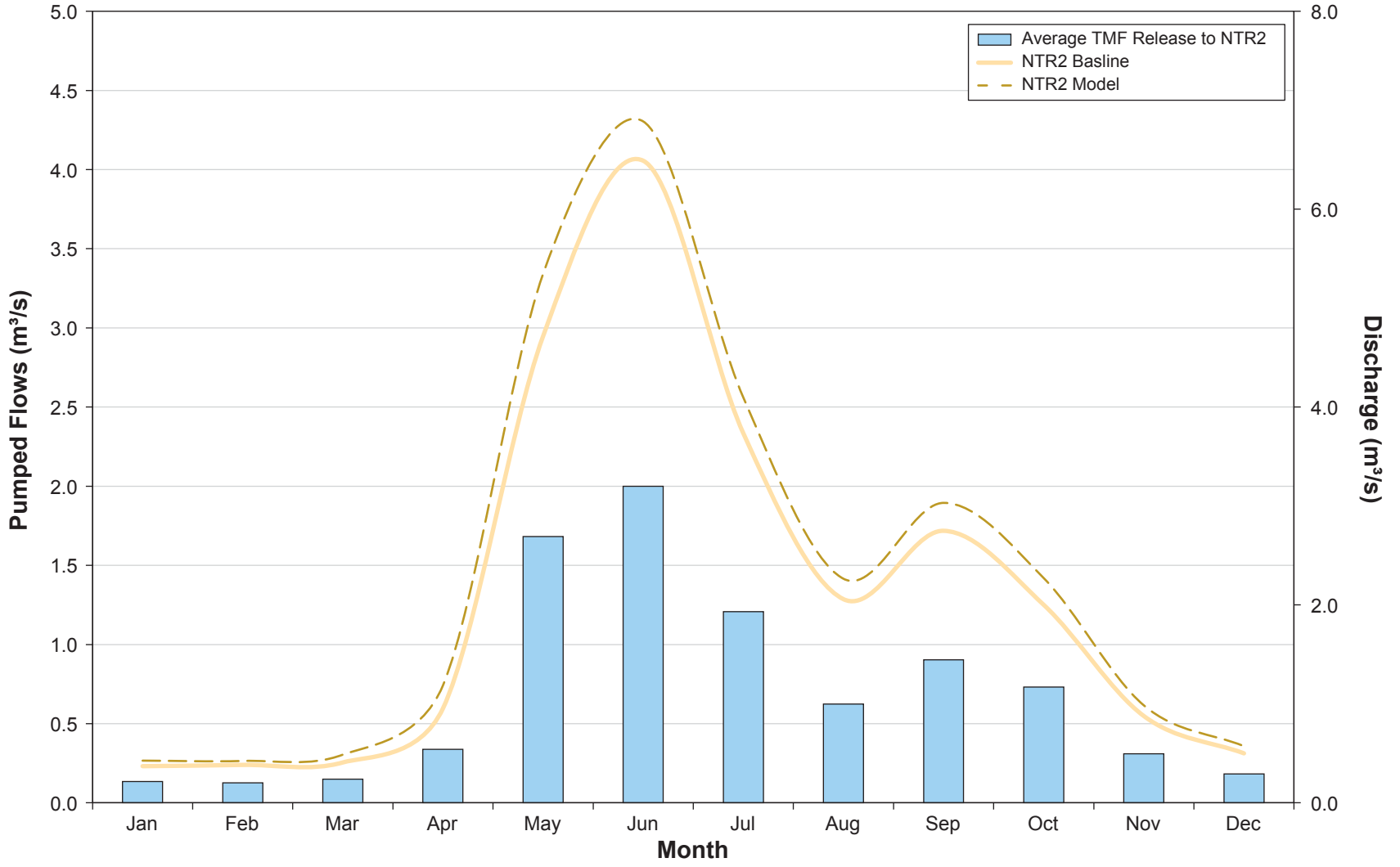

Figure 26.17-23

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within North Treaty Creek for a 1 in 200 Wet Year

Figure 26.17-23

Rescan™ Engineers & Scientists

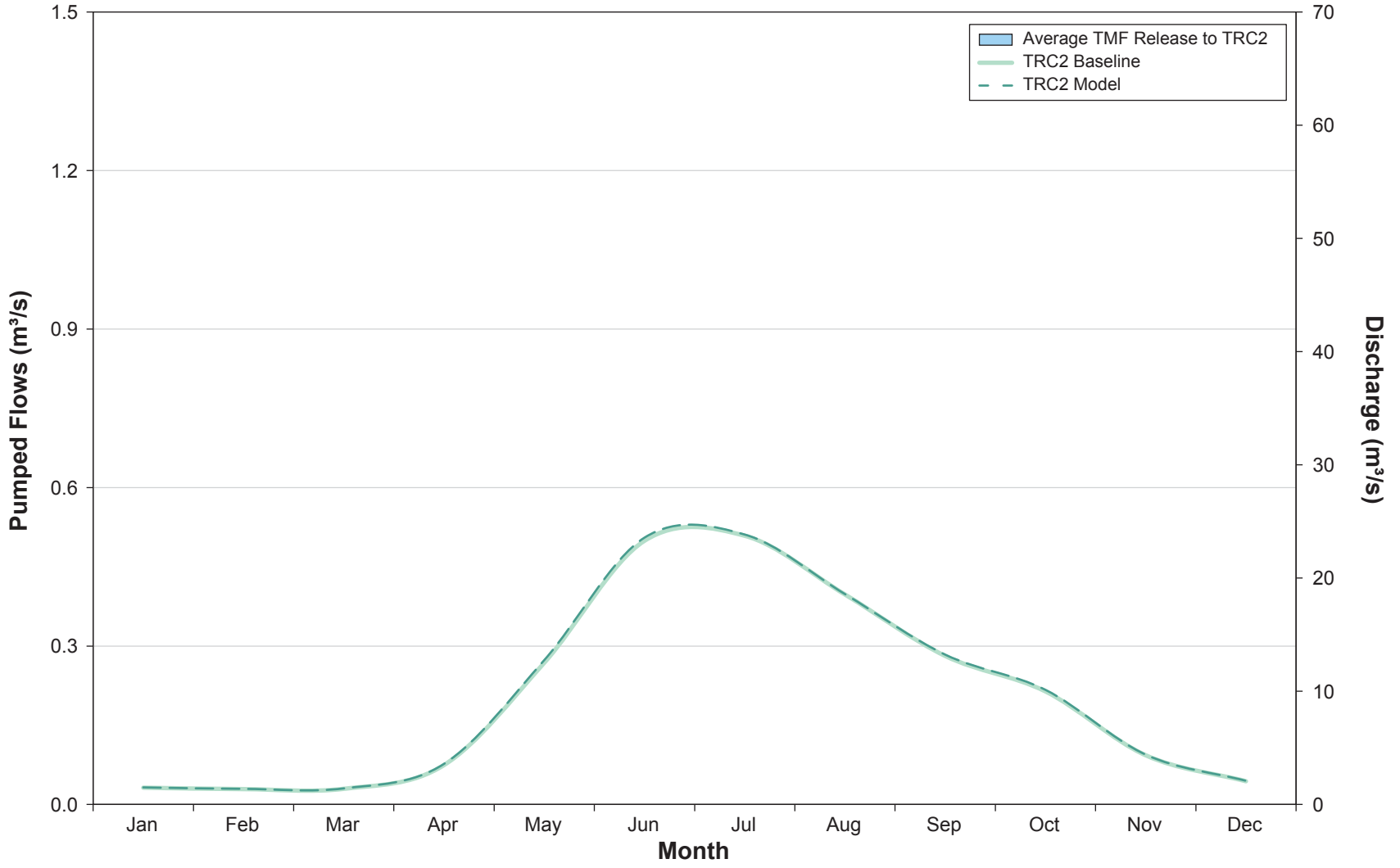

Figure 26.17-24

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within Treaty Creek for a 1 in 200 Dry Year

Figure 26.17-24

Rescan™ Engineers & Scientists

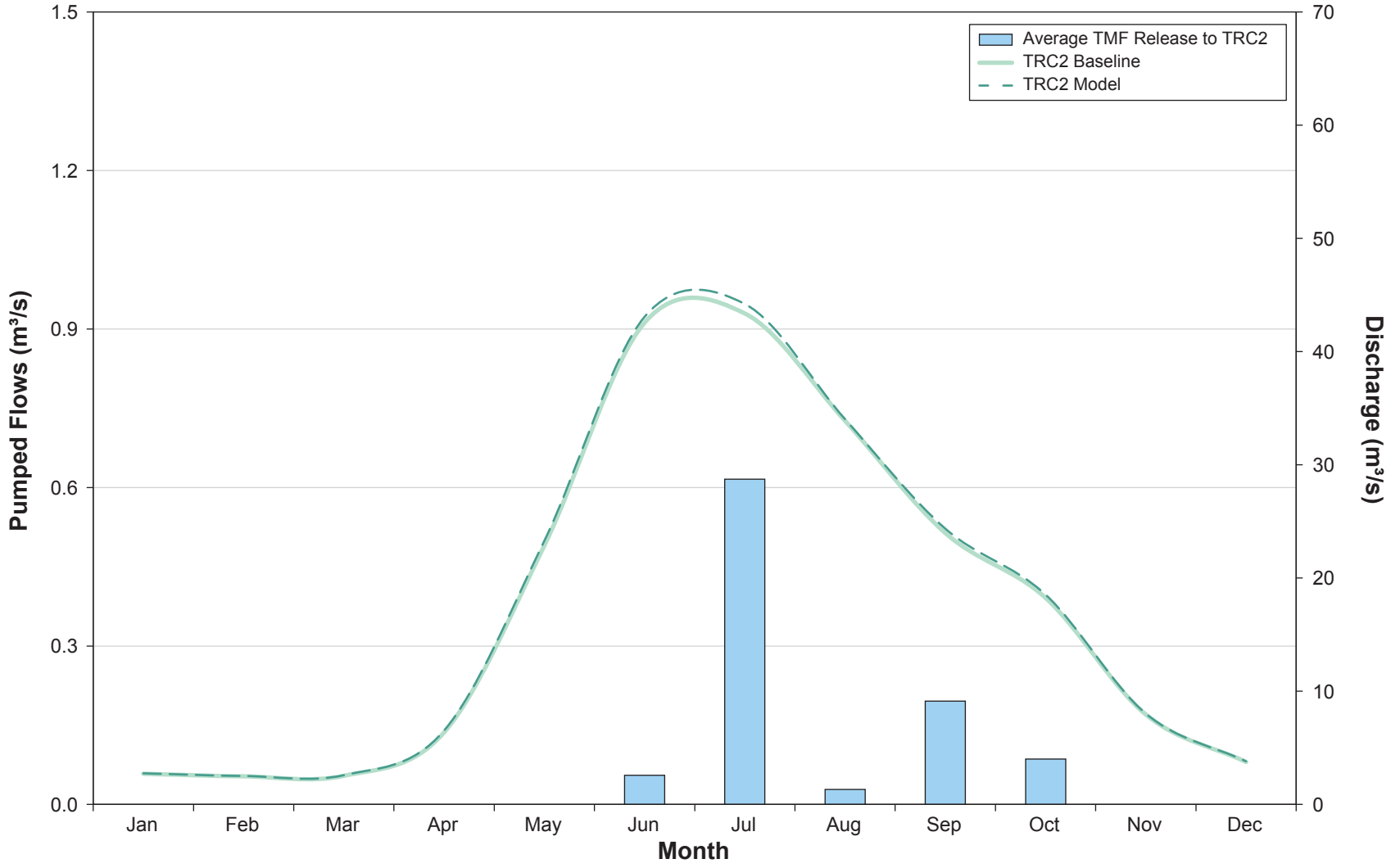

Figure 26.17-25

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within Treaty Creek for an Average Year

Figure 26.17-25

Rescan™ Engineers & Scientists

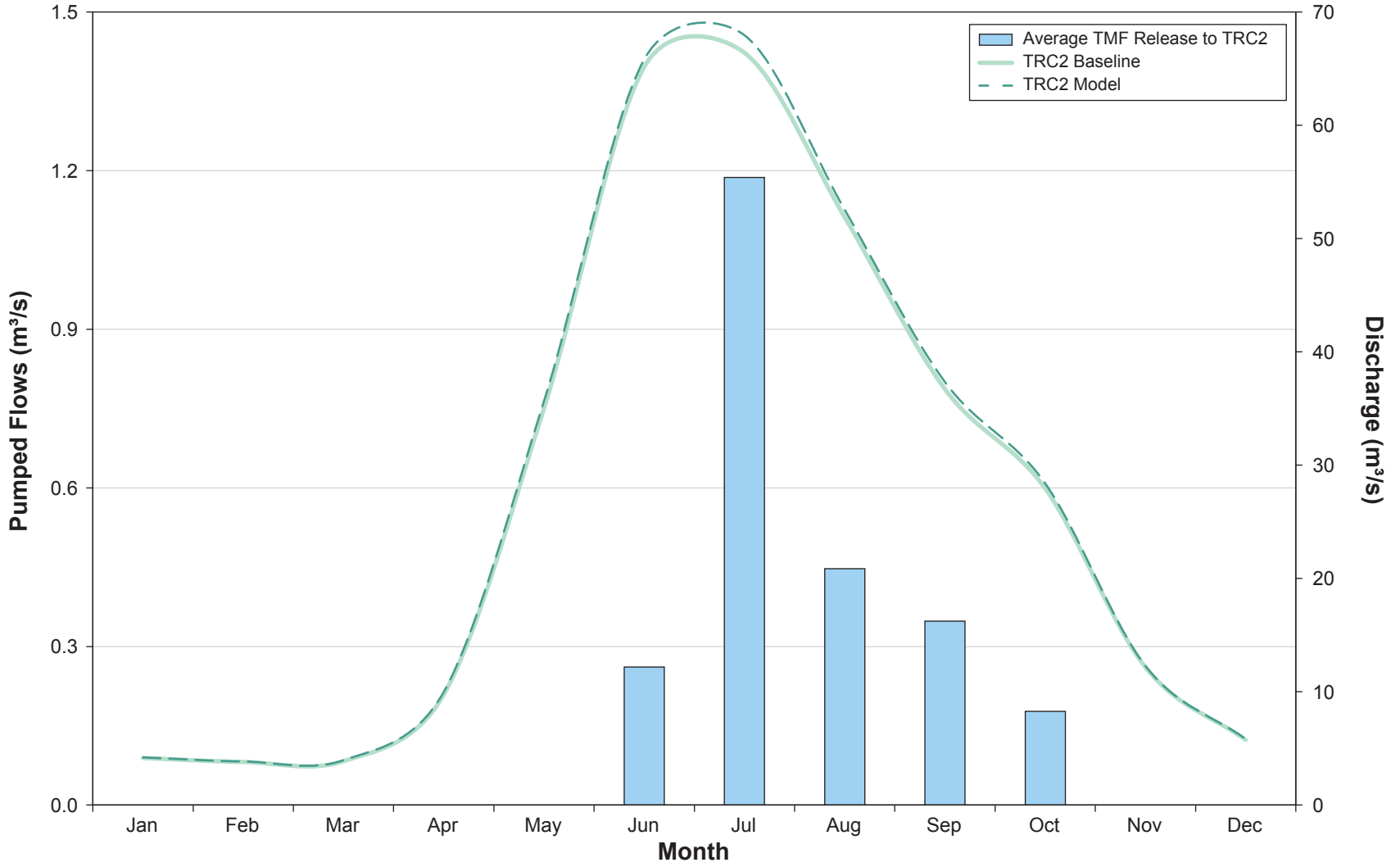

Figure 26.17-26

SEABRIDGE GOLD
KSM PROJECT

Predicted and Baseline Flows within Treaty Creek for a 1 in 200 Wet Year

Figure 26.17-26

Rescan™ Engineers & Scientists

The tailing will be ultimately retained by four compacted cyclone tailing dams (North dam, Southeast dam, Splitter dam, and Saddle dam). Perimeter diversions and a diversion tunnel will be constructed to route non-contact runoff from the surrounding slopes and from the East Catchment (creek) away from the TMF. The TMF is designed such that surface water management maintains stream flows for fish habitat in Teigen Creek, which flows north from the TMF. Discharges from the TMF will be pumped south to Treaty Creek provided the discharge meets provincial and federal regulatory requirements.

Water management structures and facilities for the PTMA are described in detail in the *2012 Engineering Design Update of Tailing Management Facility* (Appendix 4-AC). The key water management elements of the TMF from this report are:

- five diversions around the perimeter of the TMF (northeast diversion, south diversion, lower east diversion, southeast diversion, and southwest diversion);
- Lower East Catchment Diversion;
- Upper East Catchment diversion dam, East Catchment diversion tunnel, and South Teigen Creek maintenance flow pipeline;
- tailing dams and seepage dams;
- TWT (TSS) facility, if required (during the construction phase);
- closure spillways (during the closure phase); and
- erosion and sediment control measures for the facilities listed above.

The main inflows to the TMF impoundment include:

- precipitation on the tailing pond and beach surfaces;
- runoff from undiverted catchments;
- leakage and groundwater bypassing the diversions;
- tailing slurry;
- runoff from the plant site reporting to the North seepage dam;
- water from cyclone sand placement (which is pumped back into the flotation pond); and
- seepage water from the seepage dams (which is pumped back into the flotation ponds).

Outflows from the impoundment include:

- mill reclaim;
- water entrained in the deposited tailing and cyclone sand;
- evaporation from the pond and wetted tailing beach surfaces; and
- contact seepage beyond the dam (pumped back to the TMF).

26.17.6.3.1 Design Criteria

Diversion Channels

Diversion channels will be constructed around the TMF and Treaty Process Plant to divert non-contact surface runoff around the facilities. The design basis for the diversion channels (from Appendix 4-AC) is as follows:

- convey the 200-year, 24-hour peak flow;
- divert the maximum possible catchment area away from the TMF;
- minimum 5-m base width to allow snow cleaning;
- freeboard of 0.3 m above the design flow water level;
- re-direct the first 2 m^3/s of flow from the East Catchment to South Teigen Creek for base flow maintenance in the creek; and
- achieve a diversion efficiency of 85% on the south side of the TMF and 80% efficiency on the east side where slopes are steeper (the efficiency is further reduced to 60% during the months of May and June for steeper slopes with snow avalanche risks).

To reduce the runoff reporting to the TMF, the diversion design includes several measures to reduce infiltration through the diversions. These measures may include lining of the diversions with bituminous geomembrane liners or compacted till, grouting fissures in the bedrock, and reducing areas of ponding in the diversions. To reduce ponding and infiltration losses, the diversions will be graded at a minimum of 1%, and if applicable, energy dissipation structures will be lined where possible.

The TMF diversion channels are a critical component of water management planning. Careful construction techniques and monitoring supervision will be applied to ensure that they are properly built to the design requirements. Regular maintenance and inspections (particularly for avalanche and snow blockage and for excessive erosion during spring runoff) will be carried out to ensure the performance of the channels. Critical sections may require up to four channel clearings per year.

Lower East Catchment Diversion Berm

The Lower East Catchment diversion berm will operate during Stage 1 (Years 0 to 24), during operation of the TMF North Cell. It will be decommissioned in Stage 2 (Years 25 to 29) when tailing deposition begins in the TMF South Cell. The purpose of the Lower East Catchment diversion berm is to direct flows from the East Catchment to the North Tributary of Treaty Creek, bypassing the Saddle dam seepage pond.

The berm has been designed with a compacted till core and impermeable liner to reduce infiltration into the TMF. To slow runoff and detain flows prior to discharge into the diversion, a sump has been included in the berm design. The sump will require periodic maintenance to remove accumulated sediment.

Upper East Catchment Diversion Dam, East Catchment Diversion Tunnel, and South Teigen Creek Maintenance Flow Pipeline

Once the TMF North Cell dam is under construction, South Teigen Creek will require flow augmentation to maintain base flows for downstream fish habitat. To provide maintenance flows to South Teigen Creek during construction and operation of the North Cell, up to 2 m^3/s of the East Catchment flows will be diverted to South Teigen Creek through a 5.5 km long pipeline that runs parallel to the northeast diversion. The remainder of the East Catchment creek reports to North Treaty Creek via the Lower East Catchment diversion berm and southeast diversion.

Once the South Cell is under construction, an East Catchment diversion dam will be required to direct maintenance flows to South Teigen Creek via the East Catchment diversion tunnel and the northeast diversion pipeline. The 5.5 km long buried pipeline, is required to protect the maintenance flows from geohazards.

Tailing Dams and Seepage Dams

The tailing will be ultimately retained by four compacted cyclone tailing dams (North dam, Southeast dam, Splitter dam, and Saddle dam) built by the centerline construction method. The North and Southeast dams will have vertical till cores to restrict seepage. The Splitter and Saddle dams forming the CIL Centre Cell will have a geomembrane liner within the dam cores that will extend across the CIL Centre Cell basin floor in order to contain seepage from the CIL Lined Pond. Surplus water collected in the ponds will be reclaimed by floating pump barges and will be returned to the Treaty OPC via pipeline as mill process water.

Seepage and runoff water from each tailing dam will be collected at downstream seepage collection dams and pumped back to the TMF. The seepage collection dams will also serve to settle solids transported by runoff or produced by dam construction activities.

For the North, Saddle (Stage 1), and Southeast dams, criteria for tailing dam safety and flood management are based on an "extreme" consequence classification under the 2007 CDA's *Dam Safety Guidelines* (CDA 2007). This includes the following criteria (from Appendix 4-AC):

- **seismic –** dams designed to withstand the 1:10,000-year design earthquake ground acceleration of 0.14 g; and
- **flood –** storage and spillways designed for the PMF resulting from 30-day probable maximum precipitation plus 100-year snow accumulation melt, with a freeboard of 1.0 m above maximum flood level during operation.

For the Splitter and Saddle dams (after Stage 1), criteria for tailing dam safety and flood management are based on a "high" consequence classification under the 2007 CDA's *Dam Safety Guidelines* (CDA 2007; from Appendix 4-AC):

- **seismic –** dams designed to withstand the 1:2,475-year design earthquake ground acceleration of 0.08 g; and

- **flood –** storage and spillways designed for the PMF resulting from 30-day probable maximum precipitation plus 100-year snow accumulation melt, with a freeboard of 1.0 m above maximum flood level during operation.

Criteria for dam safety and flood management for the seepage collection dams are based on a "significant" consequence classification under the 2007 CDA's *Dam Safety Guidelines* (CDA 2007) (described in detail in Section 26.4 above):

- **seismic –** dams designed to withstand the 1:2,475-year design earthquake ground acceleration of 0.08 g; and
- **flood –** storage designed for the 200-year, 24-hour flood event, with a freeboard of 3.0 m above maximum flood level; spillways designed to pass the 500-year 24-hour flood event.

26.17.6.3.2 Construction

Excavated rock from diversion ditch construction will be stockpiled for the construction of the tailing starter dams or for use as rip-rap channel protection. In areas where channels are excavated in bedrock, there will be no need for erosion protection within the channels. However, shotcreting or grouting may be required to seal areas of significant fractures or deep fissures that are identified by visual inspection. To reduce regions of fractured rock, excessive blasting will be avoided where possible. Where diversion channels are not excavated in bedrock, the channels will be lined with compacted till, geomembrane, and/or rip-rap to prevent erosion and to reduce seepage. Alternative lining materials may also be considered in detail design.

In some areas, energy dissipation structures will be required at the top and/or the base of diversion channel outlets where diverted flows are released into natural stream channels. Portions of these outlet chutes will be excavated in bedrock. Where bedrock is not exposed, the chutes may be lined with geomembrane and/or grouted rip-rap with a specified D_{50}. Alternative concrete or other lining materials may also be considered in the designs.

The northeast diversion and south diversion will cross several streams that will require additional construction techniques and precautions. Construction of stream crossing portions of the northeast diversions will require the following procedures (Appendix 4-AC):

- excavation of a stilling basin upstream of the diversion alignment;
- lining stilling basins with an impermeable liner to restrict seepage losses, and rip-rap lined to resist erosion, if necessary;
- placement of a temporary dewatering pump (or gravity pipeline) at the stilling basin to pump water around the diversion and discharge it downstream; and
- following completion of the diversion, removal of the dewatering pump, and re-direction of flow into the diversion channel.

At the North, Splitter, Saddle and Southeast dams, cofferdams will be constructed upstream of the tailing starter dams. Temporary HDPE diversion pipelines/siphons, pumps, and channels will be

used to route water around the construction areas. Collected water will be routed in a low gradient, gravity-driven pipe beyond the tailing starter dam to a downstream seepage collection dam. The cofferdams will be designed to route a 10-year 24-hour storm flow through the pipelines.

If necessary, in addition to the downstream seepage collection ponds, temporary sediment ponds may be constructed as additional sediment control. The seepage collection ponds will have the option of total suspended solids and turbidity treatment facilities (flocculant dosing systems) if additional treatment is required to meet discharge permitting requirements.

26.17.6.3.3 Operation

During operation, diversions will continue to divert non-contact flows around Project infrastructure to downstream reaches, while all contact water will be captured by different channels and directed to the TMF. Tailing pond levels will be recorded monthly and will be used, in conjunction with pond filling curves, to plan the tailing discharge and to evaluate the success of the seepage collection dams in capturing seepage. Pumping rates from the seepage collection ponds back to the tailing ponds will be recorded to assess the seepage rate from the tailing dams.

Each spring before and during snow melt, diversion channels will be inspected and cleared of snow, to ensure proper operation. Flows in the diversion ditches will be monitored to assess the TMF water balance. Avalanche protection strategies for diversions will be assessed further as experience at the site accumulates. The current diversion designs mitigate against avalanches by including buried pipes in parallel with the surface channels in areas with avalanche risk to route the diversion flow in the event of a surface blockage caused by presence of an avalanche deposit. Additional protection measures that could be implemented, if required, may include the installation of an avalanche shed over portions of the diversion, allowing debris and snow to pass over the structure and into the TMF pond in the event of an avalanche.

26.17.6.3.4 Closure and Post-closure

When mining ceases, the TMF will be flooded with freshwater from rainfall, snow melt, and glacier melt, such that the tailing is covered by water in perpetuity. A water treatment plant will be constructed and operated at the process plant site to treat water from the TMF, if required. The seepage collection pond pumping system will operate on closure until seepage collection pond water quality meets regulatory permit requirements. The two seepage collection ponds will be encouraged to evolve into small lakes or wetlands.

Vegetation will be planted around the TMF to develop a vegetated riparian zone, and the impoundment will resemble a small lake or wetland. More information on site reclamation is provided in Chapter 27. The spillways will allow for release of surface water to South Teigen and North Treaty creeks below the main dams. The East Catchment tunnel and pipeline will be decommissioned, and the stream hydrological patterns will be restored through the re-vegetated TMF to provide a more natural flow regime.

At final closure, all diversion channels except for the south diversion will be decommissioned to restore stream hydrological patterns back into the TMF. The south diversion will be maintained

to provide post-closure flows to South Teigen Creek until discharge from the North spillway is approved. A channel will be dredged through the tailing and through the Saddle and Splitter dams to allow pond levels to equalize in the South, Centre, and North cells. This channel will be 20 m wide at the base and will be lined with rip-rap armour to prevent erosion.

During the initial stages of closure, excess flows from the ponds will be pumped to the Treaty Creek diffuser until water quality is acceptable for discharge. Then a rock cut closure spillway will be constructed around the North dam to South Teigen Creek, returning South Teigen Creek drainage patterns closer to pre-mining configuration. Once South and Centre Cell closure water quality is confirmed, a rock cut closure spillway will be constructed around the Southeast dam to North Treaty Creek. At this stage, the south diversion channel will be decommissioned, returning drainage patterns closer to pre-mining configuration.

Both the North spillway and the Southeast spillway are designed to route the PMF for the entire TMF via internal weirs between cells that overtop only in extreme events. In this way, if either spillway is blocked the PMF can still be routed. Operation of the closure spillways will require monitoring to inspect for blockages to the spillways from avalanches, landslides, or other geohazards.

Flotation tailing exposed above the closure pond will be NPAG, and the beaches will be capped by till soil and re-vegetated. The steeper dam surfaces will be suitably reclaimed to prevent erosion and to meet post-closure land use targets. To prevent erosion at the beach-pond interface, a minimum of 1.0 m of well-graded sand and gravel will be placed on the tailing beach adjacent to the tailing pond. Due to the wet nature of the tailing beach in this area, sand and gravel may not be placed until several years after cessation of operations to allow for consolidation of the tailing, and may be placed in winter when the frozen tailing improves trafficability.

The Treaty Creek access road will be maintained through grading, resurfacing, cleaning of ditches and culverts, and inspection of bridges. Other PTMA roads will be either regularly maintained or, if no longer necessary, demobilized by bridge and culvert removal, re-grading, stabilization, and re-vegetation.

In general, all waterbodies and watercourses affected by the Project will be rehabilitated as much as possible by means of soil stabilization and re-vegetation in riparian areas to prevent erosion and sediment transport. Site reclamation and rehabilitation will result in most riparian areas being restored to full functionality, similar to nearby unaffected sites.

26.17.7 Monitoring

A monitoring program will enable the Proponent to measure the success of the management strategies and to identify where additional mitigation is necessary. The Aquatic Effects Monitoring Program (AEMP; Section 26.18.2), includes water quantity, water quality, sediment quality, water toxicity, and benthic invertebrate and fish assessments downstream of all mine infrastructure, including the WSF and TMF. The AEMP will monitor long-term effects (if any) of effluent decants or seepages to downstream areas.

Senior and technical staff, as well as trained environmental technicians, will be employed at the Project to supervise, direct, monitor, and implement avoidance, control, and mitigation measures.

Environmental technicians will have the authority to temporarily stop construction when risks are identified. Environmental technicians will report to the Environmental Superintendent, who will report significant environmental concerns directly to the Project Manager. Project staff and contractors will report any potentially adverse incidents of erosion, structural or function failure, culvert/bridge debris build-up, spills, seepages, leaks, or similar occurrences to the environmental staff.

This section presents an overview of surface water monitoring procedures. Additional details of the surface water quality monitoring program are provided in the Aquatic Effects Monitoring Plan (Section 26.18.2). Groundwater quality monitoring procedures are discussed separately (Section 26.15).

26.17.7.1 Water Quality Monitoring

Effluent will be continuously discharged from the WTP, seasonally increasing to mimic natural stream hydrology highs and lows. Discharge from the TMF to Treaty Creek will occur only between the months of May and October. Discharge from the TMF North Cell to North Treaty Creek will occur year-round after Year 27.

Effluent quality will be monitored as outlined in the Aquatic Effects Monitoring Plan (Section 26.18.2).

Effluent quality will be collected in accordance with the frequency required under MMER (SOR/2002-222) and as determined during the permitting process through consultation with permitting agencies. The MMER requirements state that water sampling at the WTP and TMF discharge points (end of pipe) will occur weekly to ensure that effluent meets discharge permit limits; this sampling will occur in all weeks in which discharges may occur.

On-site performance monitoring prior to effluent discharge will be achieved through waste rock performance monitoring, tailing performance monitoring, and site surface water quality monitoring. Site surface water quality will be monitored at the Selenium Treatment Plant, the WSF, major diversion structures at the Mine Site and PTMA, and the three TMF cells.

Surface water quality will be monitored downstream of WTP and TMF effluent discharges. Sample sites will be located downstream of infrastructure with both near-field and far-field exposure to Project activities so that a gradient of potential effects can be assessed. Reference sites will be located either upstream (if possible) or in unaffected watersheds with similar hydrological conditions.

All water samples will be analysed for physical parameters required by the MMER (SOR/2002-222) in addition to a number of other physico-chemical parameters, anions, nutrients, total cyanide, total organic carbon, and total and dissolved metals. The sampling methodology and lab analysis will be consistent with the *British Columbia Field Sampling Manual* (BC MWLAP 2003), the BC *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012), and the Environmental Data Quality Assurance Regulation (BC 301/90). Results of water quality analyses will be compared to either the Canadian Council of Ministers of the Environment (CCME) or the BC Ministry of Environment (BC MOE) water

quality guidelines for the protection of aquatic life or to site-specific water quality objectives developed during permitting (CCME 1999; BC MOE 2006), as appropriate.

26.17.7.2 Waste Rock Performance Monitoring

The Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14) outlines the compilation and maintenance of a geochemical inventory for the storage and management of waste rock. Additional monitoring and test work is proposed for waste rock performance monitoring during the construction, operation, and closure phases as follows:

- continued maintenance and monitoring of some humidity cells started during the environmental assessment process to monitor the progress of NP depletion;
- continued maintenance and monitoring of on-site field leach barrels;
- quarterly monitoring of seeps from RSFs and Sulphurets Pit Backfill for water quality parameters;
- maintenance of an overall up-to-date site water and chemical load balance to compare predictions of metal loadings with conditions during operation; and
- completion of an annual audit of management practices.

26.17.7.3 Tailing Performance Monitoring

The Metal Leaching and Acid Rock Drainage Management Plan (Section 26.14) outlines the compilation and maintenance of a geochemical inventory for the storage and management of tailing. Monitoring and testwork proposed for tailing performance monitoring during the operation and closure phases is as follows:

- quarterly monitoring of seepage collected in the North, Saddle, and Southeast seepage recovery ponds for water quality parameters; and
- quarterly monitoring of dam runoff collected in sediment control ponds for water quality parameters.

26.17.7.4 Post-closure Monitoring

The post-closure monitoring program will continue the construction, operation, and closure phase monitoring. Over time, it is expected that monitoring frequency will be reduced if water quality is not changing. If accelerating oxidation and potential acid rock drainage onset is detected, monitoring may increase in frequency and other mitigation strategies may be applied.

26.17.7.5 Surface Water Quantity Monitoring

Stream flow is a core parameter to be measured at mine sites (BC *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* [BC MOE 2012]). Measuring discharge volumes from sampling sites is an important factor in determining loading calculations as required by MMER (SOR/2002-222) and to calculate downstream water dissolved metal concentrations, allowing comparison with ambient guidelines, designating site specific water quantity and quality objectives, and environmental reporting during all phases of

the Project. Monitoring of stream flow is also important in order to assess the potential effects of the Project on fish and aquatic habitat.

Surface water quantity will be monitored at the same locations as water quality sampling sites wherever possible. Discharge flow monitoring at the WTP and TMF discharge points (end of pipe) will occur continuously. At other sampling locations (see Table 26.18-3 in Section 26.18.2), current velocity measurements will be conducted six to eight times annually wherever possible until a rating curve is established. Current velocity measurements will be obtained using a handheld current meter or, in cases where water depth or flow velocity conditions do not allow field personnel to safely wade across the streams, using an Acoustic Doppler Current Profiler (ADCP) or a tracer-dilution procedure.

Methods employed in the monitoring program will follow the provincial standard operating procedures as outlined in the Resources Information Standards Committee (RISC) *Manual of British Columbia Hydrometric Standards* (RISC 2009).

26.17.8 Responsible Persons

The KSM Project Environmental Superintendent or other designated person will be responsible for ensuring water monitoring reporting for the Project, overseeing the water monitoring operations, maintaining inspection and maintenance reports, and providing guidance on any changes or needs of the program, with the support of qualified specialists, when required.

The KSM Project Environmental Officer or other designated person will oversee the aspects of water monitoring operations, will maintain inspection reports, and will provide guidance to the Environmental Department.

26.17.9 Reporting

Records will be maintained during all Project phases, including a description of surface water flow paths in relation to each major infrastructure footprint, existing surface water management/treatment measures and assessment of their performance, undertaken repairs or mitigation activities, and a log of dated photographs. The monitoring program results and corrective actions will be included in the EMS. The reports will be kept in the Mine Site office or another designated area.

26.18 Fish and Aquatic Habitat Management Plan

The following plans are described in this section:

- Fish and Aquatic Habitat Effects Protection and Mitigation Plan;
- Aquatic Effects Monitoring Plan; and
- the Fish Salvage Plan.

26.18.1 Fish and Aquatic Habitat Effects Protection and Mitigation Plan

The Fish and Aquatic Habitat Protection and Mitigation Plan for the proposed KSM Project is based on the pre-construction physical and biological habitat data. As detailed in previous

sections, effects on fish and aquatic habitat may arise from the construction, operation, closure, and post-closure phases of the Project. These potential effects include:

- increased sedimentation;
- contamination as a result of spills of hazardous substances;
- loss or alteration of fish habitat;
- alteration of water quality and/or sediment quality; and
- alteration of the productive capacity of aquatic habitat.

Potential effects will be mitigated through engineering and mine design. This section details the protection and mitigation strategies that will be employed to reduce or eliminate any adverse effects from mine construction, operation, closure, and post-closure. Where mitigation is not possible (i.e., due to habitat loss), compensation plans will be developed to ensure that no net loss of fish and aquatic habitat occurs. This measure is in accordance with the *Policy for the Management of Fish Habitat* (DFO 1986). In addition, an environmental effects monitoring program will be implemented to evaluate the effectiveness of environmental protection measures and to monitor the health of aquatic ecosystems potentially affected by the Project.

Key management objectives with respect to fish and aquatic habitat in the regional study area are to:

- ensure continued and uninterrupted rearing, spawning, and migration of fish in all fish-bearing streams of the regional study area;
- avoid loss of fish habitat unless authorized by DFO under Section 35(2) of the *Fisheries Act* (1985c);
- avoid deposition of any substances, including sediments, that are deleterious to fish into waters frequented by fish (unless authorized under Section 36 of the *Fisheries Act* [1985c]); and
- protect, preserve, and enhance fisheries resources in the regional study area during construction, operation, closure, and post-closure.

26.18.1.1 Legislation and Standards

There are numerous manuals and guidelines on the methods required to prevent loss of fish habitat. These include resources such as the *Fish-Stream Crossing Guidebook* (BC MOF 2002b), the *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), and *Standards and Best Practices for Instream Works* (BC MWLAP 2004b). These guidelines detail the purpose and practices of setting buffer zones, using erosion and sediment control measures, managing drainage water, working in streams, and designing stream crossings, in addition to recommending operating windows for construction in fisheries sensitive zones (FSZs). By following these federal and provincial guidelines and others noted below, no significant residual impacts on aquatic habitat are anticipated.

Other comprehensive guidelines to protect fish and aquatic habitat include the following, which offer a range of effective measures that will, when followed appropriately, ensure no net adverse impacts to streams, wetlands, and lakes:

- *Operational Statement for Clear-span Bridges and Timing Windows* (DFO 2007b);
- *Operational Statement for Overhead Line Construction* (DFO 2007e);
- *Operational Statement for Maintenance of Riparian Vegetation in Existing Rights-of-Way* (DFO 2007d);
- *Operational Statement for Bridge Maintenance* (DFO 2007a);
- *Operational Statement for Culvert Maintenance* (DFO 2007c);
- *Operational Statement for Temporary Ford Stream Crossing* (DFO 2007f);
- *Fish Passage and Culvert Inspection Procedures* (Parker 2000);
- *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998);
- *Environmental Objectives and Procedures for Water Crossings* (Saremba and Mattison 1984);
- *Guidelines for Land Development and Protection of the Aquatic Habitat* (DFO 1993);
- *Riparian Assessment and Prescription Procedures - Field Guide* (Oikos Ecological Services Ltd. and T. Johnson and Associates 1996);
- *Resource Road Rehabilitation Handbook: Planning and Implementation Guidelines* (Moore 1994);
- *Culvert Guidelines: Recommendations for the Design and Installation of Culverts in British Columbia to Avoid Conflict with Anadromous Fish* (Dane 1978);
- *Stream Stewardship - A Guide for Planners and Developers* (DFO and BC MELP 1993);
- *Environmental Code of Good Practice for Highways and Railways* (Storgaard and Associates 1979);
- *A Handbook for Fish Habitat Protection on Forest Lands in British Columbia* (Toews and Brownlee 1981);
- *Reclamation and Environmental Protection Handbook for Sand, Gravel and Quarry Operations in British Columbia* (BC MOT and NRC 1995);
- *Riparian Management Area Guidebook* (BC MOF and BC MOE 1995);
- *Bioengineering Techniques for Streambank Restoration* (Donat 1995); and
- *BC Sewage System Standard Practice Manual* (BC MOH 2007).

26.18.1.2 Objectives

The objectives of this plan are:

- to minimize fish habitat loss due to the Project, where possible;
- where not possible, to receive the required permits to achieve DFO's no net loss of fish habitat requirements; and
- to protect listed species at risk.

26.18.1.2.1 Habitat Loss Avoidance

Fish and fish habitat are protected under a variety of federal and provincial regulatory acts and principles. The *Fisheries Act* (1985c) prohibits the harmful alteration, disruption, or destruction (HADD) of fish habitat through physical, chemical, or biological means.

Under Section 35(2) of the *Fisheries Act* (1985c), any project or activity that causes HADD requires an authorization from DFO. The *Fisheries Act* (1985c) defines fish habitat as "spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes." Included in this definition are both fish-bearing and non-fish bearing waterbodies, including the surrounding riparian areas and FSZs.

The Metal Mining Effluent Regulations (SOR/2002-222), enacted in 2002, were developed under Section 36 of the *Fisheries Act* (1985c)to regulate the deposit of tailing and other waste matter produced during mining operations into natural fish-bearing waters. These regulations, administered by Environment Canada, are for both new and existing mines. If a developer proposes to use a natural fish-bearing waterbody for tailing management then a fish habitat compensation plan must be developed to ensure no net loss of fish habitat results from the use of this waterbody.

To avoid and prevent fish habitat loss and the introduction of deleterious substances to watercourses, and to minimize the adverse effects of any unavoidable disturbances to fish habitat, a range of specific and generally accepted techniques for sediment control, riparian care, site isolation, timing windows, reclamation, and rehabilitation will be used. These methods are detailed below and in related environmental protection plans for the Project.

26.18.1.2.2 No Net Loss Policy

The objective of DFO's *No Net Loss Policy* is to balance unavoidable habitat losses with habitat replacement. This principle prevents further reductions to fish populations and fish habitat. No Net Loss is achieved through a hierarchy of preferences (DFO 1986). In developing a habitat compensation plan to offset habitat loss, a key guiding principle is to ensure that the amount of compensation is equal to at least a 2:1 gain to loss ratio to ensure certainty of success to maintain the overall net productive capacity.

Productive capacity refers to the capability of fish habitat, including all its physical, chemical, and biological characteristics, to produce fish. In practice, productive capacity is generally measured in terms of aquatic habitat area, which includes both the aquatic ecosystem and the associated riparian areas and vegetation.

26.18.1.2.3 Protection of Sensitive Species and Species at Risk

The Canadian *Species at Risk Act* (SARA; 2002d) protects vulnerable and at-risk species from extinction, and further serves to create and enforce recovery strategies. Currently, none of the fish or aquatic invertebrate species observed during the baseline data collection (Rescan 2009, 2010a, 2010b) are protected under SARA (COSEWIC 2010). However, the BC Conservation Data Centre classifies Dolly Varden on the Yellow List, and bull trout on the Blue List. Blue-listed species are indigenous species and/or subspecies considered to be of special concern in BC. Blue-listed species are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Dolly Varden are widely distributed in BC (McPhail 2007a) and within the Teigen Creek, Treaty Creek, and Unuk River watersheds. Bull trout are present in BC (McPhail 2007a), including in Teigen and Treaty creeks. This designation identifies these two species as vulnerable, necessitating impact management consideration during the construction, operation, closure, and post-closure phases of the KSM Project.

26.18.1.3 Targets

The targets of this plan are to minimize fish habitat loss due to the Project, where possible. If habitat loss is unavoidable, compensation projects will be developed to achieve at least a 2:1 gain to loss ratio to ensure the overall net productive capacity of fish habitat. The final target is to protect listed species at risk.

26.18.1.4 Actions to Avoid, Control, and Mitigate

Prior to construction activity for the access roads, transmission line, Mine Site and Treaty Process Plant infrastructure, TMF, tunnels, pits, and related facilities, fish or aquatic habitat values will be identified and detailed construction mitigation measures will be developed. General fish and aquatic habitat protection and mitigation measures, applicable to most Project infrastructure, are discussed in Sections 26.18.1.5 to 26.18.1.11.

26.18.1.4.1 Planning

To protect fish and aquatic habitat during construction, certain measures will be undertaken. These measures may include, but are not limited to, the following:

- development of detailed engineering specifications for each stream crossing, including crossing type, location, distances to stream banks, equipment staging/laydown areas, and footing locations;
- detailed mapping of any footprint area, including corresponding habitat classifications and determination of fish-bearing status, such as the presence of species of management concern—all fish-bearing waterbodies will be clearly marked on maps used by construction crews; and
- acquisition of relevant permit approvals from the BC Ministry of Environment Water Stewardship Division, DFO, and Transport Canada (for navigable waters).

26.18.1.4.2 Site Access

Routes for temporary access roads will also be planned to minimize environmental disturbance. Where possible, crossing fish-bearing streams will be avoided. Where stream crossings are

necessary, riparian disturbance will be minimized and fish passage will be provided. Furthermore, for permanent access roads:

- entry gates will be installed along access roads to prohibit non-authorized vehicles;
- gates and security measures to control access will be designed to address the mobility of snow machines and all-terrain vehicles;
- at closure, all non-essential roads will be deactivated and traffic will be reduced;
- all employees and contractors will be prohibited from angling while present at the Mine Site or while travelling to and from the mine on company business; and
- personnel will be bussed from communities at the start and end of each shift during mine construction and operation.

26.18.1.4.3 Fuel Management

The introduction of fuel or other deleterious substances into streams will be prevented. Steps to be taken to prevent the occurrence of a spill may include:

- inspection of all equipment and machinery prior to and during instream/riparian work to ensure that it is clean and free of leaks;
- use of biodegradable fluids (fuels and oils) for machinery working within 30 m of any stream;
- placement of drip pans and spill pads underneath pumps or other stationary machinery within riparian areas; and
- provision of readily accessible spill kits in all areas where machinery or fuel tanks will be used, stored, or refueled, and training of personnel in their use prior to beginning construction.

The Spill Prevention and Emergency Response Plan will detail the steps to be taken to properly contain, clean and report any spills that may take place. To ensure a rapid response to leaks and spills, designated personnel will be trained in the procedures outlined in the Spill Prevention and Emergency Response Plan (Section 26.10).

26.18.1.4.4 Sediment and Erosion Control Measures

Increased erosion and sediment mobilization are possible risks of construction in stream areas. Construction plans will be designed to maintain bank stability and mitigate or repair any stream bank damage caused by Project works. To control and minimize the sediment mobilization and bank erosion, control measures will include the following, which are also identified in Section 26.13.3:

- using water diversion structures to direct dirty water from the work zone to a sediment control area;
- installing silt fencing, geotextile cloth, straw bales, berms, or other sediment control structures;

- conducting instream work from the point farthest away from the construction access point and working backward;
- allowing constructed ponds to settle before connecting to the stream;
- storing soil, substrate, removed vegetation, and building materials in stable areas away from the channel;
- ensuring that all rock materials used in the stream are inert;
- ensuring constructed banks are graded at a stable slope; and
- stabilizing excavated materials and areas denuded of vegetation using temporary erosion control blankets, biodegradable mats, planted vegetation, or other erosion control techniques.

A response plan will be adhered to that details sediment and erosion control measures to be taken in the event of an unexpected increase in overland runoff or saturation of the work area due to precipitation. Additional measures will also be taken in the event that construction monitoring identifies a failure or potential failure of existing sediment control structures.

26.18.1.4.5 Waste Management

All construction waste and excess material created or imported for Project construction will be stored and treated or removed to avoid causing environmental harm. Examples of potential waste management strategies include:

- developing protocols for waste reduction, reuse, and recycling during the construction, operation, and closure phases;
- storing soil excavated during construction on a stable surface outside of the stream channel and covered or contained by erosion control structures or replanted vegetation;
- managing vegetation removed from the work zone by either storing for salvage and replanting or piling away from the stream banks for storage or burning; and
- when they are no longer required, removing non-biodegradable materials brought into the site, including sediment control structures, equipment, and supplies.

26.18.1.4.6 Water Management

Should water diversion be required, coffer dams, pumps, or other approved water diversion methods may be used to temporarily divert water around the construction zone while still maintaining flow downstream. Dirty water will be pumped to a sediment control area where the sediment can settle or be removed before returning water to the stream. Backup pumps may be kept on site in case of mechanical failure.

Where draining of wetted areas occurs, measures will be taken to ensure that the process will not cause erosion of stream banks or terrestrial areas.

26.18.1.4.7 Blast Management

To mitigate noise impacts within fish-bearing streams, construction activities will work in accordance with DFO's *Guidelines for the Use of Explosives in or Near Canadian Fisheries*

Waters (Wright and Hopky 1998). Site blasting will be at least 10 m away from fish-bearing streams (blasts will also be kept below 100 kPa) to avoid possible adverse spawning habitat effects on fish behaviour (Wright and Hopky 1998).

26.18.1.4.8 Fish Salvage

Prior to dewatering wetlands or streams, fish will be salvaged and removed from the site. As part of the fish salvage and exclusion process, the following steps will be taken to minimize disturbance:

- fish salvage permits will be obtained from the DFO and BC Ministry of Environment;
- the pond or stream will be isolated using seine nets;
- passive or active capture techniques, or a combination of the two, will be chosen based on characteristics of the site and will be used to capture fish;
- fish will be immediately removed to recovery buckets; and
- post-recovery fish will be moved to suitable habitat located nearest to the salvage site.

In larger mainstem areas where isolation and salvage would be prohibitively difficult, the site will not be sectioned with nets. Instead, electrofishing will be used to encourage fish to move from the immediate area immediately prior to any instream works.

26.18.1.4.9 Construction Timing

The schedule of instream work will follow the recommended periods of least risk for fish species, as outlined in the *Fish-Stream Crossing Guidebook* (BC MOF 2002b). The PTMA, including the TMF, Process Plant, transmission line, and Treaty Creek access road will be located in the Nass Timber Supply Area (TSA). The Mine Site, including the KSM Project Camp, open pits, haul roads, tunnels, and Coulter Creek access road, will lie in the Cassiar TSA. Therefore, different Least Risk Windows for construction will need to be adhered to in each TSA. In certain instances, instream work may need to occur outside of the Least Risk Windows. Therefore, necessary permits will be obtained from appropriate agencies, and work will comply with permit conditions. Tables 26.18-1 and 26.18-2 list the Nass TSA and Cassiar TSA Reduced Risk Work Windows for the fish species of concern.

Table 26.18-1. Reduced Risk Work Windows for Fish Species within the Nass Timber Supply Area

Species	Period of Least Risk*	
	Start Date	Finish Date
Dolly Varden	June 1	August 31
Bull Trout	June 1	August 31
Cutthroat Trout	August 1	January 31
Rainbow Trout	August 1	January 31
Whitefish	June 1	September 15
Coho Salmon	June 15	September 1
Chinook Salmon	June 1	July 15
Sockeye Salmon	June 1	July 20

*** These dates apply to construction in the Teigen and Treaty Creek watersheds.**

Table 26.18-2. Reduced Risk Work Windows for Fish Species within the Cassiar Timber Supply Area

Species	Period of Least Risk*	
	Start Date	Finish Date
Dolly Varden	June 15	August 31
Bull Trout	June 15	August 31
Cutthroat Trout	September 1	April 30
Rainbow Trout	September 1	April 30
Coho Salmon	April 1	August 15
Chinook Salmon	May 1	July 31
Sockeye Salmon	April 1	May 31

*** These dates apply to construction within the Unuk River watershed.**

26.18.1.5 Access Roads: Avoidance, Control, and Mitigation

26.18.1.5.1 Construction

Permanent stream crossing structures will be installed during the initial road-building phase. This will include the Coulter Creek access road from the existing Eskay Creek Mine road to the Mine Site, and the Treaty Creek access road from Highway 37 to the Treaty Process Plant, TMF, and Mitchell-Treaty Saddle Area. The most appropriate measures and techniques to protect fish and aquatic habitat will be used in the construction of the access roads. These measures will include the following:

- On-site education and environmental supervision will be provided to construction crews regarding the need to protect fish and aquatic habitat values and the means to accomplish this protection, including the measures outlined in this report.
- Temporary fording of creeks will, whenever possible, occur during periods of low flow at areas of stable substrates, and will coincide with reduced Risk Work Windows.
- Machinery will arrive on site in a clean condition and will be maintained so as to be free of fluid leaks.
- Machinery will be washed, re-fuelled, and serviced, and fuel will be stored at locations away from watercourses to prevent deleterious substances from entering them.
- Any fish-bearing stream crossing will be designed to bear the intended loads, pass 1-in-100-year floods, retain fish habitat quality, and ensure continued fish passage.
- Fish-bearing waterbodies that will be crossed or that lie near the road alignment will be marked with flagging tape and signs so all contractors are aware of which streams contain fish; fish-bearing streams will also be shown on local study area maps used by construction crews.
- Restrictions on construction timing windows will be considered for the periods of least risk to fish species of concern. Tables 26.18-1 and 26.18-2 show the currently established and accepted low-risk periods for each fish species within the two TSA regions (unless otherwise approved by regulatory agencies).

- The areas of disturbance at crossing sites will be restricted, thus leaving as much vegetation as possible in the riparian management zone above and below the crossing point, while ensuring that vehicle traffic safety is maintained.
- Special attention will be paid to cut and fill slopes at stream crossings and anywhere that erosion and sediment transport can potentially reach surface drainages; seeding, including stable mulching methods, will be used wherever needed.
- Stormwater runoff and sediment control measures will be implemented, including isolation of work areas from surface waters, the use of temporary diversion methods (e.g., lined ditches, flumes, and dam-and-pump), and proper use of sediment traps, geotextile cloth, silt fences, gravel berms, and straw bales.
- All transported fuels, solvents, and other chemicals will be isolated, contained, and carefully managed.
- Blasting near watercourses will be stringently supervised and monitored; the federal guidelines for the use of explosives in or near fish-bearing waters (Wright and Hopky 1998) will be followed.
- Appropriately sized stream crossing structures will be installed to span the entire width of the stream channel, contain 100-year flood events, provide natural substrates for fish, allow for fish migration where applicable, and prevent sediments from entering streams. Bridges or open-bottom culverts will be used for fish-bearing stream crossings (where appropriate), while all other crossings will have steel culverts; bridges will preserve natural substrates, minimize bank disturbance, and allow fish passage.
- Proper use and maintenance of ditches, including roadside, perimeter, and cross-ditching, will be incorporated into operational practices to control surface runoff and sediment transport.
- Lines of communication will be established between field staff and environmental managers to facilitate reporting of any incident or concern during the construction process. Workers will be encouraged to communicate any concerns including erosion and sediment production, debris or snow jams at stream crossings, and contaminant releases. Environmental staff will also closely monitor stream crossings during and after road construction. Remedial actions, if needed, will be implemented immediately by the Environmental Department for reported concerns that have the potential to harm fishery resources.

26.18.1.5.2 Operation

During operation of the roads, regular inspection and maintenance schedules will be implemented for any bridges, culverts, and ditches, as well as sediment control measures. Any potential concerns for fish and aquatic habitat will be managed on an ongoing basis by Environmental Technicians.

Specific measures to protect fish and aquatic habitat during the operational years of the access roads include the following:

- Environmental Department staff will conduct visual inspections of stream crossing sites and wetlands along access roads, particularly during snow melt and after periods of heavy rainfall. Immediate attention will be paid to blockages by debris, ice, and snow in order to prevent road washout.
- Immediate attention will be given to incidents of ground erosion or sediment transport toward any waterbodies or watercourses, especially those that are fish-bearing; this will include potential erosion sites, ditch failures, culvert blockage, or outside seepage because such problems could lead to slope failure and sediment transport.
- All runoff and sediment control measures or physical features that could compromise the protection of fish and aquatic habitat will be inspected, maintained and, where necessary, repaired.
- Contingency plans for potential structural or process failures, erosion/sedimentation incidents, or chemical spills will be prepared proactively, so that they can be activated quickly. Appropriate equipment and materials will be based on site to ensure an immediate response, when needed, including items such as clean-up kits with oil absorbent blankets, clean gravel supplies, silt fencing, geotextile lining, and hand-tools. Priority access to larger, heavy equipment, and operators, will be standard procedure. Notifications will be immediately given to environmental staff, the Environmental Superintendent, and the regulatory agencies as appropriate for any incident in which fish and aquatic habitat could be adversely affected.

26.18.1.5.3 Closure and Post-closure

The Closure process for the access roads will include a number of specific measures to protect and enhance fish and aquatic habitat. The Treaty Creek access road will be maintained through grading, resurfacing, cleaning of ditches and culverts, and inspection of bridges. The Coulter Creek access road will be decommissioned once it is no longer required through the removal of bridges and culverts, the stabilization of road cuts and fills, and re-vegetation. The haul roads will be stabilized, filled, re-vegetated, and all bridges and culverts will be removed.

In general, all areas of fish and aquatic habitat affected by the Project will be rehabilitated as much as possible by means of soil stabilization and re-vegetation in riparian areas to prevent erosion and sediment transport. Site reclamation and rehabilitation will result in most riparian areas being restored to full functionality, similar to nearby unaffected sites. The impact avoidance and mitigation measures to protect fish and aquatic habitat during deactivation and closure of access roads will be similar to those used during the construction phase. Any instream work requirements will be completed during the periods of least risk to fish, using worksite isolation and dewatering techniques, or by scheduling instream work during periods agreed upon with regulatory agencies. Specific measures to be used during the closure and post-closure phases will include the following:

- All bridges and culverts along permanently closed sections of the roads will be removed; techniques such as isolating the work area, containing sediment, and avoiding fish habitat loss will be used during removal of the crossing structures, rehabilitation of the stream channels, and restoration of riparian areas.

- Bank restoration and rehabilitation of crossing sites will be accomplished through re-grading, stabilizing with clean rip-rap, re-topping with soil, seeding, and/or mulching to ensure no erosion or sediment transport occurs.
- Roadways and ditches along the decommissioned roadway sections will be re-graded to the surrounding ground level and seeded.
- After mine and road closure, crossing sites will be inspected to ensure that all reclamation measures are functioning properly.

26.18.1.6 Transmission Line: Avoidance, Control, and Mitigation

26.18.1.6.1 Construction

A 287 kV Transmission will extend approximately 28.5 km from Highway 37, following the Treaty Creek access road to a substation located at the Treaty Process Plant. The right-of-way will generally be 40-m wide and is currently anticipated to cross fish-bearing streams. In addition to the measures used for access road construction, the following measures will also be used during construction of the transmission line:

- Site-specific riparian management prescriptions will be developed for each stream crossing prior to construction; these riparian management prescriptions will be developed to reduce the amount of riparian vegetation to be removed.
- Transmission towers will be placed as close to fish-bearing streams as possible, without encroaching on the 30 m riparian zone, in order to reduce line sag, thus minimizing the required pruning and topping of riparian vegetation.
- Erosion and sediment control methods will be used to control potential runoff.
- Native species are preferred for re-vegetation of disturbed soils within the right-of-way, and re-vegetation will be accelerated through seeding and mulching.

26.18.1.6.2 Operation

During operation of the transmission line, inspection and maintenance measures will be implemented. Any structural failures or other potential concerns for fish and aquatic habitat will be managed on a regular ongoing basis. A reporting system will also be established wherein other personnel, such as drivers, can call in any potential concerns they may notice.

The specific measures to protect fish and aquatic habitat during transmission line operations, in addition to measures already implemented during construction, will include site-specific riparian maintenance prescriptions for each stream crossing during operation; these riparian maintenance prescriptions will be developed to reduce the amount of riparian vegetation to be removed.

26.18.1.6.3 Closure and Post-closure

The transmission line will be retained in place to supply power for facilities during the closure phase. After closure, the transmission line will serve to transmit any surplus power, created by the small hydro generators, to the provincial grid. As such, the specific measures to protect fish and aquatic habitat will be similar to those used during the operation phase.

26.18.1.7 McTagg Power Plant: Avoidance, Control, and Mitigation

26.18.1.7.1 Construction

A small hydro facility (the McTagg Power Plant) is planned within McTagg and Gingras creeks, which are confirmed as non-fish-bearing creeks. Although no fish are present, there are potential downstream effects including disturbed waterflow patterns, shifting erosion patterns, and increased sedimentation, all of which could affect aquatic habitat. To control these potential effects, the following measures will be implemented during construction:

- water flow will be diverted around the work site, and will rejoin the creek downstream of the in-channel construction;
- the construction area will be dewatered and surrounded by silt fencing to control any potential release of sediment-laden water caused by precipitation;
- sediment-laden water will be removed from the construction site and pumped to a settling pond prior to release downstream;
- machinery will arrive on site in a clean condition and will be maintained free of fluid leaks; and
- machinery will be washed, refueled, and serviced, and fuel will be stored at locations away from watercourses to prevent any deleterious substance from entering them.

26.18.1.7.2 Operation

During operation, the hydro facility will function to generate electricity for Project operation. Regular inspection and maintenance of the hydro facility and energy dissipation system will be required. As alterations in flow patterns will occur only in non-fish-bearing creeks, negligible downstream impacts to fish and aquatic habitat are anticipated.

26.18.1.7.3 Closure and Post-closure

Upon cessation of mining activities, the small hydro facility will remain in place and will produce energy for closure activities. Once all mine closure activities have been completed, the McTagg Power Plant will remain in place to supply electricity for the provincial power grid via the transmission line. It will continue to use the energy dissipation system already in place. The structure will continue to be inspected and maintained as it was throughout the Project lifespan.

26.18.1.8 Camps and Associated Infrastructure: Avoidance, Control, and Mitigation

26.18.1.8.1 Construction

Two permanent camps will be constructed for the operation of the KSM Project: the Mine Site camp near the confluence of Mitchell and Sulphurets creeks (the Mitchell operating camp), and the PTMA camp (the Treaty operating camp). Additionally, 11 temporary construction camps will be built to facilitate road and tunnel construction. The two permanent camps will include accommodation quarters, offices, storage buildings, fuel storage tanks, general maintenance yards, work areas, and sewage treatment facilities, as well as roads and out-buildings for

helicopter and vehicle support. The primary concern for fish and aquatic habitat related to camps is sediment generation and transport as well as the potential for contamination from spilled fuel, sewage, solvents, and other industrial agents. These and other concerns are addressed in the following proposed impact mitigation and aquatic habitat protection measures:

- If site runoff from the camp and associated work areas is observed during construction, water will be directed into low areas to settle out. Perimeter ditching may also be installed to catch and slowly transport runoff to sedimentation ponds, such that no potentially contaminated or sediment-laden water will reach streams.
- Other planned sediment control measures include constructing temporary settling ponds downslope of construction areas, directing sediment-laden water to forested terrain, installing geotextile or straw blankets on exposed erodible ground and polyethylene sheeting over temporary soil stockpiles, isolating work areas, and limiting work near streams during high rainfall events.
- All camp sewage will be filtered, treated, and discharged in accordance with the Municipal Sewage Regulation (BC Reg. 97/2012) or the (BC Reg. 326/2004) in a manner that does not impair the receiving environment.
- Angling will be prohibited by all Project staff.

26.18.1.8.2 Operation

Camp operations will include all of the domestic activities associated with a large camp, as well as some limited fuel storage, offices, hardware storage, core sheds, maintenance yards, vehicle parking, and sewage containment. The specific measures that will be used to ensure that there are no adverse effects to fish and aquatic habitat from camp operations include the following:

- Bulk fuel will be stored away from streams. Bulk storage will be in high capacity steel tanks, within lined and bermed containments sized to store 110% of the capacity of the largest tank.
- All camp sewage will be filtered, treated, and discharged in accordance with the Municipal Sewage Regulation (BC Reg. 97/2012) or the Sewerage System Regulation (BC Reg. 326/2004) in a manner that does not impair the receiving environment.

26.18.1.8.3 Closure and Post-closure

Upon closure, camps that are no longer required will be decommissioned and their sites re-graded, stabilized, and seeded in order to re-vegetate and revert to potential wildlife habitat. The specific mitigation measures to protect fish and aquatic habitat in the watershed include the following:

- Sediment control works will be similar to those used during camp construction and operation, especially the use of perimeter/diversion ditches.
- The camp footprint will be stabilized, seeded, and mulched and/or fibre-matted with approved plant seeds to stabilize the ground surface and prevent long-term erosion.

26.18.1.9 Mine Site and Associated Infrastructure: Avoidance, Control, and Mitigation

26.18.1.9.1 Construction

The KSM Project Mine Site, including all open pits and underground works, the Mitchell OPC, and the Mitchell and McTagg RSFs and all ancillary facilities will be surrounded by a system of perimeter ditches and diversion channels to divert non-contact surface runoff. The diversion channels will direct all clean surface water, including glacial meltwater and upslope runoff, around the Project infrastructure to downstream reaches. Surface runoff from within the mine pits, rock storage facilities, and camps will be diverted to the WSF for further treatment (discussed below). These and other sediment and contaminant control measures will be implemented soon after Project approvals and before mine excavation begins. Specific construction-related aquatic habitat protection and mitigation measures associated with the Mine Site will include the following:

- Drainages interrupted by mine infrastructure will be rerouted into existing stream courses using water diversion channels or tunnels.
- Perimeter diversion ditches, armoured with rip-rap on steep slopes to prevent erosion and bank slumping, will be installed to catch and transport all site runoff from the Mine Site and associated work areas to sedimentation ponds, such that no sediment-laden water directly reaches a watercourse.
- Sediment control measures will include constructing temporary sediment ponds downslope of construction areas and installing geotextile cloth, straw blankets, silt fencing, and other runoff and sediment control measures on exposed erodible ground in order to direct sediment-laden water to diversion ditches.
- Seepage ditches and ponds will be constructed downslope of some Project infrastructure to collect seepage contaminants, which will be piped into the WSF for treatment.
- Lines of communication will be established between the construction site contractors and the Environmental Technicians and Coordinators for reporting incidents or concerns during the construction phase; environmental concerns, including erosion and sediment production or contaminant release, will be reported.
- Machinery will arrive on site in a clean condition and will be maintained free of fluid leaks.
- Machinery will be washed, refuelled, and serviced, and fuel will be stored at locations away from watercourses to prevent any deleterious substance from entering them.
- An emergency spill kit will be kept at each construction site in case of fluid leaks or spills from machinery.
- Fuels, solvents, and other chemicals used during construction will be isolated, contained, and carefully managed.

26.18.1.9.2 Operation

In addition to the construction phase measures already cited, specific measures to be used to minimize adverse effects to aquatic habitat for mine operations include the following:

- Surface water from within the mine infrastructure will be directed to the WSF for containment and treatment prior to release (when discharge criteria are achieved).
- Diversion ditches will transport surface water around the mine infrastructure to a point below the mine infrastructure for discharge to the receiving environment.
- Bulk fuel will be stored well away from streams and the main buildings at the Mine Site in high capacity steel tanks with lined and bermed containments sized to store 110% of the largest tank.
- Explosives will be stored well away from the main Mine Site buildings in a fenced area with restricted access and appropriate internal site containment in the event of spills and external drainage diversion ditches.

26.18.1.9.3 Closure and Post-closure

Upon cessation of mining activities, the diversion channels will continue to function in directing surface runoff. The Mitchell Pit will be allowed to flood to reduce the area of pit wall rock exposed to oxidation and potential acid generation. The Mitchell OPC will be decommissioned, with industrial waste buried on site, subject to regulatory approval, or removed, and any hazardous waste either disposed of in an engineered facility or shipped off site. Mine closure will also include a number of other measures to protect fish and aquatic habitat in the area:

- Portions of the rock storage facilities will be re-graded and covered with 0.5 m of till or overburden and vegetated.
- Diversion ditches sited above the Mitchell operating camp the Mitchell OPC, and the Mitchell and McTagg RSFs will remain in place to continue diverting drainage into downstream sections; channels will be over-built and well armoured with rip-rap to maintain their shape and function in perpetuity; and seepage and runoff will be collected and directed to the WSF.
- Long-term monitoring of water quality at the site will be part of the post-closure environmental effects monitoring (EEM) program.

26.18.1.10 Tailing Management Facility and Water Storage Facility: Avoidance, Control, and Mitigation

26.18.1.10.1 Construction

In designing the TMF, consideration was given to water management systems that would minimize effects in Teigen and Treaty creeks. These efforts included:

- designing diversion ditches to minimize water loss;
- altering diversion ditch flow patterns to coincide with the various phases of TMF development; and
- alternating TMF discharge into Treaty and North Treaty creeks during TMF operations.

Water diversions will be constructed upslope of both dammed areas in order to maintain clean water flow to the lower stream reaches. Furthermore, excavation of the main diversion channels from the upper reaches around the TMF and WSF will be completed prior to operation. This is recognized as an important step in ensuring acceptable water quality in the creeks downstream, and in dewatering and isolating the work sites. Other mitigation measures to avoid sedimentation in the creeks and other potential effects include the following:

- Coffer dams or diversion tunnels will be installed to isolate instream construction and to prevent the introduction of sediments or contaminants into downstream areas.
- Localized dam-and-pump or excavate-and-hold methods will be used to contain and control sediment-laden water in work areas. Similarly, perimeter ditching may be used within the TMF footprint area to contain sediments and contaminants within specific work sites.
- Fish salvages within the TMF footprint will be required. All fish in the affected stream sections will be captured and live-transported downstream within the same waterbody or within another waterbody. Pre-planning of such sites will allow for orderly processing of fish salvage permits from the DFO and BC Ministry of Environment.
- Environmental monitoring and supervision of fish and aquatic habitat protection measures by the Environmental Department will be ongoing from the planning and implementation stages to completion of the TMF and associated structures and systems. During construction, Environmental Technicians will monitor construction works.

26.18.1.10.2 Operation

Operation of the TMF and WSF will be permitted or authorized under the BC *Mines Act* (1996j) and the *Environmental Management Act* (2003). The federal *Fisheries Act* (1985c) and its Metal Mining Effluent Regulations (SOR/2002-222) also apply and include prescriptive requirements for environmental monitoring and surveillance. An EEM program will be initiated for the KSM Project upon approval by regulatory agencies. The EEM program will include water quality, sediment quality, water toxicity, and benthic invertebrate and fish assessments downstream of all mine effluent discharges, including the TMF and WSF (Section 26.18.2). This program will monitor long-term effects (if any) of effluent discharges or seepages to downstream areas that support fish populations. Other possible measures to ensure no deleterious effects of the TMF and WSF systems on fish and fish habitat downstream include the following:

- Discharges from the WSF will be treated using a high-density sludge process using lime to reduce metal content and to ensure that it will have a pH in a range acceptable for fish.
- Any seepages from the TMF dams will be captured by seepage collection dams immediately downstream and will be pumped back into the impoundment for further detention and metals complexion before eventual discharge.
- During construction and operation, when discharge criteria are achieved, discharges from the TMF will be directed into North Treaty and Treaty creeks.
- During all operations, the main diversion channels will continue to carry all freshwater (or non-contact) flows from above the site around the mine infrastructure to downstream

reaches, while all site-generated (or contact) water will be captured by different channels and directed to the TMF or WSF.

- An EEM program will be implemented, including fish, water quality, and invertebrate sampling..

26.18.1.10.3 Closure and Post-closure

When mining ceases, the TMF will be deactivated, except for the seepage pond recycle pumps, which will continue operating through the closure and post-closure phases. The TMF will be flooded with freshwater, such that the PAG tailing material will be enclosed within the impoundment underwater. A water treatment plant (the Treaty WTP) will be constructed and operated at the process plant site to treat and discharge water from the TMF until the TMF water meets permit limits for direct discharge. Once the seepage pond recycle pumps are shut off, releases through the spillways will be "free release" of rainwater, ice, and snow melt from the facilities. The two seepage recovery ponds will be developed, as far as possible, into small lakes suitable for aquatic invertebrates. Other measures to protect fish and aquatic habitat after mine closure will include the following:

- Treated water will decant as free releases over the spillway of the dams to downstream reaches; water will be monitored for contaminant transport into fish-bearing waters.
- All PAG tailing material will be placed in the TMF, where it will remain saturated with water in perpetuity. Both rainfall and glacial meltwater will provide freshwater to the impoundment. Vegetation will be seeded and planted around the impoundment to develop a riparian zone, such that the impoundment will resemble a small lake or wetland. The bottom will consist of NPAG tailing, and the outlet will be free to release surface water to South Teigen and North Treaty creeks below the main dams, once water quality has reached acceptable levels for discharge.
- The flow from the East Catchment will be routed through the decommissioned and re-vegetated TMF to provide a more natural hydrograph to the creek flows.
- Post-closure monitoring of the creek flows and water quality, as well as of downstream fish, will continue after the areas are deactivated.

26.18.1.11 Mitchell-Treaty Twinned Tunnels: Avoidance, Control, and Mitigation

26.18.1.11.1 Construction

The MTT will connect the Mine Site to the PTMA. The MTT are 23-km long. The parallel tunnels will be excavated from the Mitchell OPC east through the mountainous terrain and into the upper watershed of Treaty Creek, approximately at km 16, where the Saddle portal will be located, and will exit further east at the Treaty Process Plant, east of the TMF in Upper Teigen Creek. A conveyor will run through one of the tunnels, carrying ore from the Mine Site to the PTMA for processing. Temporary construction camps, laydown areas, fuel and explosives storage, and the development of waste rock storage areas are required for MTT construction. Therefore, the following measures will be employed to protect fish and aquatic habitat:

- PAG and NPAG rock will be removed from the tunnel and stored in appropriate rock storage areas with water collection and treatment facilities.
- During excavation, water from the PAG rock lined pads will be collected and directed to settling ponds and water treatment systems.
- Sludge will be collected and disposed of in an appropriate manner.

26.18.1.11.2 Operation

Enacted measures for operation of the MTT will include the following:

- The MTT will be constructed on an east-west gradient, forcing all tunnel drainage to flow to the Mitchell OPC, and all tunnel drainage will be captured in the water storage pond for treatment.
- An extensive and thorough spill response plan will be developed, and all required resources will be available to activate the plan on very short notice.
- The conveyor will be constructed to required engineering standards.

26.18.1.11.3 Closure and Post-closure

At closure, the MTT will remain active, allowing mine personnel access to the WSF, maintaining transmission line service to the Mine Site, and allowing vehicle access for personnel, supplies, and haulage of water treatment reagents. The transmission lines will remain in place to transfer electricity generated by the McTagg Power Plant to the BC power grid. Tunnel drainage from the MTT will continue to drain to the WSF.

26.18.1.12 Monitoring Goals

The Proponent's primary environmental responsibility is to ensure that all environmental protection measures are implemented properly and effectively in the regional study area. To that end, senior environmental staff as well as Environmental Technicians will be employed throughout the life of the Project to supervise, direct, monitor, and implement all protection measures. Environmental Department staff will have the authority to temporarily stop construction when activities are affecting, or have the potential to affect, fish and aquatic habitat. Environmental technicians will report to the Environmental Coordinators or Environmental Superintendent, who may report directly to the Project Manager or Mine Manager on any significant environmental concern. Project staff and contractors will report any potentially adverse incidents of erosion, structural or function failure, culvert/bridge debris build-up, spills, seepages, leaks, or similar occurrences to the environmental staff.

Good engineering, careful construction planning, trained staff, and environmental monitoring during all phases of the Project will ensure no net loss of fish and aquatic habitat due to the construction, operation, or closure of Project infrastructure. The environmental monitoring program, including fish population and habitat quantifiers, will include post-closure monitoring of the Treaty Creek, Teigen Creek, and Unuk River watersheds and their associated tributaries to detect changes due to WSF discharge and TMF seepage.

26.18.1.13 Reporting

Record keeping will be carefully managed for all monitoring and surveillance programs to ensure that the status of each area is reported to management and regulatory agencies if required. A report on the management program will be prepared, describing all monitoring results and comparing previous results, to provide feedback on successful projects and to adapt successful operating procedures and build effective site-specific management and monitoring tools.

26.18.1.14 Responsibilities

All monitoring results will be reported, including a description and assessment of all adaptive management initiatives. The Vice President of Environment (the Project's Environmental Department) will ultimately be responsible for the development, implementation, and monitoring of all environmental programs, including the Fish and Aquatic Habitat Protection and Mitigation Plan.

26.18.2 Aquatic Effects Monitoring Plan

This AEMP provides an overview of the aquatic monitoring program that will be implemented to ensure that the aquatic receiving environment will be protected from potential adverse effects due to Project activities. There are two main goals of the AEMP. The first goal is to ensure that aquatic monitoring occurs at the frequency and to the extent required by regulations such as the federal Metal Mine Effluent Regulations (MMER; SOR/2002-222), made under the *Fisheries Act* (1985c), or by provincial discharge permits issued under the *Environmental Management Act* (EMA; 2003) for effluent discharge. The second goal is to address requirements under the *Canadian Environmental Assessment Act* (CEAA; 1992a) related to follow-up monitoring or information needs for risk assessment.

The AEMP includes a description of the monitoring and reporting requirements under the MMER (SOR/2002-222). A separate, more detailed EEM Plan including selection of specific sampling sites, methodology, and data analysis/interpretation will also be developed in consultation with regulators and in compliance with Section 7 and Schedule 5 of the MMER (SOR/2002-222).

The AEMP also recognizes the need for an aquatic sampling program that will meet the monitoring requirements of the provincial EMA (2003) related to discharges from the TMF, the Mine Site WTP, various temporary WTPs during construction, and sedimentation ponds (if applicable). Monitoring of discharges is required under the EMA (2003) at the discharge point and downstream of areas where discharges occur. The AEMP is intended to provide flexibility in the selection of sampling sites during the permitting process in consultation with regulators. A separate, more detailed plan including sampling sites, methodology, and data analysis/interpretation will be developed in consultation with regulators and in compliance with the EMA (2003) as a requirement of the permits and licences under which the KSM Project will operate.

The final portion of the AEMP details an aquatic monitoring program that will address the follow-up monitoring requirements under the CEAA (1992a). In addition, Seabridge Gold Inc. has committed to conducting an ecological risk assessment of the potential for impacts associated with selenium to the Lower Unuk River that may occur as a result of Project-related

activities. The monitoring program described in this final section will be carried out with a frequency and scope that will satisfy both the CEAA (1992a) requirements and that will be used in the ecological risk assessment of the Lower Unuk River. This monitoring program will also be summarized in the follow-up program outlined in Chapter 38..

26.18.2.1 Objectives of the Aquatic Effects Monitoring Plan

Water quality and quantity, water toxicity, sediment quality, primary producers, benthic invertebrates and zooplankton, fish, and fish habitat will be monitored as part of the AEMP. The proposed AEMP will be implemented to:

- verify the predictions of environmental effects assessments, address uncertainty associated with some of the significance determinations in the environmental assessment, and determine if mitigation measures are working as intended;
- assist in identifying the potential cause-effect relationship between Project activities and environmental effects;
- detect any unforeseen effects or emerging environmental trends as measured against baseline conditions established as part of the initial environmental assessment;
- allow for development of adaptive management and mitigation strategies if effects are detected; and,
- ensure regulatory compliance with respect to discharge criteria for the receiving environment and permitting conditions to be established at the permitting stage.

The AEMP will be useful in increasing the overall predictive power related to the effects assessment, and may also be useful in redefining appropriate valued ecosystem components and environment targets. The monitoring program will take into account both discharge points and proximity to infrastructure to ensure that both local and broader scale impacts can be identified. The effectiveness of the AEMP will be assessed and adjusted accordingly throughout the various phases of Project activities (construction, operation, closure, and post-closure), but sampling will, at minimum, meet monitoring requirements of the MMER (SOR/2002-222) and any effluent permit conditions determined under EMA (2003) during the permitting stage.

Wherever possible, monitoring to meet the federal (MMER [SOR/2002-222] and CEAA [1992]) requirements, provincial (EMA [2003]) requirements, and data collection needs for the ecological risk assessment will be integrated to avoid unnecessary duplication of monitoring efforts.

26.18.2.2 Metal Mining Effluent Regulations Monitoring Requirements

The MMER (SOR/2002-222) specifies minimum sampling requirements and frequency for water quality, toxicity, sediment, benthic invertebrates, and fish in areas downstream of discharge points. The MMER (SOR/2002-222) defines a final discharge point as "…an identifiable discharge point of a mine beyond which the operator of the mine no longer exercises control over the quality of the effluent." Monitoring of both end-of-pipe effluent quality (Section 26.18.2.2.1) and biological monitoring at locations downstream of the final discharge point are required (Section 26.18.2.2.2). Table 26.18-3 provides an overview of the types of testing required, parameters to be measured, and the frequency of monitoring to meet MMER (SOR/2002-222).

Table 26.18-3. Sampling Locations and Frequency for Monitoring Required under the Metal Mining Effluent Regulations

Sampling Site	Location of Site	Rationale for Site Selection	Effluent Quality Monitoring				Biological Monitoring		
			Water Quality	Water Quantity	Toxicity Testing		Sediment Quality	Benthic Invertebrates	Fish
					Acute	Chronic			
Mine Site	WTP discharge	Source; end of pipe for effluent discharge	Weekly	Continuous	Quarterly[a]	Annually[b]	-		
	Downstream site(s) on Sulphurets Creek	Downstream of WSF/WTP and other infrastructure	Monthly		-		3 year cycle		Insufficient fish population[c]
	Downstream site(s) on Unuk River	Downstream of WSF/WTP and other infrastructure	Monthly		-		3 year cycle		
	Reference site(s)	Reference site(s) for comparison with potentially affected sites							
Processing and Tailing Management Area	TMF discharge	Source; end of pipe for effluent discharge	Weekly	Continuous	Quarterly[a]	Annually[b]	-		
	Downstream site(s) on South Teigen Creek	Downstream of TMF and other site infrastructure	Monthly		-		3 year cycle[d]		
	Downstream site(s) on Teigen Creek	Downstream of TMF and other site infrastructure							
	Downstream site(s) on North Treaty Creek	Downstream of TMF and other site infrastructure							
	Downstream site(s) on Treaty Creek	Downstream of TMF and other site infrastructure							
	Downstream site(s) on Bell-Irving River	Downstream of TMF and other site infrastructure							
	Reference site(s)	Reference site(s) for comparison with potentially affected sites							

a Acute toxicity testing will be done monthly for the first year of operations (discharge) and will be reduced to quarterly if the effluent is not acutely lethal
b Chronic (sublethal) toxicity testing will be done twice per year for the first three years and annually thereafter
c Fish sampling is not proposed for Sulphurets Creek downstream of the cascade because baseline data indicates insufficient population abundance for appropriate statistical rigor
d Water, sediment and biological monitoring at sites on the Bell-Irving River will only be done if monitoring at sites closer to the TMF indicate significant alterations (see text)

General sampling site locations are provided in Table 26.18-3, which will allow flexibility to select monitoring sites that will best measure potential aquatic impacts. Monitoring will be conducted at near-field, far-field, and reference sites. Some of the sampling sites that were used during baseline studies will be selected for continued assessment (since data are available for these sites pre-development), and reference sites will be chosen to allow for a "before-after-control-impact" design. Once discharges have been initiated, the sampling described under the AEMP must be implemented in potentially affected downstream areas and at applicable reference sites. The following sections provide additional details regarding the individual components of the monitoring plan based on MMER (SOR/2002-222) requirements. A more detailed plan will be developed with reference to the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012c).

26.18.2.2.1 Effluent Monitoring Requirements

Monitoring of Deleterious Substances and pH Testing

Division 2 of the MMER (SOR/2002-222) describes the monitoring that is required for effluent (end-of-pipe). Effluent testing of pH and deleterious substances (listed in Table 26.18-4) is required on a weekly basis (Sections 12 and 13 of the MMER). Monitoring of the effluent for cyanide concentration is required in the discharge from the TMF only, since cyanide is used as a process reagent in the Treaty Process Plant.

Table 26.18-4. Deleterious Substances under the Metal Mining Effluent Regulations

Parameter	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Arsenic	0.50	0.75	1.00
Copper	0.30	0.45	0.60
Cyanide	1.00	1.50	2.00
Lead	0.20	0.30	0.40
Nickel	0.50	0.75	1.00
Zinc	0.50	0.75	1.00
Total Suspended Solids	15.00	22.50	30.00
Radium^{226}	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L

Table taken from Schedule 4 of the MMER (SOR/2002-222).

Bq/L = becquerels per litre

All concentrations are total values and are in units of mg/L unless otherwise noted.

The monitoring requirements for radium^{226} may be reduced to quarterly if the concentration in the effluent is less than 0.037 Bq/L in 10 consecutive tests (MMER [SOR/2002-222]). The frequency of effluent monitoring for a final discharge point can be decreased to quarterly if the mean monthly concentration of the five metals (arsenic, copper, lead, nickel, and zinc) and cyanide at that final discharge point are less than 10% of the value set out in column 2 of Schedule 4 of the MMER (SOR/2002-222). If any of these six deleterious substances are greater than 10% of the value set out in column 2 of Schedule 4, effluent monitoring at that site must be done on a weekly basis.

Notification in writing, 30 days in advance, must be provided to the authorization officer (Environment Canada) before any reduction of monitoring frequency can occur.

The MMER (SOR/2002-222) also requires that the volume of effluent be measured for each discharge point to allow the calculation of mass loading on a monthly basis for each of the deleterious substances in the effluent (Section 19). This can be done using one of the approaches specified in Section 19(2) of the MMER (SOR/2002-222), which include concurrent measurement of the flow rate with the collection of the effluent sample, calculation of the average monthly flow rate, or use of a continuous monitoring system for effluent volumes.

Toxicity Testing of Effluent

Division 2, Sections 14 to 17 of the MMER (SOR/2002-222) lay out the requirements for acute toxicity testing of effluent at each discharge point. This testing must be conducted using the specified methods for the rainbow trout acute lethality test and the *Daphnia magna* acute lethality monitoring test. Effluent testing from each discharge point must be carried out monthly on a grab sample that is collected concurrently with enough effluent to also conduct water chemistry measurements for effluent characterization and deleterious substances, if needed.

If an effluent is found to be not acutely lethal (the undiluted effluent causes the death of less than 50% of rainbow trout in the acute lethality test) over a period of 12 consecutive months, the frequency of acute toxicity testing can be reduced to quarterly (MMER [SOR/2002-222]). If an effluent is found to be acutely lethal, effluent characterization must be done and sampling frequency for acute lethality must be increased to twice per month. Effluent must then be tested twice per month until at least three consecutive tests conducted at least seven days apart show that the effluent is not acutely lethal, at which time frequency can again be reduced to monthly.

26.18.2.2.2 Environmental Effects Monitoring Studies

The requirements for the EEM studies are provided in Schedule 5 of the MMER (SOR/2002-222). The first component is effluent and water quality monitoring studies and the second is biological monitoring studies. A description of the MMER (SOR/2002-222) requirements is provided in the following sections.

Effluent and Water Quality Monitoring Studies

There are three components to the effluent and water quality monitoring studies: effluent characterization, sublethal toxicity testing, and water quality monitoring (MMER, SOR/2002-222). These studies must be done on the same sample of effluent.

Effluent characterization requires the measurement and recording of hardness, alkalinity, and total concentrations of aluminum, cadmium, iron, mercury (if mercury is greater than 0.1 µg/L in the effluent), molybdenum, ammonia, and nitrate (MMER, SOR/2002-222). The frequency of required testing is quarterly, with at least one month between samples. If the concentration of mercury is less than 0.1 µg/L in 12 consecutive samples, it does not have to be monitored further.

Sublethal toxicity testing must also be conducted at least twice per calendar year in the first three years of operation, with a frequency of once per year after that. Tests must be conducted on a

fish species, an invertebrate species, a plant species, and an algal species using the methodologies specified in the MMER (SOR/2002-222).

Water quality monitoring must also be done concurrently and must include samples from both the area surrounding the final discharge point and reference areas (MMER, SOR/2002-222). For each sample, water temperature, dissolved oxygen, pH, hardness, alkalinity, and total concentrations of deleterious substances (Table 26.18-4) and the metals measured during effluent characterization must be measured. The parameters that are required to be measured during water quality monitoring are summarized in Table 26.18-5.

Table 26.18-5. Parameters for Water Quality Monitoring under the Metal Mining Effluent Regulations

Water Quality Monitoring Parameters		
Aluminum	Molybdenum	Hardness
Arsenic	Nickel	Alkalinity
Cadmium	Radium^{226}	Dissolved Oxygen
Copper	Selenium	Temperature
Cyanide	Zinc	pH
Iron	Ammonia	Conductivity
Lead	Nitrate	
Mercury	Total Suspended Solids	

Biological Monitoring Studies

There are four components of biological monitoring studies: site characterization, a fish population and tissue residue study, a benthic invertebrate study (including sediment sampling for particle size and total organic carbon), and water quality monitoring (MMER [SOR/2002-222]).

The requirements for site characterization studies are outlined in Schedule 5, Section 11 of the MMER (SOR/2002-222). Requirements include the following:

- description of the effluent mixing zone with an estimate of effluent concentration at 250 m from each discharge point;
- description of the reference and exposure areas;
- mine production processes and environmental protection practices;
- summary of all laws that are applicable to the mine;
- description of other factors that may affect the findings of the biological monitoring studies; and
- any other relevant information.

The second component of the biological monitoring studies under the MMER (SOR/2002-222) requires the sampling of fish communities and biology (fish population study). Dolly Varden are present at all baseline monitoring sites downstream of potential discharge locations (except

Mitchell Creek or Upper Sulphurets Creek, which are non-fish bearing) and are the most abundant species in these locations, allowing for direct site-to-site comparisons. Dolly Varden is a resident fish species with limited movement and dispersal (Bryant and Lukey. 2004; Ihlenfeldt 2005) and would therefore have greater risk of metal bioaccumulation and subsequent toxicity than migratory fish species such as salmon. The species possesses short- to medium-term longevity (eight to nine years), age and length at maturation are relatively short (three to five years, and 130 to 162 mm, respectively), spawning is site-specific, and their diet is primarily benthic invertebrates (Ihlenfeldt 2005; BC MOE 2012; McPhail 2007b).

Sampling will be conducted in late August, whenever possible, to include the summer growing season, while avoiding the spawning season. All fish caught will be identified to species, enumerated, measured for fork length and body weight, gonad weight, and liver weight, and sampled for aging structures including otoliths, fin rays, and scales. Ripe ovaries will be removed for fecundity analysis and egg size determination. Stomach contents will be identified to the lowest possible taxonomic level, enumerated, and weighed. Fish will also be physically examined for abnormalities including lesions, deformities, and tumours. As required by the MMER (SOR/2002-222), these data will be used to compare baseline and reference data with the three principle endpoint fish responses: energy use, energy storage, and survival (Table 26.18-6).

Table 26.18-6. Summary of Three Principal Endpoint Responses for Fish Community and Biology Environmental Effects Monitoring

Type of Response	Effect Indicator	Lethal Effect and Support Endpoint	Non-lethal Effect and Support Endpoint
Energy Use	Growth	*Size-at-age (body weight-at-age); Length-at-age	*Length of YOY (age 0) at end of growth period; *Weight of YOY (age 0) at end of growth period; Size of the 1+ fish; Size-at-age (if possible)
	Reproduction	*Gonad weight vs body weight; Gonad weight at length; Fecundity (number of eggs/female at body weight, length, and/or age)	*Relative abundance of YOY (% composition of YOY); YOY survival
Energy Storage	Condition	*Body weight at length; *Liver size at body weight; Liver weight at length; Egg weight at body weight and/or age (mature females only)	*Body weight at length
Survival	Survival	*Age; *Age-frequency distribution; Length-frequency distribution	*Length-frequency distribution; Age-frequency distribution (if possible)

YOY = young of year
***Fish survey effect endpoints used for determining effects as designated by statistically significant differences between exposure and reference streams. Other endpoints within an effect indicator category can be used to support analyses.**

The main concern using Dolly Varden for biomonitoring is that it is a yellow-listed species. Because of the destructive nature of collecting tissue samples, lethal sampling of fish from sites downstream of discharge points could adversely affect the local population since these small

oligotrophic streams are typically characterized by slow fish growth and low population densities. There is concern that sampling may decimate Dolly Varden populations, particularly in areas where they are present in low numbers or are already experiencing stress due to existing poor water quality (e.g. Lower Sulphurets and Unuk River near the confluence with Sulphurets). If fish sampling appears to be significantly decreasing the population abundance, alternative monitoring programs using non-fish species will be considered (such as the use of caged bivalves). The use of other fish species in the MMER (SOR/2002-222) monitoring program may also be considered instead of or in addition to Dolly Varden.

The MMER (SOR/2002-222) requires that fish tissue metal analysis be included as part of the biological effects monitoring for discharges when the total mercury concentration in the effluent exceeds 0.1 µg/L. Mercury levels are predicted to exceed this concentration in end-of-pipe discharges from the TMF (see Chapter 14 for concentrations of mercury in the North and South cells of the TMF), which would trigger tissue metal analysis in downstream areas.

The third component of biological monitoring is the benthic invertebrate study. This must include assessment of the total benthic invertebrate density, evenness, richness and similarity index (MMER [SOR/2002-222]). A sediment sample should also be collected and analyzed for total organic carbon content and particle size distribution. Environment Canada (2012c) also strongly recommends measurement of sediment metal concentrations for this sediment sample.

The final aspect of biological monitoring under MMER (SOR/2002-222) is water quality monitoring. Water quality monitoring must be done concurrently and must include samples from both the area surrounding the final discharge point and reference areas, as well as each sampling location for fish community studies, fish tissue residue sampling, and benthic invertebrate studies. For each sample, water temperature, dissolved oxygen, pH, hardness, alkalinity, and total concentrations of deleterious substances and the metals measured during effluent characterization must be measured (see Table 26.18-5 for the parameter list).

26.18.2.3 Reporting Requirements

The MMER (SOR/2002-222) specifies reporting requirements for effluent quality and biological monitoring. Detailed descriptions of the MMER reporting requirements will be provided in the EEM program, but a general overview is provided in the following paragraphs.

Reporting of monitoring results for effluent/water quality and acute toxicity testing is required on a quarterly basis, within 45 days of the end of the quarter. The reporting of mass loadings will also be included in the reports. If no effluent is discharged during a quarter, the report will consist of a statement to that effect. An annual report summarizing the effluent monitoring, water quality monitoring, acute toxicity testing, and sublethal toxicity testing is required to be submitted by March 31 of the following year. Reports will be made electronically to Environment Canada wherever possible, and in writing if electronic submission is not possible.

For biological effects monitoring (site characterization, fish community study, fish tissue analysis, benthic invertebrate study, sediment analysis, and associated water quality monitoring), a report detailing the study design for biological monitoring must be submitted at least six months in advance of beginning studies. After the first study design submission, subsequent study design submissions must also include a summary of the results from previous biological monitoring studies.

Studies and interpretative reports for biological effects monitoring are required on either a 36-month cycle or a 72-month cycle, depending on whether significant effects are identified and how many reports have been previously submitted (Environment Canada 2012c). The first and second biological effects monitoring studies and interpretative reports produced must be submitted on the 36-month cycle. If significant effects are noted, subsequent reports and studies to identify the magnitude, extent, and cause of the effects are required on a 36-month cycle until no significant effects are observed in two consecutive reporting periods. If no significant effects are noted over two consecutive 36-month reporting periods, interpretative reports are required on a 72-month cycle thereafter.

26.18.2.4 Provincial Monitoring Requirements

At the provincial level, effluent discharges that occur during Project activities will require an effluent waste discharge permit issued under the EMA (2003). Examples of effluent discharges that may require a permit under the EMA include discharges from the TMF, Mine Site WTP, TWT facilities during construction, and sedimentation ponds (if applicable). The types of sampling and parameters to be monitored may vary for each type of discharge and may include physical parameters, water quality, sediment quality, and/or biological monitoring (toxicity testing, periphyton, benthic invertebrates, or fish studies). The full scope, scale, and frequency of monitoring, including the selection of specific sampling sites, will be determined as part of the permitting process, in consultation with provincial regulators.

As part of the provincial permitting process under the EMA (2003), receiving environment targets may also be determined. This may be particularly relevant for metals that were present in concentrations greater than BC water quality for the protection of aquatic life or sediment quality guidelines (BC MOE 2006a, 2006b) during baseline studies.

26.18.2.5 Monitoring Requirements under the *Canadian Environmental Assessment Act* and Information Requirements for Risk Assessment

The CEAA (1992a) requires that a follow-up monitoring program be implemented to confirm that the effects assessment of the environmental assessment was accurate, that uncertainties identified in the assessment are addressed, and that proposed mitigation measures are working as intended.

Project-related residual effects due to changes in water quality downstream of the Mine Site were identified through predictive water quality modelling, predominantly for selenium (Chapter 14). Mitigation strategies for potential water quality effects include collection of Mine Site contact water in the WSF and two types of water treatment: (1) an ion-exchange Selenium Treatment Plant for drainage from Kerr waste rock, and (2) an HDS lime WTP for water discharged from the WSF. Discharge from the WTP will be staged to the natural hydrograph to minimize potential water quality effects by using the dilution capacity in the receiving environment. Follow-up monitoring is proposed to validate water quality predictions, address uncertainties in the effects assessment, and to monitor the effectiveness of mitigation strategies.

The potential for toxicity due to selenium bioaccumulation was identified as a potential concern for fish and aquatic habitat downstream of both the Mine Site and the TMF (Chapter 15).

During the environmental effects assessment process, uncertainties were identified that affected the significance determination for fish and aquatic habitat, specifically related to the potential for toxicity due to bioaccumulated selenium. Uncertainties were also identified in the qualitative assessment of the potential for residual effects related to water quantity changes and the potential for subsequent temperature changes downstream of the TMF (Chapter 15). Changes due to the diversion of water (which alters stream flows) and discharges from the TMF (which could potentially affect water temperature in the receiving environment), have the potential to affect fish populations in areas downstream of the TMF, and data gaps were identified during the assessment.

Based on the above, the following items were identified that require follow-up monitoring under the CEAA (1992a):

- monitoring to ensure that mitigation measures proposed for the Mine Site (contact water collection, treatment, and staged discharge) are effective in minimizing the potential for effects on the aquatic receiving environment;
- the potential for residual effects to fish and aquatic habitat due to discharges from the TMF and Mine Site WTP, particularly related to the potential for toxicity due to selenium bioaccumulation;
- the potential for residual effects to salmon spawning habitat associated with water quantity changes downstream of the TMF; and
- the potential for residual effects to fish and aquatic habitat due to water temperature changes that may occur in the receiving environment downstream of the TMF as a result of water quantity changes.

In addition, in January 2013, Seabridge Gold Inc. committed to conducting or providing resources to conduct an ecological risk assessment (ERA) of the Lower Unuk River to determine if Project-related activities result in alterations in the far-field area downstream of the Mine Site WTP. The full scope of the ERA has not been determined, but it would focus on fish and aquatic habitat that may be affected by changes in water quality in the Lower Unuk River, and would include input on the ERA design from United States regulators. This may include sampling or surveys of water, sediment, benthic invertebrates, fish, waterfowl, or frogs. Monitoring for metal concentrations in water, sediment and tissues (e.g., benthic invertebrates, fish, frogs, and bird eggs) may be required.

The following sections detail the type of monitoring that will be required under the CEAA (1992a) or to meet information needs for a risk assessment of the Lower Unuk River, including the rationale for including each component of the monitoring program.

26.18.2.5.1 Surface Water Quality

Based on predictive water quality modelling, changes in water quality were identified as a potential residual effect of Project activities, particularly for selenium downstream of the Mine Site WTP discharge (Chapter 14). Monitoring of surface water quality is required to confirm predictions of the water quality model, to confirm that mitigation measures related to water

treatment and staged discharges are effective, and to address uncertainties in the effects assessment. This information will also be useful in the ERA of the Lower Unuk River.

Surface water quality will be monitored at sites with the potential for effects attributable to Project infrastructure such as the WTP and TMF. Sampling sites will be located downstream of infrastructure with both near-field and far-field exposure to Project activities so that a gradient of potential effects can be assessed. Reference sites will be located upstream (if possible) or in unaffected watersheds with similar hydrological conditions. The exact sampling locations will be determined in consultation with regulators and, wherever possible, will use the same sampling sites identified under the MMER (SOR/2002-222) water quality monitoring program (Section 26.18.2.2.2) or EMA discharge permit requirements (Section 26.18.2.4) to avoid duplication of efforts. A summary of general monitoring locations and frequency are provided in Table 26.18-7.

Water quality sampling in areas downstream of the discharge points is required on a monthly basis, which will allow the quick detection and correction of potential water quality effects. Discharge from the Mine Site WTP is expected to occur on a continuous basis in perpetuity, while discharges from the TMF are expected to occur only between March and October during the Project operation and closure phases. Water samples will also be collected concurrently with all sediment and biotic samples to enable interpretation of the results of the other assays and measurements.

All water samples will be analyzed for physical parameters required by the MMER (SOR/2002-222) in addition to a number of other physio-chemical parameters, anions, nutrients, total cyanide, total organic carbon, and total and dissolved metals that are typically required as part of permitting under the EMA (2003; Table 26.18-8). The analysis will be consistent with what was completed during baseline studies to enable a complete comparison between baseline data and data collected following initiation of Project activities. This will also enable the detection of a wide range of potential changes in water quality that may occur as a result of Project activities, and will be used to confirm water quality model predictions as required by CEAA.

The sampling methodology and lab analysis will be consistent with the *British Columbia Field Sampling Manual* (M. J. R. Clark 2003), the BC *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012), and the Environmental Data Quality Assurance Regulation (BC Reg. 301/90). Results of water quality analyses will be compared to either BC Ministry of Environment (BC MOE) or Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life, or to receiving environment targets developed during permitting (CCME 1999a, 1999b; BC MOE 2006b).

The sampling frequency can be re-evaluated on an annual basis and can be reduced if no parameters are greater than either water quality guidelines or receiving environment targets. Sampling frequency will also be re-evaluated prior to the closure and post-closure phases to ensure that appropriate monitoring levels are maintained during these phases of Project activities, once discharges have ceased from the TMF.

Table 26.18-7. Follow-up Monitoring under the *Canadian Environmental Assessment Act* and for Risk Assessment, KSM Project

Sampling Site	Location of Site	Rationale for Site Selection	Water Quality	Water Quantity	Sediment Quality	Primary Producers	Benthic Invertebrates	Fish	Temperature Monitoring
Mine Site	Downstream site(s) on Sulphurets Creek	Downstream of WSF/WTP and other infrastructure; required under CEAA	Monthly	Monthly	Annually	Annually	Annually		
	Downstream site(s) on Unuk River	Downstream of WSF/WTP and other infrastructure; required under CEAA							
	Lower Unuk River (United States)	Downstream of WSF/WTP and other infrastructure; required for risk assessment purposes	TBD	TBD	TBD	TBD	TBD	TBD	
	Reference site(s)	Reference site(s) for comparison with potentially affected sites; required under CEAA and for risk assessment purposes	Monthly	Monthly	Annually	Annually	Annually		
Processing and Tailing Management Area	Downstream site(s) on South Teigen Creek	Downstream of TMF and other site infrastructure; required under CEAA	Monthly	Monthly	Annually	Annually	Annually		Annually[b]
	Downstream site(s) on Teigen Creek	Downstream of TMF and other site infrastructure; required under CEAA	Monthly	Monthly	Annually	Annually	Annually	Annually[a]	Annually[b]
	Downstream site(s) on North Treaty Creek	Downstream of TMF and other site infrastructure; required under CEAA	Monthly	Monthly	Annually	Annually	Annually		Annually[b]
	Downstream site(s) on Treaty Creek	Downstream of TMF and other site infrastructure; required under CEAA	Monthly	Monthly	Annually	Annually	Annually		Annually[b]
	Reference site(s)	Reference site(s) for comparison with potentially affected sites; required under CEAA	Monthly	Monthly	Annually	Annually	Annually		Annually[b]

Note: frequency of sampling may be adjusted periodically if data collected indicates significant effects are not occurring

a Refers to Teigen Creek Chinook Salmon Monitoring Program

b Refers to the Stream Temperature Monitoring Program

Table 26.18-8. Surface Water Quality Parameter List

Physical Parameters and Dissolved Anions		**Total and Dissolved Metals**	
Colour	Alkalinity, Bicarbonate (as $CaCO_3$)	Aluminum	Mercury
Conductivity	Alkalinity, Carbonate (as $CaCO_3$)	Antimony	Molybdenum
pH	Alkalinity, Hydroxide (as $CaCO_3$)	Arsenic	Nickel
Total Suspended Solids	Total Alkalinity (as $CaCO_3$)	Barium	Phosphorus
Turbidity	Bromide	Beryllium	Potassium
Total Dissolved Solids	Chloride	Bismuth	Selenium
Hardness (as $CaCO_3$)	Fluoride	Boron	Silicon
Acidity	Sulphate	Cadmium	Silver
Nutrients		Calcium	Sodium
Ammonia (as N)	Total Nitrogen	Chromium	Strontium
Nitrate (as N)	Total Phosphate (as P)	Cobalt	Thallium
Nitrite (as N)	Ortho Phosphate (as P)	Copper	Tin
Total Kjeldahl Nitrogen		Iron	Titanium
Cyanides		Lead	Uranium
Total Cyanide	Cyanide, Weak Acid Dissociable*	Lithium	Vanadium
Thiocyanate*		Magnesium	Zinc
Organic Carbon		Manganese	
Total Organic Carbon			

***At monitoring sites downstream of the Processing and Tailing Management Area only.**

26.18.2.5.2 Surface Water Quantity

Stream flows are listed in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* as a core water quality measurement (BC MOE 2012). Stream discharge measurements from sampling sites are an important factor in determining loading calculations as required by MMER (SOR/2002-222), allowing comparisons with receiving environment water quality standards or waste discharge permits. Monitoring of stream flow is also important in order to confirm the assessment of the potential effects of altered stream flows associated with Project activities on fish and aquatic habitat. As such, surface water flows will be monitored at the same locations as water quality sampling sites wherever possible. A summary of general monitoring locations and frequency are provided in Table 26.18-7.

Discharge flow monitoring at the WTP and TMF discharge points will occur continuously; this is critical for ensuring discharges are properly staged with the hydrological regime of the receiving environment, and it is required by the MMER (SOR/2002-222). At other sampling locations, current velocity measurements will be conducted six to eight times annually wherever possible. This frequency was established in order to capture a wide range of flows throughout each year. Generally, measurements will be conducted monthly from June to September, with additional low flow measurements in the early spring and in late winter. Current velocity measurements will be obtained using a handheld current meter or in cases where water depth or flow velocity conditions are too high to allow field personnel to safely wade across the streams, a tracer-dilution procedure will be used.

Methods employed in the monitoring program will follow the provincial standard operating procedures as outlined by the RISC for BC (RISC 2009).

26.18.2.5.3 Sediment Quality

Sediments can act as both a sink for deleterious substances and as an important resource/habitat for primary and benthic invertebrates. Sediment quality can be affected by water quality, and adequate monitoring frequency is required to identify potential effects as early as possible. Sediment quality will be sampled annually since water quality degradation was identified as a concern, particularly downstream of the Mine Site WTP. A summary of general monitoring locations and frequency is provided in Table 26.18-7.

Sediment samples will be collected from both reference sites and sites downstream of discharge points, concurrently with water and biological samples. Stream and river sediment samples will be collected at each site using appropriate sampling equipment with the appropriate replication. Measured parameters will include moisture content, particle size, cyanides, nutrients, organic carbon, and total metal concentrations (Table 26.18-9).

Table 26.18-9. Sediment Quality Parameter List

Physical Parameters	**Organic / Inorganic Carbon**	**Metals**	
% Moisture	$CaCO_3$ Equivalent (%)	Aluminum (Al)	Mercury (Hg)
pH	Inorganic Carbon (%)	Antimony (Sb)	Molybdenum (Mo)
	Total Carbon (%)	Arsenic (As)	Nickel (Ni)
Particle Size	Total Organic Carbon (%)	Beryllium (Be)	Phosphorus (P)
% Gravel (> 2 mm)		Bismuth (Bi)	Potassium (K)
% Sand (2.0 mm - 0.063 mm)	**Plant Available Nutrients**	Barium (Ba)	Selenium (Se)
% Silt (0.063 mm – 4 µm)	Available Phosphate-P	Cadmium (Cd)	Silver (Ag)
% Clay (<4 µm)		Calcium (Ca)	Sodium (Na)
Cyanides	**Nutrients**	Chromium (Cr)	Strontium (Sr)
Cyanide, Total	Total Nitrogen	Cobalt (Co)	Sulphur (S)
	Total Phosphorus	Copper (Cu)	Thallium (Tl)
		Iron (Fe)	Tin (Sn)
		Lead (Pb)	Titanium (Ti)
		Lithium (Li)	Vanadium (V)
		Magnesium (Mg)	Zinc (Zn)
		Manganese (Mn)	

Data will be compared with both the BC and CCME sediment quality guidelines (CCME 1999a; BC MOE 2006b). The BC working guidelines are predominantly based on the CCME Interim Sediment Quality Guidelines (1999a) and Probable Effect Level guidelines. There are also working guidelines in BC for iron, nickel, selenium, and silver, which are based on the screening level concentration to give both the Lowest Effect Level and the Severe Effect Level. These sediment quality guidelines are used to evaluate the toxicological significance of sediment

chemistry data, and concentrations below such guidelines are not expected to be associated with any adverse biological effects. To fully assess whether sediment chemistry changes are due to Project activities, comparisons to both guideline limits and baseline levels will be made.

The sediment sampling frequency can be annually re-evaluated after five years of data have been collected (this timeframe should be adequate to establish a solid dataset for trend analysis), and can be subsequently reduced to once every three years if parameters are less than either sediment quality guidelines or receiving environment targets developed during the permitting process (see Section 26.18.2.4). Sampling frequency will also be re-evaluated prior to the closure and post-closure phases to ensure that appropriate monitoring levels are maintained during these phases of Project activities, once discharges have ceased from the TMF.

26.18.2.5.4 Primary Producers

The potential for water quality degradation was identified as a residual effect downstream of both the TMF and the WTP, which could affect primary producers residing in these areas due to metal exposure or bioaccumulation of metals (see Chapters 14 and 15). Periphyton are a mosaic of sessile organisms, such as algae, fungi, microbes, and detritus, that are often associated with aquatic substrates. This community often contributes the dominant proportion of the primary productivity in stream environments and, given their rapid generation rates, can respond quickly to environmental change. They are the first step in the food chain for benthic invertebrates and some fish, and may take up metals or other contaminants from their water and sediment surroundings. These qualities make periphyton an early indicator of environmental health. Monitoring of these organisms is required to confirm that mitigation measures for water quality (Chapter 14) are working to minimize effects to the productive capacity of the aquatic environment (Chapter 15). It may also serve to confirm the significance determination related to nutrient loading from blasting residue and Sewage Treatment Plant effluent (Chapter 15). A summary of general monitoring locations and frequency are provided in Table 26.18-7.

For periphyton in streams, chlorophyll *a* biomass and taxonomy samples will be analyzed to assess changes in biomass, genus richness, relative abundance, evenness, and diversity (Simpson's Diversity Index). Proper replication levels will be determined beforehand using a power analysis. All results will be compared with baseline data (Rescan 2010a) as well as between the exposure and reference site to assess for effects.

26.18.2.5.5 Benthic Invertebrates

The potential for water quality degradation was identified as a residual effect downstream of both the TMF and the WTP, which could affect benthic invertebrates residing in these areas due to metal exposure or bioaccumulation of metals, including selenium (see Chapters 14 and 15). This sampling is required to reduce uncertainty associated with the potential for residual effects (toxicity) due to bioaccumulation of selenium for fish and aquatic resources identified in Chapter 15. It may also serve to confirm the significance determination related to nutrient loading from blasting residue and Sewage Treatment Plant effluent (Chapter 15). A summary of general monitoring locations and frequency are provided in Table 26.18-7.

Benthic invertebrates, which consist predominantly of aquatic insects, are commonly used in biomonitoring programs since they are important prey items for fish. In addition, they are relatively sedentary organisms that may respond to changes in the environment, particularly to changes in biodiversity in relation to environmental conditions. These communities will be monitored in conjunction with sediment quality sampling at all monitoring sites (Table 26.18-7). Invertebrates will be monitored using the standardized Canadian Aquatic Biomonitoring Network (CABIN) protocols and the Reference Condition Approach (RCA) for site assessment. The RCA is a bioassessment tool that is recognized and approved by the BC Ministry of Natural Resource Operations (BC MOE 2012) and for environmental effects monitoring of metal mines (CCME 2002).

There are a number of environmental parameters to be measured along with the invertebrate samples as part of the CABIN protocol. These environmental parameters include canopy coverage, riparian vegetation, substrate size class, substrate embeddedness, channel slope, wetted width, bankfull width, mean wetted depth, mean velocity, air temperature, water temperature, pH, conductivity, and dissolved oxygen. The environmental data collected serves two purposes. First, some of the variables will be predictor variables for the RCA. Second, some of the environmental variables will provide background information on fish and aquatic habitat and will facilitate interpretation of the benthic invertebrate community data and the site assessment.

For each monitoring site, all samples will be collected following BC MOE, CCME, and CABIN protocols (BC MOE 2009b). The invertebrate samples will be sent to a qualified taxonomist for identification and enumeration to the lowest possible taxonomic level. Invertebrate density; richness; relative abundance; evenness; Simpson's Diversity Index; Ephemeroptera, Plecoptera, and Trichoptera genus richness; and Bray-Curtis similarities will also be calculated and compared among sites and among sampling years. Sampling results may also be compared to the results of northwest BC regional benthic invertebrate studies conducted by the BC MOE, (which also follows the CABIN protocol).

Samples will also be collected for measurement of tissue metal residues, which can be used in assessing metals that may bioaccumulate through the food chain (e.g., mercury or selenium). This has not been done previously as part of baseline studies and therefore must be done prior to initiation of construction to establish background metal concentrations in benthic invertebrates and to provide input data for potential food chain models of bioaccumulative metals. The parameters to be measured are indicated in Table 26.18-10 and are consistent with the parameters measured in fish tissue residue sampling during baseline studies. Tissue residues measured during Project operations will be compared to baseline and reference site data.

Zooplankton will also be sampled in conjunction with phytoplankton at Sulphurets Lake (potentially affected by non-contact diversion water from Mitchell Creek) and at Knipple Glacier Lake (reference lake). Replicate samples will be collected from the deepest part of the lake. The depth of deployment will be measured, and a flow meter will be used to allow for the calculation of density. Samples will be identified and enumerated to the lowest possible taxonomic level, allowing for calculations of genus richness, relative abundance, evenness, and

diversity (Shannon and Simpson's diversity indices). All measures will be compared with baseline (Rescan 2010a) and reference site data.

Table 26.18-10. Benthic Invertebrate and Fish Tissue Metal Residue Parameter List

Physical Tests	Total Metals		
Moisture	Aluminum	Copper	Potassium
	Antimony	Iron	Selenium
	Arsenic	Lead	Sodium
	Barium	Lithium	Strontium
	Beryllium	Magnesium	Thallium
	Bismuth	Manganese	Tin
	Cadmium	Mercury	Titanium
	Calcium	Molybdenum	Uranium
	Chromium	Nickel	Vanadium
	Cobalt	Phosphorus	Zinc

26.18.2.5.6 Fish

Fish (Dolly Varden, or equivalent) will be sampled every three to five years as part of monitoring requirements under the MMER (SOR/2002-222; see Section 26.18.2.2.2 of the Application/EIS). The analysis of fish tissue for the metals listed in Table 26.18-10 will also be carried out on any fish that are sampled as part of the MMER biological monitoring studies. This will be done to address uncertainties identified during the residual effects assessment with the potential for selenium bioaccumulation and toxicity in fish.

There is concern that sampling more frequently than required by the MMER (SOR/2002-222) may cause declines in Dolly Varden populations, particularly in areas where they are present in low numbers or are already experiencing stress due to existing poor water quality (e.g., Lower Sulphurets and Unuk rivers near the confluence with Sulphurets). For this reason, sampling of fish is only recommended at the frequency required by the MMER (SOR/2002-222). Benthic invertebrate tissue metal analysis will be used as an annual surrogate for estimating the potential for bioaccumulation of selenium in the food chain and in assessing the potential for toxicity to fish. The effectiveness of using benthic invertebrate tissue metals as a surrogate for assessing risk to fish from bioaccumulation and toxicity of selenium must be re-evaluated periodically. If there is too much variability in the data collected or if inadequate tissue volumes of benthic invertebrates are obtained to conduct tissue metal analysis, increased replication (to address variability) or alternative methods (e.g., caged bivalves) may be required.

26.18.2.5.7 Teigen Creek Chinook Salmon Monitoring

Predicted hydrological data from Teigen Creek, downstream of the TMF, indicates that flows may be reduced due to the construction of the TMF and diversion structures. These variations in monthly discharge lie within normal annual baseline discharge variability in Teigen Creek. Analysis indicates that significant negative effects to fish and aquatic habitat, such as chinook salmon spawning and rearing habitat, are not expected in Teigen Creek since water quantity

changes are not substantial (Chapter 15). Furthermore, South Teigen Creek flow alterations are not expected to reduce sediment transport/recruitment or lead to sediment aggregation in Teigen Creek.

Since the analysis of potential effects of Teigen Creek hydrological changes on fish and aquatic habitat was qualitative with respect to population level effects (Chapter 15), it is important to confirm the findings of the residual effects assessment with quantitative data as part of follow-up monitoring. The monitoring plan outlined below is important in addressing and alleviating concerns from Nisga'a Nation and First Nations in regard to potential effects of Project activities on Teigen Creek salmon stocks. The monitoring plan is also important in confirming the results of the Fish Habitat Compensation Plan in off-setting for habitat loss. The monitoring program would only be conducted downstream of the TMF on Teigen Creek, since this is predominantly where the salmon populations are located and where effects related to altered hydrological regime may occur. A summary of general monitoring locations and frequency are provided in Table 26.18-7.

A chinook salmon stock-recruitment monitoring program will be used to monitor adult spawning abundance and fry recruitment. It is assumed that the major factor limiting freshwater chinook salmon production is likely spawning habitat. Chinook salmon stocks disperse from spawning areas to downstream rearing habitat throughout their natal tributaries (e.g., Teigen Creek) and, in some cases, to rearing habitats in non-natal tributaries (e.g., Bell-Irving River). Parken et al. (2002) argue that spawning habitat is therefore a more likely bottleneck than juvenile rearing habitat because of downstream dispersal and the apparent large amount of downstream rearing habitat available in the Bell-Irving River. Spawning habitat limitation implies density dependence between adult spawner abundance and viable eggs remaining in the gravel following the spawning period. Indices of freshwater production are useful in that stock/recruitment relationships can be assessed in the absence of the confounding effect of variability in marine survival. For streams, the most feasible surrogate for chinook smolt abundance is late summer fry standing stock. Adult-to-fall fry stock/recruitment data are useful for evaluating habitat-based model predictions of stock/recruitment parameters for Teigen Creek chinook salmon.

The chinook salmon monitoring program is intended to develop the stock/recruitment relationship using paired fry and spawner abundance data and to evaluate flow changes and freshwater carrying capacity in Teigen Creek. On an annual basis (up to 10 years of the Project operation phase), chinook salmon escapement data will be obtained through redd and adult counts during the months of August and early September. Surveys will be conducted 7 to 10 days apart until new fish and redds are no longer observed. Redd longevity and observer efficiency in redd detection will be estimated by tracking the condition of individual redds measured from previous surveys. Chinook salmon fry abundance data will be obtained through backpack electrofishing and/or grid electrofishing. Sampling of a subset of removal and/or mark-recapture sites will be conducted to calibrate single pass sites. All fish caught will be identified to species, enumerated, and measured for length and weight. A stock recruitment relationship will be developed to monitor the predicted results of the effects assessment.

To monitor the accuracy of the significance determination in the environmental assessment, a habitat monitoring program would also be used to monitor sediment transport/recruitment in

Teigen Creek. The monitoring program will include hydraulic geometry, habitat surveys, monitoring of cross sections for scour and fill, sediment source sampling, and assessment.

Baseline data exist for Teigen Creek chinook salmon; however, the data collection methods need to be modified for annual comparison purposes and to develop the stock recruitment relationship. Pre-construction data collection is required prior to the beginning of construction. Once construction is completed, the monitoring program will continue for the first 10 years of the Project operation phase, since years 0 to 45 is the stage with the greatest hydrological change compared to the other TMF stages. The monitoring program will be discontinued after 10 years if the data suggest that hydrological changes in Teigen Creek are not having a significant effect on chinook salmon stocks or fish habitat. Portions of the Teigen Creek chinook salmon monitoring could be combined with fish habitat compensation studies, wherever possible, to minimize the duplication of efforts between monitoring programs.

26.18.2.5.8 Stream Temperature Monitoring

Qualitative assessment of water temperature downstream of the TMF in South Teigen, North Treaty, and Treaty creeks suggested that the discharge of warmer water from the TMF is unlikely to have adverse effects on fish or aquatic habitat due to changes in ambient water temperature (Chapter 15, Fish and Aquatic Habitat). However, the extent of potential change in water temperature downstream of the TMF was not estimated quantitatively, so follow-up monitoring will be done to confirm the assessment that effects to fish or aquatic habitat are unlikely (Chapter 15).

To ensure that temperature fluctuation due to water quantity changes will not affect fish communities, temperature changes in South Teigen, North Treaty, Teigen, and Treaty creeks will be monitored for the first six years of the Project operation phase (to coincide with two cycles of fish community and biology sampling required under the MMER [SOR/2002-222], Section 26.18.2.2.2). Data collection is required prior to TMF construction in all creeks. Temperature data loggers will be installed in South Teigen Creek, Teigen Creek, North Treaty Creek, Treaty Creek, and a reference creek, in conjunction with hydrometric monitoring wherever possible. A summary of general monitoring locations and frequency is provided in Table 26.18-7.

Water temperatures will be assessed annually until Year 6 of Project operation. Data will be compared to baseline creek temperatures, reference creek temperatures, and discharge water temperatures to determine whether significant temperature changes occur as a result of Project construction and operation. This component of the AEMP will continue until data suggest that temperatures in these creeks are not different compared to baseline creek temperatures or reference creek temperatures. This program may also be terminated if results of the biological effects monitoring program (periphyton, benthic invertebrates, fish) required under the MMER (SOR/2002-222) indicate that there are no significant changes in these endpoints in six consecutive years (two cycles of biological monitoring).

26.18.2.5.9 Data Interpretation and Additional Actions

A series of caution, warning, or trigger levels may be developed to increase the speed at which alterations in the receiving environment are detected. These levels will refer to environmental targets or criteria that will provide advance warning that guideline concentrations, toxic effect

thresholds, or the rate/degree of environmental change (trend analysis) are approaching potentially problematic levels. This would facilitate the implementation of early mitigation or other adaptive management strategies. The caution, warning, or trigger levels will be developed in consultation with regulators as part of the permitting process, particularly for those chemicals of potential concern that are greater than water quality guidelines under baseline conditions.

In addition to the use of caution, warning or trigger levels, the guiding principles provided in the *Metal Mining Technical Guidance for Environmental Effects Monitoring* document will also be applied to the data collected to meet CEAA requirements (Environment Canada 2012c). In the event that the same, statistically significant alteration is detected in a biological endpoint (i.e., measured in primary producers, benthic invertebrates, or fish) in two consecutive monitoring studies, the next annual study to be done must determine the geographic extent and magnitude of the significant effect (if it was not apparent from the previous studies). Once the extent and magnitude of the significant effect is established, the subsequent annual study must then investigate the cause of the effect. Based on the studies of geographic extent, magnitude, and cause of the significant effect, additional monitoring or mitigation measures may be required.

If further attenuation of water quality parameters is required downstream of the Mine Site area as demonstrated by the results of the EEM effluent monitoring studies (26.18.2.2.1), biological (26.18.2.2.2) monitoring studies, or CEAA follow-up monitoring studies (26.18.2.5), the WTP effluent may be discharged to a constructed wetland that will drain to lower Mitchell Creek (Figure 4.5-67A). Some attenuation of water quality parameters (i.e., nutrients) would be expected.

Other monitoring or mitigation measures may include the development of a food chain model to predict fish tissue metal residues, a risk assessment to determine the actual ecological/toxicological risk and implications posed by the significant alteration, new or altered water treatment methods or mitigation strategies, or other adaptive management strategies designed to decrease the extent, magnitude, or cause of the effect.

26.18.3 Fish Salvage Plan

Prior to development, all proponents are required, as a condition of a *Fisheries Act* (1985c) authorization, to conduct a fish salvage program on watercourses that will be affected. The KSM Project proposes to develop a TMF which is located within portions of the South Teigen and North Treaty watersheds. The only fish present in the TMF are Dolly Varden, and these fish must be removed.

Dolly Varden from South Teigen and North Treaty watersheds are not suitable for human consumption because of their small size (maximum length of 210 mm; Rescan 2010b). Dolly Varden will be permanently relocated to nearby suitable habitats.

General fish salvage programs have been developed for lake environments lost due to mining developments (DFO 2008, 2010). However, guidelines have not been developed for stream or wetland environments. This plan is intended to provide a general fish salvage and study design program for stream and wetland environments using principles developed by DFO. It is expected

that more specific details beyond those contained within this general program will be developed and refined as circumstances dictate.

26.18.3.1 Objectives

The overall objectives of the Fish Salvage Plan include the following:

- fulfill the Proponent's legal obligations to conduct a fish salvage program within the TMF, as required under Schedule 2 of the MMER (SOR/2002-222);
- allow for survival of fish located within the TMF footprint;
- develop methods to ensure that all fish are removed from the South Teigen and North Treaty watersheds and are relocated to a suitable location in an appropriate manner; and
- confirm baseline data on fish population abundance and structure in the South Teigen and North Treaty watersheds of the TMF.

Fish salvage programs provide an opportunity to:

- collect accurate data on the number, age, growth, and condition of fish being removed;
- test the accuracy of mark-recapture methods of population estimation, as well as methods of population estimation that are based on multiple-pass depletion methods; and
- test links between the spatial distribution of fish and habitat characteristics such as gradient and cover.

To confirm fish population abundance and structure in the South Teigen and North Treaty watersheds of the TMF, the Fish Salvage Plan objectives are to:

- use the decline in catch-per-unit-effort (CPUE) over the duration of the salvage period as the primary method of confirming that the fish salvage program successfully removed all Dolly Varden from the TMF footprint; and
- use baseline Dolly Varden density data (Rescan 2010b) to compare with mark-recapture data and to the total number of fish removed from mark-recapture sites during the CPUE/removal phase.

Details of the Fish Salvage Plan are presented below, including project management, field methods, and reporting, and the plan schedule.

26.18.3.2 Project Management

A Registered Professional Biologist will oversee the KSM Project Fish Habitat Compensation Plan implementation and resulting Fish Salvage Plan. This development will include meetings with DFO, the BC MOE, and Aboriginal groups. All permits required for the Fish Salvage Plan will be obtained.

26.18.3.3 Field Methods

26.18.3.3.1 General

The fish salvage field program is divided into three phases:

- **mark-recapture:** site selection and exclusion with block nets, marking and recapture of fish within a sub-sample of sites;
- **CPUE/removal:** intensive removal with an electrofisher for stream environments and minnow traps for wetland environments beginning 48 hours after the end of the marking phase to remove all Dolly Varden from individual watercourses; and
- **relocation:** transfer of removed fish to suitable locations.

26.18.3.3.2 Mark-recapture

Fieldwork

Following freshet and prior to snowfall (July to October), a subsample of stream and wetland sites will be selected for mark-recapture population estimates. Site selection will vary depending upon habitat conditions (i.e., percent cover and substrate composition), channel gradient, and location within watershed (i.e., tributary or mainstem).

Blocking nets, with proper mesh size to prevent fish escapement, will be installed at upstream and downstream ends of site boundaries. The entire bankfull width will be blocked to prevent fish immigration and emigration to/from the site. For stream habitats, one pass with a backpack electrofisher will be conducted in an upstream direction within the site boundaries. Baited minnow traps will be set within wetland habitats for a 24-hour period.

All captured fish will be counted, identified to species and life history stage, and marked with a partial fin clip. Based on 2009 fork length class distribution sampling data from the Teigen and Treaty watersheds (Rescan 2010b), Dolly Varden fry are 25 to 45 mm long, parr are 45 to 85 mm long, and subadults and adults are greater than 85 mm long. All fish will be measured for fork length to the nearest 1 mm and will be weighed to the nearest 0.1 g. A subset of aging samples (scale and pelvic fin ray) will be collected from fish greater than 85 mm in length. Effort will be made to minimize stress to fish and to return the marked fish to the water as soon as possible.

Habitat assessments will be conducted at each mark-recapture site. Habitat unit composition (riffle, cascade, glide, and pool) will be determined, and then an array of habitat and channel attributes will be collected for each habitat unit. These attributes include data on substrate composition, cover for fish, and fish habitat type.

At a subset of locations, blocking nets will be maintained for a 48-hour period, and a second sampling event will be conducted using the same methods previously discussed; recaptures will be counted, and fish will be removed from the site for relocation. The second sampling event will be conducted at the same time as the CPUE/removal phase of the fish salvage program.

Analysis

During the mark-recapture phase, unbiased closed population abundance estimates will be derived using the adjusted Petersen method (Ricker 1975). The equation is:

$$N = [(M + 1)*(C + 1)]/(R + 1)$$

Where N = the total number of Dolly Varden at a stream site at the time of marking; M = the total number of Dolly Varden that were marked by the end of the first sampling event; C = the total number of Dolly Varden caught during the second sampling event; and R = the number of marked Dolly Varden that were recaptured during the second sampling event. The 95% confidence limits of N will be estimated using methods described in Ricker (1975).

The abundance estimate and density estimates derived from baseline studies (Rescan 2010b) will be compared to the total number of Dolly Varden removed from mark-recapture sites during the CPUE/removal phase.

26.18.3.3.3 Catch-per-unit-effort/Removal

The removal phase will commence 48 hours after the first mark-recapture event. Removal will commence on tributaries and wetlands of South Teigen and North Treaty creeks, followed by mainstream reaches. A permanent blocking net, with proper mesh size to prevent fish escapement, will be installed at tributary confluences for each stream/wetland. The entire bankfull width will be blocked to prevent fish immigration and emigration to and from the stream during the entire removal phase.

For tributaries, backpack electrofishing will be conducted in an upstream direction from the confluence blocking net to the point of "end of fish use." The point of "end of fish use" was determined and mapped during 2009 baseline fish and fish habitat assessments for each watercourse (Rescan 2010b). Four consecutive passes will be conducted, one hour apart, to reduce fish electrofisher avoidance/concealment behaviour. Furthermore, each pass will include sampling mark-recapture sites. After a 24-hour period, a fifth electrofishing pass will be conducted. Depending on the catch results of the fifth pass and comparison with previous pass catch results, subsequent passes may be required. The CPUE/removal objective is no catch following an electrofishing pass. Upon removal of all fish from a tributary, mark-recapture block nets will be removed, and the confluence block net will be maintained for the duration of the fish salvage program to ensure that there will be no fish movement from the mainstem to tributaries.

Wetland fish removal methods are similar to those previously discussed for tributaries, except baited minnow traps will be set for a 24-hour period.

Fish removal for mainstem reaches of South Teigen and North Treaty creeks will commence upon removal of fish from tributaries and wetlands. Mainstem fish removal methods are similar to those previously discussed for tributaries. Depending upon discharge, velocity, and water clarity conditions of South Teigen Creek, alternative gear types such as pole seines may be used for fish removal.

The declining CPUE, to a target of zero catch during the removal phase, will be used to confirm the removal of all fish from a stream.

All captured fish will be processed in the same manner as previously discussed for mark-recapture sites. However, all captured fish will be placed in an aerated live well for relocation.

26.18.3.3.4 Relocation

During the removal phase, all captured fish will be transferred to large aerated live wells. The fish will then be transferred and distributed, by helicopter, throughout Treaty Creek mainstem for immediate release. Treaty Creek was selected as appropriate for relocation because of the following:

- Dolly Varden is the most abundant species within Treaty Creek, suggesting suitable biological and physical conditions for survival, growth, and reproduction.
- The low abundance of bull trout reduces the risk of increased hybridization.
- There is a large area of suitable rearing and overwintering habitat available for Dolly Varden.
- There is abundant Dolly Varden spawning habitat within Treaty Creek tributaries.
- The short distance from the TMF provides similar genetic stock and maximizes the survival of relocated fish (Rescan 2010b).
- North Treaty Creek is located within the Treaty Creek watershed.

26.18.3.4 Reporting

The data collected during the fish salvage program will be presented in a technical report that will be provided to the DFO, the BC Ministry of Environment, and Aboriginal groups. The report will describe and discuss the objectives, methods, and results of the program. All data will be shown as appendices.

The report will compare the total number of Dolly Varden removed with estimates of the total number from mark-recapture, density, and CPUE-based methods.

The report will summarize the biological characteristics of the Dolly Varden population in the South Teigen and North Treaty watersheds, including length frequencies, weight-length relationships, age frequencies, and length-age relationships.

26.18.3.5 Schedule

The commencement of the fish salvage plan will be dependent upon the TMF construction schedule. However, fisheries field sampling/salvage is restricted to after freshet and prior to snowfall (July to October). Data analysis and reporting will begin once the fieldwork has been completed.

26.18.3.6 Reporting and Responsible Persons

Reporting on the fish salvage plan will ultimately be the responsibility of the Environmental Superintendent and delegates. Reports will be submitted to the appropriate regulatory agencies as required. The BC Ministry of Environment requires reporting on fish salvage plans to provide

feedback on the salvage permit, and the DFO may also require feedback as a permit condition of the authorization for the TMF fish habitat compensation plan fish salvage.

26.19 Wetlands Management Plan

The Wetlands Management Plan was developed to reduce potential effects to wetlands in the Project area during construction and operation. This plan also considers operational requirements and the safety of Project employees. The overall objective of this management plan is to minimize effects on wetlands through implementing targeted activities, monitoring, and adaptive management.

26.19.1 Wetlands Management Plan Rationale

The Wetlands Management Plan outlines strategies for wetland management based on targets related to wetland hydrological, biochemical, and habitat function. As wetlands are ecosystems at the transition between aquatic and terrestrial environments, they contain a number of elements associated with both environments. Therefore, the maintenance of aquatic elements and functions are best achieved by following aquatically appropriate management plans, while maintenance of terrestrial elements and functions are best achieved by following terrestrially appropriate management plans. Management plans developed for the KSM Project include components that apply to wetlands but that do not necessarily state that they have any specific wetland-related target or objective. For example, the Terrestrial Ecosystems Management and Monitoring Plan addresses invasive plant management. Following this plan will support wetland ecological function, although that specific target is not referenced in the plan. Applicable management plans and their relationship to wetland management targets are summarized in Table 26.19-1.

Table 26.19-1. Management Plans and Associated Wetland Management Target

Target	Management Plans
Minimize a loss of wetland extent	Traffic and Access Management Plan
Maintain hydrological function	Terrain, Surficial Geology and Soil Management and Monitoring Plan and Water Management Plan
Maintain biochemical function	Terrain, Surficial Geology and Soil Management and Monitoring Plan; Water Management Plan; Spill Prevention and Emergency Response Plan
Maintain ecological function	Terrestrial Ecosystems Management and Monitoring Plan; Terrain, Surficial Geology and Soil Management and Monitoring Plan
Maintain habitat function	Fish and Aquatic Habitat Management Plan; Wildlife Management Plan; Noise Management Plan; Domestic and Industrial Waste Management Plan; Traffic and Access Management Plan

26.19.1.1 Legislation and Standards

There are a number of federal and provincial policy statements and acts pertaining to wetland aspects such as function, wildlife, and fish habitat; these include:

- *Federal Policy on Wetland Conservation* (Environment Canada 1991);

- *Migratory Birds Convention Act* (1994);
- *Species at Risk Act* (2002d);
- *Fisheries Act* (1985c); and
- BC *Wildlife Act* (1996q).

Cox and Cullington (2009) developed a series of draft BMPs for a variety of industries in BC. The following key management practices were developed for mine construction, operation, and reclamation:

- protect unaffected wetlands;
- control leaching and sedimentation;
- ensure that the dewatering production process does not affect wetland hydrology;
- limit the effects of noise;
- re-vegetate using pre-development area species;
- use low impact re-vegetation techniques;
- re-establish functional wetland loss; and
- monitor enhancement, restoration, and creation activities to ensure success (Cox and Cullington 2009).

The BMPs also emphasize caution around planning, construction, and use of trails and roads because they can:

- be a major source of sediment;
- cause habitat loss and/or fragmentation through infilling or dewatering;
- enable invasive species encroachment; and
- provide opportunities for recreational impacts (Cox and Cullington 2009).

Riparian ecosystems, which can include wetlands, are protected by the *Forests and Range Practices Act* (2002c). Recommendations for management zones around riparian and wetland areas are contained within the Forest Practices Code *Riparian Management Area Guidebook* (BC MOF and BC MOE 1995). Furthermore, the provincial BMPs (BC MOF 2012) recommend that developers avoid ecosystems listed by the BC Conservation Data Centre.

26.19.1.2 Objective

The objective of the Wetlands Management Plan is to maintain affected wetlands to levels of functionality similar to baseline conditions.

26.19.1.3 Targets

Targets for managing wetland ecosystems include:

- minimal loss of wetland extent beyond what was predicted in the effects assessment;
- maintaining hydrological function associated with the area's wetlands within the potentially affected area;
- maintaining biochemical function associated with the area's wetlands within the potentially affected area;
- maintaining habitat function associated with the area's wetlands within the potentially affected area; and
- maintaining wetland ecological function by minimizing loss of wetland extent and maintaining other wetland functions (hydrological, biochemical, and habitat).

26.19.1.4 Actions to Avoid, Control, and Mitigate

26.19.1.4.1 General Management Considerations

Access management plans for each proposed construction location will be developed to minimize the disturbance to wetlands through avoidance, or by limiting construction activities to wetland margins.

Construction and operation activities shall be conducted such that damage to vegetation and soil will be minimized by:

- limiting disturbance to low-growing shrubs, herbs, and graminoids;
- using low ground pressure equipment or hand methods in areas of saturated organic soils; and
- avoiding watercourse alterations and discharges to/within wetlands.

Development within wetlands will be confined to wetland margins and away from hydrologically active areas such as seeps, rivulets, or ponded areas.

If construction of transmission lines overlaps in wetlands, sites should be selected in order to maximize conductor ground clearance.

Mitigation activities are summarized in Table 26.19-3.

26.19.1.4.2 Specific Management Considerations

Avoiding wetlands and establishing wetland buffers will be the primary way to minimize Project effects on wetland extent and function. Maintaining extent is the best way to maintain function; however, mitigation measures for specific targets (extent and individual functions) are described below.

Preventing Loss of Wetland Extent

Buffers will be established around wetlands in accordance with the *Riparian Management Area Guidebook* (BC MOF and BC MOE 1995). The guidebook calls for the establishment of buffers around wetlands, depending on whether wetlands are in complex and on their size. Wetlands in

complex and large wetlands have large buffers, whereas simple wetlands and small wetlands have small buffers. Two types of buffers are proposed:

- **Wetland Reserve Zone —** an area of wetland where no development or activities should take place; and
- **Wetland Management Zone —** an area surrounding a wetland where limited activities can take place.

The smallest reserve zone (10 m) proposed in the guidebook (BC MOF and BC MOE 1995) will be extended to all wetlands. This will provide adequate protection of the vegetation, soil, and hydrological constituents of wetlands, which will maintain their extent and function.

Wetland Management Zones will be extended (if possible) beyond the 10 m reserve zone to a distance of:

- 20 m for any wetland less than 5 ha;
- 40 m for all wetland complexes; and
- 30 m for all wetlands greater the 5 ha (Table 26.19-2).

Table 26.19-2. Wetland Buffer Guidelines

Environmental Feature	Reserve Zone	Management Zone
Small Wetlands (1 – 5 ha)	10 m	20 m
Large Wetlands (> 5 ha)	10 m	30 m
Wetland Complexes	10 m	40 m

Light activities, such as access, sediment and erosion controls, and targeted vegetation clearing will be permitted within the Wetland Management Zone; however, permanent features such as buildings and main roads will be located outside this zone wherever possible. Following recommendations in the Traffic and Access Management Plan will also help meet the target of minimizing a loss of wetland extent.

Maintaining Hydrological Function

Maintaining wetland hydrology is often the key to maintaining a viable wetland. To this end, water management is important. Thus, to ensure that hydrological function is maintained, it is crucial to follow the Terrain, Surficial Geology and Soil Management and Monitoring Plan. Sediment and erosion control measures will include:

- installing effective sediment control and protection strategies prior to initiating construction or operation activities (silt fences, sumps, proper ditching/culverts, etc.);
- regularly inspecting these devices and conducting maintenance or replacement when required;

- implementing erosion and slope protection measures on disturbed soils and covering all organic and mineral soil stockpiles (developing stockpiles away from surface water, skirting with silt fences, re-vegetation, etc.);
- minimizing vegetation clearing;
- minimizing exposed soils;
- minimizing construction and operation activities during unfavourable weather conditions such as high precipitation events; and
- conducting site restoration as soon as possible to re-establish ground cover.

Maintaining Biochemical Function

Wetland biochemistry affects the quality of the water within wetlands and water that is discharged from wetlands to surface water and groundwater reserves. Maintaining biochemistry involves following the recommendations of the Water Management Plan; the Terrain, Surficial Geology and Soil Management and Monitoring Plan; and the Spill Prevention and Emergency Response Plan. Tracking water sampling results, sampling frequencies, and threshold limits will ensure that water quality is consistent and that it is within appropriate water quality guidelines by allowing the implementation of adaptive management strategies such as changing discharge locations, treatment, and retention times.

Spill prevention and emergency response is intended to prevent and mitigate the effects of deleterious substances discharged into wetlands. It also provides emergency response procedures should a spill occur. Spill prevention and emergency response measures include:

- storage, handling, and labelling of fuels and other hazardous substances away from wetlands and waterbodies;
- implementing equipment and servicing procedures such that servicing and maintenance occur in designated areas away from aquatic features;
- details on the location and nature of spill response equipment;
- spill response, reporting, and notification procedures; and
- containment, recovery, and clean-up procedures and training.

Hydrocarbon sampling will be required if a spill of petroleum hydrocarbons occurs within a Wetland Reserve Zone, Wetland Management Zone, or waterbody directly connected to a wetland.

Maintaining Habitat Function

Wetland habitat function includes providing aquatic, semi-aquatic, and transition environments that are used by a variety of fish and wildlife. Thus, the following fish and wildlife management plans will see the habitat function for wetland-dependant species maintained.

Fish and aquatic habitat located in or associated with wetlands will be protected by strategies identified in the Fish and Aquatic Habitat Management Plan. Specific activities for managing aquatic habitat include:

- minimizing removal and disturbance of low-growing shrub, herb, or grass species;
- avoiding grubbing;
- modifying riparian vegetation by hand, where practical; machinery shall only operate from outside the Wetland Reserve Zone (10 m) and in a manner that minimizes disturbance to aquatic habitat;
- directional felling of trees away from the waterbody; and
- preserving root structure and stability of topped trees.

Wildlife and wildlife habitat areas that are located within or are associated with wetlands are to be protected by strategies identified in the Wildlife Management Plan, the Noise Management Plan, the Domestic and Industrial Waste Management Plan, and the Traffic and Access Management Plan. These plans provide additional guidance for mitigation of effects.

The primary targets for wildlife protection include:

- protecting wildlife, birds, and amphibians;
- protecting species richness and abundance; and
- protecting bird nests, mammal dens, and hibernaculum.

Strategies for wildlife habitat protection include minimizing loss of high quality habitat and maintaining access. Specific activities for managing terrestrial and aquatic wildlife habitat include:

- minimizing riparian vegetation clearing;
- wildlife tree retention;
- minimizing effects of construction and operation-related light and noise on wildlife; and
- avoiding construction and operation activities, especially vegetation clearing, during sensitive periods.

If construction and operation activities must take place within sensitive periods, appropriate pre-construction and operation surveys are to be conducted to ensure minimal risk to wildlife, birds, and amphibians. Sensitive periods, specific guidelines, and applicable legislation for species of concern are presented in the Wildlife Management Plan (Section 26.21).

Mitigation activities are summarized in Table 26.19-3.

26.19.1.5 Monitoring

Monitoring programs are recommended to assess ongoing effects of construction and operation and to identify changes in wetland ecosystems that may trigger additional mitigation. Specific monitoring programs will be instituted within each associated management plan referenced in the Wetlands Management Plan to ensure that mitigation measures and strategies are effective. A specific wetland monitoring program will be instituted under the Project Aquatic Effects Monitoring Plan. Activities specific to the wetland monitoring section will include:

- vegetation sampling for biomass and tissue metal concentrations (at select sites); and
- photo point monitoring to evaluate changes in vegetation and site characteristics (at select sites).

Table 26.19-3. Summary of General and Specific Mitigation Activities

Level of Action	Wetland Management Target	Timing	Activity	Monitoring[1]
General	Minimize loss of wetland extent	Construction	Develop Construction Management Plan for construction locations	
	Maintain hydrological, biochemical, ecological, and habitat functions	Construction	Site transmission lines to maximize conductor ground clearance	Monitoring will be conducted at select sites to assess changes in vegetation biomass, and photo point monitoring at select sites will be conducted to assess changes in site ecology
	Maintain hydrological, biochemical, ecological, and habitat functions	Construction and Operation	Avoid clearing low-growing shrubs, herbs, and graminoids	Monitoring at select sites will be conducted to assess changes in vegetation biomass
	Minimize loss of wetland extent, and maintain hydrological, biochemical, ecological, and habitat functions	Construction and Operation	Use low ground pressure equipment or hand methods in areas of saturated organic soils	Monitoring at select sites will be conducted to assess changes in vegetation biomass
	Maintain hydrological, biochemical, ecological, and habitat functions	Construction and Operation	Avoid watercourse alterations and discharges to/within wetlands	Monitoring at select sites will be conducted to assess changes in tissue concentrations of metals
	Minimize loss of wetland extent	Construction and Operation	Confine any development within wetlands to wetland margins, and avoid hydrologically active areas such as seeps, rivulets, or ponded areas	Photo point monitoring will be conducted at select sites to assess changes in site ecology
Specific	Minimize loss of wetland extent	Construction and Operation	Establish buffers in accordance with Table 26.19-2	Monitoring at select sites will be conducted to assess changes in vegetation biomass, and photo point monitoring will be conducted at select sites to assess changes in site ecology

(continued)

Table 26.19-3. Summary of General and Specific Mitigation Activities (completed)

Level of Action	Wetland Management Target	Timing	Activity	Monitoring[1]
	Maintain hydrological, biochemical, ecological, and habitat functions	Construction and Operation	Follow Terrain, Surficial Geology and Soil Management and Monitoring Plan	Monitoring at select sites will be conducted to assess changes in vegetation biomass, and photo point monitoring will be conducted at select sites to assess changes in site ecology
	Maintain hydrological, biochemical, ecological, and habitat functions	Construction and Operation	Follow Water Management Plan; Terrain, Surficial Geology and Soil Management and Monitoring Plan; and Spill Prevention and Emergency Response Plan	Monitoring will be conducted at select sites to assess changes in vegetation biomass, and photo point monitoring at select sites will be conducted to assess changes in site ecology
	Maintain ecological and habitat functions	Construction and Operation	Follow Fish and Aquatic Habitat Management Plan and Wildlife Management Plan	Photo point monitoring will be conducted at select sites to assess changes in site ecology

[1] **Monitoring activities presented in this table are detailed in Section 26.19.1.5**

Vegetation sampling for biomass will occur at select sites to track potential changes to vegetation cover and biomass. Sites that are subject to surface disturbance or vegetation clearing—or that are proximate to development—and reference locations will be selected for monitoring. Sampling will identify the response of site vegetation to construction and operation activities and will identify if changes to wetland ecology are occurring.

Vegetation sampling will occur at select sites to track the concentrations of tissue metals. Sites subject to dustfall, site water runoff, and reference locations will be selected for monitoring. Sampling will identify the concentrations of metals within vegetation, which will be used to identify if changes are occurring to wetland biochemistry.

Photo point monitoring is a tool used to track subtle changes to ecosystems over time. Photo point monitoring is a monitoring tool that uses photographs taken at locations across multiple years to track changes to vegetation composition. As this is a scientific monitoring tool, the camera location, focal length, and photograph centre are all fixed. Each year, a biologist trained in photo point monitoring and surveying will re-establish the camera mount, align the camera in the desired direction, establish site markers, and take a series of high resolution digital photographs. The scale of the photographs will be calculated based on measuring the size of features in the photograph. Delineations of vegetation layers within these photographs will be

digitized and analyzed for consistency between years. Additionally, photo point monitoring will occur on the same day every year, to control for seasonal variations. A photo point network will be established to document changes to wetlands at sites that are:

- subject to surface disturbance;
- subject to vegetation clearing;
- proximate to development;
- susceptible to dustfall;
- susceptible to site water runoff; and
- reference locations.

Photo point monitoring will occur annually during construction and operation, and will follow standard protocols described in the *Photo Point Monitoring Handbook* (Hall 2002).

26.19.1.6 Reporting

The wetland monitoring program requires an annual report, which will include an analysis of results compared between years (i.e., baseline and annual monitoring) and recommendations (if any) for changes to wetland monitoring and management practices and reporting frequency. It is expected that once changes stabilize, reporting frequencies can and will be reduced.

26.19.1.7 Responsible Person

The Project's Environmental Manager will ultimately be responsible for the development, implementation, and monitoring of the Wetlands Management Plan. Senior and technical environmental staff, as well as environmental monitors, may be employed throughout the construction and operation phases to supervise, direct, monitor, and implement the management strategies.

26.20 Terrestrial Ecosystems Management and Monitoring Plan

Goal

The overall goal of the Terrestrial Ecosystems Management and Monitoring Plan is to minimize effects on vegetation and terrestrial ecosystems resulting from the construction, operation, closure, and, post-closure activities of the KSM Project, and to present vegetation management recommendations that are environmentally responsible, realistic, and operationally feasible. Four separate subcomponent EMPs have been prepared to address terrestrial ecosystem management and monitoring needs and are described below:

- Vegetation Clearing Management Plan;
- Invasive Plant Management Plan;
- Transmission Line Management Plan; and
- Terrestrial Plant Tissue Metal Concentrations Monitoring Plan.

Each of the management plans considers potential effects on terrestrial ecosystems and references applicable legislation and/or best management practices. Based on the initial management results, it may be necessary to review and adapt the plans as best management practices and recommendations, legislation, or requirements from regulatory agencies evolve over time. At the regional level, recommendations within the management plans will help achieve the biodiversity-related objectives of the Cassiar Iskut-Stikine Land and Resource Management Plan (BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (BC MFLNRO 2012).

Objectives

The four subcomponent Terrestrial Ecosystems EMPs focus on the following objectives:

- minimizing vegetation loss and disturbance of ecosystems (with emphasis on identified sensitive ecosystems) resulting from land clearing and vegetation maintenance activities;
- avoiding the introduction and subsequent spread of invasive plant species (with emphasis on regionally-important plant species); and
- monitoring metal concentrations in terrestrial plant tissues to minimize potential risk to human and wildlife health.

26.20.1 Vegetation Clearing Management Plan

The Vegetation Clearing Management Plan is designed to minimize the effects of vegetation clearing and vegetation degradation (secondary vegetation loss and disturbance) linked to clearing activities. Mitigating the loss of ecosystem function is of critical importance. Ecosystem functions include habitat, hydrological, water quality, and soil stability functions. Where applicable, to maintain consistency across disciplines, reference is made to other management plans. Vegetation clearing activities may occur during the construction, operation, and closure phases; as such this plan is applicable to each phase.

26.20.1.1 Legislation and Standards

The following legislation, guidelines, operational statements, and governing agencies establish the provincial framework for vegetation clearing activities (as part of overall vegetation management):

- *Forest and Range Practices Act* (2002c): Forest Planning and Practices Regulation (BC Reg. 14/2004), Sections 47 to 52. This Act and Regulation apply constraints to when, where, and how forest clearing is undertaken (for forest and range licensees), and applies to the protection of old forests (through establishment of old-growth management areas) and riparian ecosystems (through Division 3, Riparian Areas, of the Forest Planning and Practices Regulation). The riparian reserve and management zones are consistent with those previously established under the *Forest Practices Code of British Columbia Act* (1996e).
- *Operational Statement: Maintenance of Riparian Vegetation in Existing Rights of Way* (DFO 2007g). This statement, applicable to freshwater systems within BC and the Yukon, applies only to existing rights-of-way at locations where they intersect and cross a waterbody; it outlines measures to protect fish and fish habitat by maintaining riparian vegetation function to ensure compliance with the *Fisheries Act* (1985c).

- *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2006c). This guidebook outlines pertinent legislation and development guidelines to protect environmentally valuable features and habitats.
- BC Conservation Data Centre. This provincial agency, part of the Environmental Protection and Sustainability Division in the BC Ministry of Environment, collects and disseminates information on the plants, animals, and ecosystems (ecological communities) at risk in BC.
- *BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010). This handbook brings together a significant body of work that has been ongoing throughout BC over the last 20 years. It provides an overview of the windthrow management framework and outlines hazard assessment, windthrow risk, best management practices, and monitoring programs.

26.20.1.2 Targets

Specific Vegetation Clearing Management Plan targets are to:

- provide general management recommendations to minimize vegetation loss and disturbance;
- minimize vegetation loss and disturbance within ecosystems recognized by the BC Conservation Data Centre as red- and/or blue-listed (listed or at-risk ecosystems);
- minimize vegetation loss and disturbance within riparian ecosystems through adherence to legislated reserve and/or management zones;
- minimize reduction in ecosystem function; and
- minimize potential for windthrow effects along new forest edges resulting from vegetation clearing.

26.20.1.3 Actions to Avoid, Control, and Mitigate

This section provides recommended management actions to help avoid and mitigate adverse effects of vegetation clearing. It has been subdivided into two categories to address general management for all ecosystems and management within sensitive ecosystems. Although minor clearing may occur within subsequent phases, the management actions pertain largely to the construction phase, when most of the disturbance to vegetation will occur.

General Management Considerations

General management actions recommended to minimize loss and disturbance include the following:

- Ensure clearing activities are coordinated with relevant provisions of other management plans, including the Air Quality Management Plan (Section 26.11); the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Section 26.13); the Fish and Aquatic Habitat Management Plan (Section 26.18); and the Wildlife Management Plan (Section 26.21). The latter EMP has identified sensitive periods (e.g., for nesting birds, denning bears, and within ungulate winter ranges) as well as other buffering (e.g., for

active dens or nests) and management requirements (e.g., vegetation maintenance and woody debris retention).

- Minimize all clearing dimensions, regardless of clearing size or ecosystem affected. This requires planning when harvesting in order to not create danger trees and windthrow. Clearings must be sized to meet management objectives only.
- Preferentially retain mature and old trees (older than 80 years), where the option exists to remove only younger stands.
- Adopt low-disturbance methods to clear vegetation within identified sensitive areas, where clearing cannot be avoided. In such areas, vegetation maintenance and removal techniques such as pruning, mowing, girdling, topping, and select tree removals allow root systems to remain intact, help bind the soil, and encourage rapid colonization of low-growing plant species (BC MOE 2010a).
- Minimize the destruction of or damage (e.g., from scarring) to trees, native shrub species, and ground cover within sensitive areas. For example, hand-clearing (slashing) of understory vegetation avoids the damage typically caused by large machinery.
- Consult the *BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010) for guidance in assessing windthrow risk and for developing prescriptions to reduce the risk of windthrow hazard linked to vegetation clearing activities.
- Re-vegetate or seed as soon as possible/feasible, in accordance with the Erosion Control Plan.

Management in Sensitive Ecosystems

In addition to the general management prescriptions outlined in the previous section, the management of sensitive ecosystems is addressed by specific management plans and regulations. The Cassiar Iskut–Stikine Land and Resource Management Plan (BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (BC MFLNRO 2012) contain objectives pertaining to the conservation and preservation of sensitive ecosystems, including red- and blue-listed, riparian, and old forest ecosystems. Although listed ecosystems are not specifically protected under current legislation, the BC Conservation Data Centre maintains the lists since the listed ecosystems exhibit characteristics, trends, or distributions that require special management (BC MOE 2011a).

Within BC, riparian areas are protected under several acts and regulations, including the Forest Planning and Practices Regulation (BC Reg. 14/2004, Division 3: Riparian Areas) of the *Forest and Range Practices Act* (2002c). The *Forest and Range Practices Act* (2002c) riparian reserve and management zones are consistent with those previously identified under the *BC Forest Practices Code of British Columbia Act* (1996e). For freshwater systems within BC and the Yukon Territory, the DFO (2007g) has developed an Operational Statement to ensure that the management of riparian vegetation in *existing* rights-of-way is conducted in a manner that complies with Subsection 35(1) of the federal *Fisheries Act* (1985c), which protects fish and fish habitat throughout Canada. The Fish and Aquatic Habitat Management Plan (Section 26.18)

identifies a number of comprehensive guidelines offering a range of effective measures that will, with proper supervision, ensure no net adverse effects to streams, wetlands, and lakes.

It is expected that, unless specifically indicated otherwise, the legislated reserve and/or management zone setbacks and work practices established under the *Forests and Range Practices Act* (2002c) will guide development activity within riparian areas, including floodplains and wetlands.

26.20.1.4 Monitoring and Reporting

Monitoring programs are recommended to assess the effectiveness of re-vegetation efforts, the occurrence of invasive plants, and to monitor the effects of windthrow resulting from vegetation clearing.

A re-vegetation monitoring program will be developed to assess all areas that have been re-vegetated following disturbance. Areas will be monitored (season or timing to be determined upon review of other plans to coordinate objectives and resources) to assess the success of re-vegetation efforts and to indicate the occurrence, extent, and magnitude of relevant soil erosion. If soil erosion is observed, or re-vegetation is determined to be unsuccessful (based on assessments of plant mortality, plant vigour, and percentage cover of live vegetation, for example), re-vegetation will be re-attempted as soon as seasonally appropriate to minimize the potential for disturbance of adjacent vegetation and to minimize potential for the introduction of invasive plant species. The results of the re-vegetation monitoring will be summarized and will be provided to the Project's designated trained personnel. Results will be used to evaluate the success of the program and to determine if adjustments are required. Results will also contribute to future management objectives.

Windthrow is a risk along newly created forest edges, especially in the first few years after clearing. Hazard depends on site-specific factors such as wind direction and velocity, tree height-to-diameter ratio, crown size and density, rooting depth, and stand density. An effective windthrow monitoring program will be developed (season or timing to be determined upon review of other plans to coordinate resources), following vegetation clearing. Monitoring surveys, referencing techniques within the *BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010), will be conducted along all newly constructed roadways and transmission lines, as well as along new edges created in riparian areas. The results of the windthrow monitoring will be used to determine:

- the effectiveness of existing mitigation methods for reducing windthrow; and
- the need for adaptation of methods for the proposed clearing of subsequent areas.

26.20.2 Invasive Plant Management Plan

The term "invasive plant," used within the Invasive Plant Management Plan, includes plants referred to as invasive plants, invasive alien plants, and noxious weeds. Invasive plants can aggressively compete with and displace native vegetation when introduced into natural settings (Haber 1997). As such, they pose a serious threat to biodiversity.

Information regarding noxious (regulated) and other invasive plants (alien plants) is available online from guides published by the Invasive Species Council of British Columbia (2012) and the Province of British Columbia (BC MAL 2002; BC MOAFF 2002; BC MFLNRO 2010). The Northwest Invasive Plant Council (NWIPC) provides support and coordination for those undertaking invasive plant management activities within the northwestern region of BC. The NWIPC prepares an annual regional management plan, which prioritizes invasive plant species and outlines effective management actions (NWIPC 2012).

26.20.2.1 Objective

The objective of this plan is to avoid the introduction and spread of invasive plant species so that the integrity of terrestrial ecosystems is maintained.

Although pre-construction baseline surveys and ongoing inventory surveys will document and report the occurrence of plant species classified as invasive under the Invasive Plants Regulation (BC Reg. 18/2004) of the *Forest and Range Practices Act* (2002c; 42 recognized species) and the *Weed Control Act* (1996h; 21 noxious species), specific emphasis will be placed on the priority species, defined for this section as those identified by the NWIPC as having particular significance to northwestern BC.

26.20.2.2 Targets

The targets of this plan are to:

- minimize the creation of suitable habitat for invasive plant species (emphasis on the NWIPC priority plant species);
- minimize the opportunity for invasive plant seeds or reproductive material to be transported into the local or regional study areas;
- promptly detect and eradicate invasive plants, through the implementation of an effective inventory, control, and monitoring program; and
- provide on-site education and training (including signage and handbooks) regarding regionally significant invasive plants.

26.20.2.3 Actions to Avoid, Control, and Mitigate

This section provides recommended management actions to help avoid, control, and mitigate any adverse effects of invasive plant species. Although the details are subject to change with the development of an operational site plan, the information is designed to outline the fundamental requirements.

The operational plan will manage invasive plant species issues where applicable within areas affected by the Project, and will outline actions to avoid, control, and mitigate their effects. The plan will be developed by the Project's designated trained personnel through discussion (as needed) with local governing agencies. The plan will draw upon the *Pest Management Plan for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010), which outlines an integrated pest management (IPM) approach for invasive alien

plants, under the authority of several partnering ministries. The implementation of an IPM approach is also a recommended strategy of the NWIPC (2011).

The *Invasive Alien Plant Program: Reference Guide* (BC MFLNRO 2010), a comprehensive online document, will be referenced in the development of an operational plan, along with other relevant documents.

Management recommendations address general management (regardless of ecosystem) to minimize suitable habitat, management to minimize risk from invasive plant material being brought into areas associated with the Project, management to ensure the early detection and eradication of invasive plants, and on-site education and training.

General Management Considerations

Invasive species thrive in recently disturbed areas where there is little shade or competition from other plant species; therefore, minimizing ground disturbance reduces the opportunity for invasive plant establishment (J. Clark 2003; Polster 2005). General management actions recommended to address the target of minimizing suitable habitat include the following:

- minimize all clearing dimensions during construction (regardless of clearing size);
- identify short-term disturbances or clearings and ensure that they are re-vegetated as soon as possible to avoid soil degradation;
- minimize soil erosion through adherence to the Erosion Control Plan; and
- ensure all vehicles and equipment restrict their travel and operation to designated, or approved (for their respective activities), roads and surfaces.

Additional detailed management practices are outlined in Section 3.1 of the *Pest Management Plan for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010).

Treatment and Control

In the event that invasive plants are identified on site, the NWIPC will be consulted to determine if control is required, as opposed to monitoring. The actions taken will be determined by the type of plant identified, the season of identification, and the degree of invasion. If control is required, appropriate treatment options and timing will be addressed.

Potential treatment options include mechanical, biological, and chemical methods. Mechanical control adopts physical means of removal, such as pulling by hand. Biological control uses living organisms, such as insects, to control pest populations of invasive plants, and chemical control uses herbicides to reduce and eradicate plant populations.

Further detail regarding control methods, including legislation and site-specific use of herbicides (from storage and transport to application and disposal), is available within the following recent documents:

- *Pest Management Plan for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010); and
- *Integrated Vegetation Management Plan for Transmission Rights-of-Way* (BC Hydro 2010).

In the event herbicide use is deemed a recommended treatment, the *Integrated Vegetation Management Plan for Transmission Rights-of-Way* (BC Hydro 2010) provides detailed methodology for treatment activities and includes management measures (including designation of pesticide-free and no-treatment zones) to protect environmentally sensitive areas such as riparian areas, fish and wildlife and their habitat, waterbodies, and areas supporting country food or medicinal plants. To the extent possible, approved herbicides will be applied using spot-control methods, rather than broad spraying techniques, to minimize adverse effects to the surrounding environment.

Education and Training

Appropriate education and training are essential to a successful management strategy. Prior to the construction phase, employees and contractors, including those responsible for moving equipment to the Project site, will be provided a brief orientation outlining what invasive plants are, associated adverse effects of invasive plants, and how to avoid the introduction and spread of invasive plants.

Project-specific documents or brochures will be prepared and made available to all employees on site (e.g., through the Project Safety Manager or other designated source).

If required, the Project's designated personnel will receive further training in existing provincial legislation, available data entry tools, and reporting programs to be better equipped to identify invasive plants (with emphasis on the regionally significant species) through more detailed descriptions, as well as training in specific management methods to prevent the introduction and spread of invasive plants within the areas affected by the Project.

26.20.2.4 Monitoring and Reporting

Monitoring programs are recommended throughout all Project phases to assess:

- the regeneration success of re-vegetated areas (to ensure invasive species have not become established);
- the specific locations where invasive species have been previously identified (extent of plant populations); and
- the effectiveness of treatments, where control activities were undertaken.

A monitoring program will be developed and implemented following Project construction (season or timing to be determined upon review of other plans to coordinate resources). The monitoring program will determine whether further treatment is required. Collectively, this information will be used to evaluate the success of the management plan and will form the foundation for future management actions.

26.20.3 Transmission Line Management Plan

The proposed 287 kV Treaty Creek Transmission Line between Highway 37 (Treaty Creek Switching Station) and the Treaty Creek substation 1, is considered part of the mine infrastructure, with BC Hydro neither building nor assuming ownership of it. As a result, the transmission line is included within the Project's environmental assessment. The proposed transmission line is described in a report by WN Brazier Associates Inc. (2012; Appendices 4-AJ and 4-AK). The report includes details of the environment through which the transmission line will be constructed, its design and construction techniques, an EMP, and restoration objectives and methods.

26.20.3.1 Objective

The objective of this plan is to minimize disturbance to vegetation along the 287 kV Treaty Creek Transmission Line right-of-way.

26.20.3.2 Targets

Specific targets of the Transmission Line Management Plan are to:

- ensure the vegetation clearance requirement (limit of approach) is maintained between vegetation and the transmission line to avoid vegetation-related outages;
- minimize vegetation loss and disturbance, to the extent possible, by trimming to achieve clearance requirement (not by "clear-cutting" to ground level);
- minimize understory vegetation and ground disturbance; and
- minimize the use of herbicides in vegetation management.

26.20.3.3 Actions to Avoid, Control, and Mitigate

This section provides recommended management actions to help avoid, control, and mitigate adverse effects resulting from the management of vegetation within the transmission line right-of-way.

General Management Considerations

The transmission line clearing activities will be conducted in accordance with the general management recommendations described previously in the Vegetation Clearing Management Plan (Section 26.20.1) and by WN Brazier Associates Inc. (2012; Appendices 4-AJ and 4-AK). Other management actions may be identified in other relevant documents referenced throughout this section. The recommended general management actions to achieve the target of minimizing vegetation loss and disturbance are outlined below:

- Ensure clearing activities are closely coordinated with other relevant management plans including the Air Quality Management Plan (Section 26.11); the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Section 26.13); the Fish and Aquatic Habitat Management Plan (Section 26.18); and the Wildlife Management Plan (Chapter 26.21). The latter EMP has identified sensitive periods (e.g., for nesting birds, denning bears, and

within ungulate winter ranges) as well as other buffering (e.g., for active dens or nests) and management requirements (e.g., vegetation maintenance, and woody debris retention).

- Minimize all clearing dimensions (regardless of clearing size or ecosystem affected).
- Ensure the clearance requirement (limit of approach) is maintained between all vegetation and the transmission line.
- Preferentially retain mature and old trees (older than 80 years), where the option exists to remove only younger stands.
- Adopt low-disturbance methods to clear vegetation within identified sensitive areas, where clearing cannot be avoided. In such areas, vegetation maintenance and removal techniques such as pruning, mowing, girdling, topping, and select tree removals allow root systems to remain intact, help bind the soil, and encourage rapid colonization of low-growing plant species (BC MOE 2010a).
- Consult the *BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010) for guidance in assessing windthrow risk and for developing prescriptions to reduce the risk of windthrow hazard linked to transmission line construction and operation. Windthrow is a risk along newly created forest edges, especially in the first few years after clearing; hazard depends on site-specific factors such as wind direction and velocity, tree height-to-diameter ratio, crown size and density, rooting depth, and stand density.
- Re-vegetate or seed, as soon as possible, in accordance with the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Section 26.13).

26.20.3.4 Monitoring and Reporting

Monitoring programs are recommended to assess the potential effects to valued components related to the transmission line. An effective monitoring program will be developed and carried out following Project construction (season or timing to be determined upon review of other plans to coordinate resources), and as required after this time period.

Where ongoing monitoring and maintenance of target vegetation is required along the transmission right-of-way, the timing and details of the monitoring program will be further developed as the specific growth rates for the target species are better understood.

Consistent with the monitoring proposed within the Vegetation Clearing Management Plan (Section 26.20.1), an effective windthrow monitoring program will be developed (season or timing to be determined upon review of other plans to coordinate resources) following vegetation clearing. The entire length of the transmission line right-of-way will be included in the surveys. Where windthrow effects (described within the BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast [Zielke et al. 2010]) are observed, the site location, number, species of windthrown trees, and the approximate area affected will be documented and recorded onto field maps. A photographic record of surveyed areas will also be included. The results of the windthrow monitoring will be provided to the Project's designated personnel.

26.20.4 Terrestrial Plant Tissue Metal Concentrations Monitoring Plan

Building on the results of baseline sampling in 2008/2009, metal concentrations within terrestrial plant tissues will be monitored to assess potential changes resulting from construction and operation of the Project.

Monitoring will complement the monitoring of metal concentrations in wetland plant tissue described within the Wetlands Management Plan (Section 26.19) and the dustfall monitoring as part of the Air Quality Management Plan (Section 26.11), as rates of dustfall may be related to metal uptake by plants. Dustfall stations monitor the amount of dust deposited but not the amount of metals being taken up by, and accumulated into, plant tissue.

Sampling details will require collaboration with the Human Health and Wildlife disciplines. Analysis of metal concentrations of concern to human health is provided in Chapter 25 (Section 25.7.3). There are currently no standards regarding tissue metal concentrations from a vegetation perspective; standards for human health exist as toxicity reference values for individual metals that may be ingested by human receptors and take into consideration consumption rates (Health Canada 2010a, 2010b). The potential effects of chemical hazards on wildlife species are addressed in Chapter 18 (Section 18.7.7).

26.20.4.1 Objective

The objective of this monitoring plan is to determine whether plants are accumulating metals in their tissue as a result of Project activities. Plant tissue chemistry can be affected by the deposition of dust (particulate matter) along unpaved roads and near blasting and processing sites. Plants can also accumulate metals from contaminated water and soil. This plan establishes a general methodology for monitoring of metal concentrations in plant tissue, and identifies opportunities for adaptive management.

26.20.4.2 Target

Multiple samples of vegetation tissue will be collected over time to assess changes in metal concentration. Adaptive mitigation measures will be implemented should metal concentration in plant tissue pose a risk to wildlife and/or human health.

Vegetation species chosen for sampling will be consistent with species relevant to human and wildlife consumption, and may include the species collected in 2008 and 2009. Vegetation sampling will be conducted in areas determined by the results of dust deposition monitoring (Section 26.11). All ten of the proposed dustfall monitoring stations occur within the terrestrial ecosystems local study area. Sampling will begin during the construction phase and will continue throughout the operation, closure, and post-closure phases, with frequency directed by dust deposition rates and metal concentrations in vegetation. Methods for sampling will include those to assess deposition on vegetation surfaces and uptake into vegetation tissues. Proposed monitoring after the closure phase is addressed separately within the Post-closure Monitoring Program (Chapter 27).

26.20.4.3 Identifying Opportunities for Adaptive Management

In the event that monitoring of vegetation detects an increase in tissue metal concentrations, and levels pose a risk to wildlife and/or human health, as discussed in the Wildlife Management Plan

(Section 26.21) and Human Health assessment (Chapter 25), a formal wildlife and/or human health risk assessment may be implemented on a species-specific basis to assess the likelihood of adverse effects in wildlife and human valued components. Adaptive management and mitigation will be implemented, where necessary.

26.20.4.4 Reporting

Sampled vegetation will be sent to a laboratory for metals analysis immediately after collection. The results will be summarized separately for the berries and the leafy tissues, as well as for the reference and non-reference sample. A report detailing the methodology and results will be produced. The report will also include representative photographs (e.g., to visually show the level of dust accumulation on road-side vegetation). A new report will be produced every two years. Each subsequent report will compare the results from the current year to results from previous years to indicate whether changes in metal concentrations are occurring.

26.21 Wildlife Management and Monitoring Plan

This section provides an overview of the Wildlife Management and Monitoring Plans for the construction, operation, and closure phases of the KSM Project (the Project). The plans provide information pertaining to the Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP; BC ILMB 2000), the Nass South Sustainable Resource Management Plan (SRMP; BC MFLNRO 2012), and other relevant provincial and federal legislated requirements. Three sub-plans are described in detail below:

- Wildlife and Wildlife Habitat Management Plan;
- Ungulate Winter Range Management Plan; and
- Wildlife Effects Monitoring Plan.

The objective of these plans is to minimize the potential effects on wildlife in association with Project construction, operation, and closure, while taking into account operational requirements and the safety of Project employees.

The plan focuses on reducing the risk of direct wildlife mortality, mitigating the potential for human-wildlife conflicts, and minimizing the level of disturbance to wildlife during the Project construction and operation phases. The management measures focus on the wildlife valued components (VCs) selected for the environmental effects assessment (Section 18.5 Valued Components) and are appropriate for relevant species occurring within the regional study area (RSA) and local study area (LSA).

Consistent with the Proponent's commitment to continual improvement, wildlife management for the Project will take an adaptive management approach. The management procedures discussed in this section have been established to consider the potential effects of Project construction and operation on wildlife, as well as current BMPs. It is recognized that management strategies will need to be reviewed periodically and updated based upon the outcome of the initial management practices and on the current best management procedures and methods. This review process will be guided by the Wildlife Effects Monitoring Program

(WEMP; Section 26.21.3) and by re-examination of up-to-date BMPs as further research findings and guidelines from regulatory agencies and scientific studies become available.

Potential effects on wildlife related to the Project could include:

- habitat loss and alteration;
- sensory disturbance;
- disruption of wildlife movements patterns;
- direct mortality;
- indirect mortality;
- attraction to the Project due to attractants; and
- health effects due to chemical hazards.

The strategies, procedures, policies, and programs that will be implemented to minimize and avoid adverse effects on wildlife and wildlife habitat include:

- wildlife and wildlife habitat management;
- mountain goat Ungulate Winter Range management;
- WEMP;
- traffic and access management (Section 26.26);
- active avalanche management (Appendix 4-W);
- noise management (Section 26.22); and
- waste management (Section 26.6).

26.21.1 Wildlife and Wildlife Habitat Management Plan

26.21.1.1 Objectives

The overall objectives of the Wildlife and Wildlife Habitat Management Plan are to:

- minimize wildlife mortality as a direct consequence of the Project; and
- avoid any adverse effects on protected species, their habitats, or breeding and feeding activities.

26.21.1.2 Legislation and Standards

The following legislation and standards apply to wildlife and wildlife habitat in the LSA:

- BC's *Wildlife Act* (1996q);
- Canada's *Species at Risk Act* (BC MWLAP 2002);
- *Migratory Bird Convention Act* (1994);

- *Forest and Range Practices Act* (2002c);
- *Migratory Birds Environmental Assessment Guideline* (Milko 1998);
- Management Plan for the Mountain Goat in British Columbia (BC MOE 2010b);
- Ungulate Winter Range U-6-002 Order, Sections 9(2) and 12(1) of Government Actions Regulation (BC Reg. 582/2004);
- Cassiar Iskut-Stikine LRMP (BC ILMB 2000);
- Nass South SRMP (BC MFLNRO 2012);
- *Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c);
- *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2006d);
- *British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears* (MacHutchon 2001);
- *British Columbia Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia* (BC MWLAP 2005);
- *Identified Wildlife Management Strategy* (Cichowski, Kinley, and Churchill 2004); and
- *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia* (BC MWLAP 2004a).

26.21.1.3 Targets

Specific targets related to achieving the objectives are to, where possible:

- meet legislation requirements (see Section 26.21.1.2) with regard to:
  - active bird nests or mammal dens disturbed or destroyed during site clearing for the construction phase, incremental growth of Project infrastructure (e.g., TMF and rock storage facilities) during the operation phase, and general Project activities;
  - active or inactive raptor nests destroyed during construction and operation; and
  - mortality of animals directly attributable to the Project, particularly protected species and migratory birds;
- minimize loss of high-quality habitat and disruption to movement; and
- prevent disturbance to goats within high-quality habitat and Ungulate Winter Range (UWR) during the winter and high quality summer habitat during the kidding period.

26.21.1.4 Actions to Avoid, Control, and Mitigate

26.21.1.4.1 Design

Due to concerns over the Mitchell-Treaty Saddle Area (Saddle Area) as a potential wildlife corridor, design changes were made during the Project planning process to limit the amount of infrastructure in this location:

- the Process Plant, Camp 5: Treaty Plant Camp, and supporting infrastructure were moved to the north end of the PTMA;
- ancillary infrastructure will be removed (e.g., construction access adit) from this area to minimize the human presence in the Saddle Area during operation;
- the MTT will no longer daylight across the valley, eliminating the potential barrier, as it will remain underground; and
- the access road to the portal will only be used as an emergency access, minimizing the amount of traffic along the Treaty Creek access road from the south end of the TMF to the Mitchell-Treaty Saddle Area.

In addition to the design changes to the Saddle Area, the following design changes/modifications were, or will be, made during construction:

- The surface footprint of the Project was designed to minimize disturbance to wildlife habitat.
- Important habitats were avoided where practicable alternatives were available (e.g., habitat loss was minimized in the Saddle Area by placing the conveyor underground and in the PTMA by moving the Treaty Process Plant out of wetland habitat).
- The bridge crossing over the Unuk River was designed to be high (5 m) enough to allow wildlife movement underneath.
- To minimize disturbance to grizzly bears along the Unuk River, no permanent camp will be located in the area.
- There will be a controlled locked gate at the Treaty Creek access road; the gate will be located on the bridge crossing the Bell-Irving River, preventing people from circumnavigating around the gate.
- Buildings will be designed and maintained to exclude wildlife wherever possible, such as covering vents with mesh and skirting to prevent bats, birds, and furbearers (e.g., wolverine) from entering and ensuring the siding of buildings is constructed to prevent wildlife from entering.
- The transmission line will be designed to include features that reduce the risk of bird collisions with the transmission line and electrocutions (including increasing the visibility of the line and preventing raptors from nesting on posts).

26.21.1.4.2 Construction

For each wildlife VC, there are time frames during which wildlife individuals will be more sensitive to disturbance (e.g., breeding). Table 26.21-1 summarizes key sensitive periods for wildlife VCs applicable to the Project, and highlights legislation or BMPs relevant to each VC that will be followed where possible. Where possible, Project activities that may disturb wildlife VCs, particularly during the construction phase (e.g., vegetation clearing), will be avoided during sensitive periods. If avoidance is not possible, pre-construction clearing surveys will be conducted to identify nests or dens that must be avoided. These surveys are described for each VC. During the construction phase (and where required during operation), an Environmental Monitor will be employed on site to identify sensitive wildlife features and implement appropriate procedures to minimize potential adverse effects to these areas.

Table 26.21-1. Wildlife Sensitive Periods Applicable to the Project

VC	Sensitive Period	Season/Life Requisite	Summary of Guidelines	Applicable Legislation and Standards
Moose	April to July	Calving/natal habitat	Avoid vegetation clearing within 2 km of confirmed natal areas.	
Mountain Goat	November 1 to June 14	Winter range	Activities within 500-m horizontal distance of mountain goat winter habitat must only take place between June 15 and October 31.	Ungulate Winter Range U-6-002 Order, sections 9(2) and 12(1) of Government Actions Regulation (BC Reg. 582/2004) (unless an exemption is granted).
	May 1 to July 15	Kidding period	Maintain 500-m buffer from kidding habitat.	Management Plan for Mountain Goat in BC (BC MOE 2010b)
	April to October	Mineral licks	Avoid destruction of licks and wallows. Minimize disturbance within 100 m of licks or wallows from May to November.	Cassiar Iskut-Stikine LRMP (BC ILMB 2000); Nass South SRMP (BC MFLNRO 2012)
	September to November	Wallows		*Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c)
Black Bear	October to April (bear)	Hibernation	Conduct clearing outside of denning season.	*Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c)

(continued)

Table 26.21-1. Wildlife Sensitive Periods Applicable to the Project (continued)

VC	Sensitive Period	Season/Life Requisite	Summary of Guidelines	Applicable Legislation and Standards
Furbearers	March to May (e.g., fisher)		If clearing must be completed during this time, pre-construction surveys for dens will be conducted to identify areas where tree clearing will be avoided.	*Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2006d)
			If active dens are identified, forested buffer zones will be maintained.	*British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears* (MacHutchon 2001)
Hoary Marmots	Year-round		Pre-grubbing surveys for hoary marmots will be conducted prior to construction activities, and mitigation will be implemented (e.g., "fish-out" program) if marmots are observed.	
Bats	October to May	Hibernation	Pre-clearing surveys will be conducted for bat hibernaculum and maternal roosts if construction occurs within the hibernation and breeding period.	*Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c)
	May to September	Maternal roosts	If hibernacula or maternity roosts are identified in the LSA, a buffer of at least 125-m radius may be maintained.	
Migratory Birds	March 15 to August 15	Nesting/fledging	Vegetation clearing activities will be scheduled outside of the general breeding bird period.	*Migratory Bird Convention Act*(1994)
			If clearing must be completed during the breeding period, pre-construction surveys will be conducted to identify areas where clearing will be avoided. If active nests are observed, buffer zones may be maintained.	BC *Wildlife Act* Section 34 (1996q)

(continued)

Table 26.21-1. Wildlife Sensitive Periods Applicable to the Project (completed)

VC	Sensitive Period	Season/Life Requisite	Summary of Guidelines	Applicable Legislation and Standards
Raptors	March 1 to August 15	Nesting/fledging	If nest is intact, the tree is protected under Section 34 of the *Wildlife Act* (1996q). Avoid construction, blasting, helicopter disturbance between March 1 and August 15 within 200 to 500 m of the nest tree (BC MWLAP 2005). If nests are observed, establish a forested buffer around the tree of 100 to 300 m (BC MWLAP 2005) if possible	BC *Wildlife Act*, Section 34(1996q): Protects the nests of eagles, peregrine falcons, gyrfalcons and ospreys year-round *Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c)
Western Toad	May to October	Breeding ponds; fall toadlet dispersal	Construction activities will be avoided in areas adjacent to potentially high-quality western toad breeding habitat from May through October. If this is not possible, pre-construction surveys will be conducted and if breeding ponds are observed, a buffer zone of at least 30 m will be established, or if this is not possible, the appropriate government agency (e.g., BC MOE) will be contacted regarding alternative mitigation (e.g., translocation) or potential compensation/offset options.	*Species at Risk Act* (Schedule 1; BC MWLAP 2002) *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in BC* (BC MWLAP 2004a)

Moose

Vegetation clearing will be avoided near identified moose calving areas where possible, unless monitored by a qualified biologist. If vegetation clearing must occur during the calving period near moose calving habitat (April to July), there will be a search (e.g., aerial survey) for current, localized evidence of calving moose before construction proceeds, followed by monitoring of the construction area, if necessary. This may be conducted in conjunction with pre-clearing surveys for bird nests. If calving habitat is identified, a forested buffer adjacent to moose natal sites to provide security cover for animals will be maintained where possible. If the area must be disturbed due to Project constraints, the relevant regulating body will be consulted, e.g., British Columbia Ministry of Forests, Lands, and Natural Resource Operations (BC MFLNRO), to develop appropriate mitigation strategies.

The Saddle Area near Treaty Creek may be monitored using remote digital cameras to determine the extent to which moose use this area as a movement corridor. Seabridge has revised the design of the MTT to ensure that human disturbance at the Treaty Saddle is minimal, localized, and of short duration. These efforts are to avoid and mitigate impacts on wildlife movement at the Saddle. A construction camp will be established for five years, and then dismantled, decommissioned, and removed. MTT construction will occur completely underground, and after construction, only an access road and portal will remain in place.

Mountain Goat

Avoid construction activities through occupied winter range during the winter (November 1 to April 30) and kidding habitat during the summer (May 1 to July 15) unless monitored by a qualified biologist. The BC mountain goat management plan (BC MOE 2010b) recommends a 500-m buffer zone (2,000-m buffer zone for canyon-dwelling mountain goats) where no industrial activity takes place adjacent to important mountain goat habitat (winter range, kidding/early rearing, mineral lick use areas, and connecting trails). A goat deterrent protocol will be developed in consultation with the BC MFLNRO (or the appropriate governing agency) to deter goats from the area if they are present during construction activities. Exemption provisions provided for in Order UWR-06-002 will be explored.

If mineral licks and/or wallows are found within the area of disturbance, destruction of the lick will be avoided and the integrity of the trails between mineral licks be maintained, where possible. If activities must occur within 100 m of a lick, disturbance will be minimized during critical use periods (May to November). If a mineral lick must be disturbed due to Project constraints, the relevant regulating body will be consulted (e.g., BC MFLNRO) to develop appropriate mitigation strategies.

Bear and Fisher Dens

Active black bear or fisher dens will not be disturbed or destroyed during site clearing. Vegetation clearing will be avoided in high quality habitat (e.g., cedars and hemlocks found in the Interior Cedar-Hemlock biogeoclimatic zone) during the black bear denning period (December to April) and fisher denning period (March to May), unless pre-clearing surveys are conducted. If active dens are identified during pre-clearing surveys, a forested buffer of approximately one tree length (based on the average height of the main tree canopy layer in the surrounding stand) will be maintained. This buffer will retain additional thermal protection and climbing trees for cubs (BC MWLAP 2004c). If an active den cannot be avoided or work must be undertaken within buffer areas, the relevant regulators will be consulted to develop appropriate strategies.

Hoary Marmots

Pre-grubbing surveys for hoary marmots will be conducted in suitable habitat prior to construction activities. If marmot colonies are identified in the immediate area where grubbing is planned, mitigation will be implemented to prevent marmot mortality. For example, a hoary marmot “fish-out” program may be implemented and marmots distributed to local communities or translocated. If a “fish-out” program is deemed necessary, the BC MFLNRO (or the appropriate governing agency) will be contacted and the appropriate permits will be obtained.

Bats

Pre-clearing surveys will be conducted for bat hibernacula in suitable habitat (McTagg Valley). Pre-clearing surveys will be conducted for maternity roosts if clearing is scheduled to occur between May and September (BC MWLAP 2004a). Surveys will only be conducted if there are known roosting sites in the area, and surveys for hibernacula will only be conducted in summer months to avoid disturbing hibernating bats. Hibernacula can be found in tree cavities, caves, rock crevices, and buildings. Maternity roost sites house aggregations of female bats and their young.

The northern long-eared myotis is the only blue-listed bat species potentially occurring in the area. The BC *Wildlife Act* (1996q) prohibits the harassment, capture, or killing of this species. The little brown myotis is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and COSEWIC has recommended to the Minister of Environment that an Emergency Order be issued to put them on Schedule 1 of the *Species at Risk Act* (BC MWLAP 2002). If hibernacula or maternity roosts are identified in the LSA, a buffer of at least 125-m radius (BC MWLAP 2004c) will be maintained, where possible, or BC MFLNRO (or the applicable agency) will be notified and alternative mitigation will be enacted. The retention patch, if implemented, will include high-quality bat habitat (e.g., foraging habitat, corridor to foraging habitat, large diameter trees, cliffs/caves), if available nearby. In addition, blasting or construction will not occur within this buffer, unless there are no other options. If activities must occur within the buffer, the relevant regulating body will be consulted (e.g., BC MFLNRO) to develop appropriate mitigation strategies.

Other bat species occurring in northern BC are yellow-listed, and the BC *Wildlife Act* (1996q) prohibits the harassment, capture, or killing of these species as well. If hibernacula or maternity roosts for yellow-listed bat species (e.g., western long-eared myotis, silver-haired bat) are identified, a buffer or retention patch of at least a 50-m radius will be maintained. In addition, disturbance will be minimized from May to September near maternity roosts, and October to May near hibernacula (BC MWLAP 2004c).

Migratory Birds

Active bird nests will not be disturbed or destroyed during site clearing for infrastructure. Vegetation clearing activities will be scheduled outside of the general breeding bird period for wetland, forest, and alpine birds (May 15 to July 31), where practical. If clearing must be completed during the breeding period, pre-clearing surveys will be conducted to identify locations of active nests. Harlequin duck pair surveys will be conducted prior to any work on crossings of streams with wet widths greater than 10 m. If any nests are identified, buffer zones of 50-m radius will be maintained throughout the breeding season, where possible, or the appropriate regulators will be consulted to develop appropriate strategies.

Raptors

Active raptor nests will not be destroyed during construction and operation. Inactive raptor nests or nests found outside of the breeding season will also be maintained or relocated, in consultation with appropriate regulators (Wildlife Act [1996q]; Demarchi, Bentley, and Sopuck 2005).

Prior to construction activities, a reconnaissance survey for large raptor nests will be conducted. If nests of eagles, osprey, or great blue heron are found within the LSA, the following guidelines will be followed:

- If nest is intact, the tree is protected under Section 34 of the *Wildlife Act* (1996q).
- Avoid construction, blasting, and helicopter disturbance between March 1 and August 15 (February 15 and August 31 for great blue heron) within 200 to 500 m (depending on the species) of the nest tree.
- Establish a forested buffer of 100 to 300-m radius (depending on the species) around the tree to provide perching and roosting sites and security cover.

Amphibians

Vegetation clearing activities will be avoided in areas adjacent to high-quality western toad breeding habitat from May through October, unless pre-clearing surveys are conducted. Where avoidance is not possible, and in accordance with BMPs for amphibians (BC MWLAP 2004a), pre-clearing surveys will be conducted and a buffer zone of at least 30 m will be established between construction activities and identified breeding habitat.

The Wildlife Management Plan will include the following mitigation measures to minimize potential effects on amphibians, particularly western toad:

- Sensitive habitat, such as wetlands and breeding ponds adjacent to work sites will be identified and avoided if possible. If breeding ponds cannot be avoided, then BC MOE will be contacted regarding alternative mitigation (e.g., translocation) or potential compensation/offset options.
- Standing water in roadside ditches of access roads will be minimized and monitored for use as breeding sites for western toads.
- Monitoring and reporting of western toad observations and incidents, including mass toad movements near access roads, will be completed.
- Construction monitors will survey wetlands and ponds for amphibian breeding prior to construction activity.

The Wildlife Management Plan will include procedural guidance in the event that western toad breeding or mass dispersal is identified. This may include guidance on buffer distances from identified breeding sites, and salvage or relocation requirements and techniques in the event work must be undertaken at breeding sites.

26.21.1.4.3 Operation

Specific actions required during operation to meet the targets outlined in Section 26.21.1.3 are presented in Table 26.21-2.

26.21.1.4.4 Closure and Post-closure

Specific actions required during closure and post-closure to mitigate effects on wildlife include:

- Inactive Project components will be deactivated when possible, and will be re-vegetated during post-closure, as outlined in the Closure Plan.
- The majority of the TMF will be reclaimed at closure. Wildlife will be deterred from using the area until monitoring programs indicate water quality and associated vegetation

are safe (Water Management Plan; Terrestrial Plant Tissue Metal Concentrations Management Plan; Migratory Birds Convention Act [1994]).

- When water quality and vegetation are deemed safe, the TMF will be managed during post-closure for browse production, and vegetation will be planted to promote movement corridors. Habitat associated with the TMF will be re-vegetated to benefit moose, and contribute to available early winter habitat. It is anticipated that post-closure water quality in the TMF will not affect moose health. Evaluation of the habitat creation strategy's progress will occur at regular intervals to ensure that its objectives (see the Closure Plan (Chapter 27) are being met. The monitoring will include assessing the extent of wildlife use of the reclaimed habitat, including moose.
- The access roads that will be deactivated will be reseeded with vegetation to establish an early seral stage that mimics natural disturbance. Natural succession will then be allowed to re-establish habitats. Debris piles will be created from stockpiled timber to provide habitat for small mammals whenever possible.

Table 26.21-2. Actions to Achieve Wildlife Management Targets during Operation

Target	Actions
Mammals	
Mortality of mammals, particularly protected species, will not be directly attributable to the Project	• Minimize sources of attractants through proper garbage and waste management to minimize incidents through the Domestic and Industrial Waste Management Plan (Section 26.6). • Restrict public access along access roads through the Traffic and Access Management Plan (Section 26.25) and implement a no hunting policy on site to avoid mortality to mammals due to hunting. • Adaptive management will be implemented to keep wildlife out of hazardous areas (e.g. falling, toxicants in water). • Minimize wildlife/vehicle mortality through the Traffic and Access Management Plan (Section 26.25). • Minimize furbearer interaction with site infrastructure; fencing/skirting will be used to prevent furbearer access to site infrastructure (e.g., tunnels, building, etc.). • Measures to exclude bats from tunnels will be implemented to prevent incidents. • Minimize mountain goat mortality according to the Active Avalanche Management Plan (Appendix 4-W).
Species richness, abundance, and diversity of mammals will not decline due to the Project	• A wildlife monitoring program will be implemented for bears and ungulates (Section 26.21.3). • Avoid helicopter disturbance to goats by following the BC Management Plan for the Mountain Goat (BC MOE 2010b). The Management Plan recommends that helicopters maintain a 2,000-m horizontal and 400-m vertical separation from mountain goat habitat. To minimize disturbance, aerial support, including helicopter access, will be directed along controlled routes or flight paths that follow the guidelines. Specific flight paths will be determined before construction commences and will be followed, unless extreme weather and safety of pilots require them to fly within the buffer. Locations of these flight paths and the reasons they must be used will be communicated to all workers involved in aviation support. Pilots will be required to follow flight paths and will be actively monitored to ensure compliance. • The Proponent will apply for an exemption permit to construct a road through the UWR.

(continued)

Table 26.21-2. Actions to Achieve Wildlife Management Targets during Operation (completed)

Target	Actions
Minimize loss of high-quality habitat and disruption to movement	• Modify design of the Project and location of Project infrastructure to minimize habitat loss or alteration of the proposed grizzly bear Wildlife Habitat Area. • Prevent transmission line right-of-way from acting as a barrier to movement for furbearers by maintaining some vegetation, where possible, particularly where the line veers away from the road (Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia [BC MOE 2006d]). • Artificial salt licks will be set out, and maintained to enhance habitat quality outside of the Mine Site. The artificial licks will be monitored for use (e.g., using remote cameras). • Prevent Proponent-controlled access roads from acting as barriers to movement for mammals through the Traffic and Access Management Plan (Section 26.25).
Minimize loss of high-quality habitat and disruption to movement (Con'd)	• Some tree snags and stumps will be retained to provide additional habitat for bat species that use tree crevices (e.g., long-eared myotis [*Myotis evotis*]) for maternal roosts (Rancourt, Rule, and O'Connell 2005). • Clear span bridges, concrete box culverts, and open bottom culverts have been used in the road stream crossing designs to enhance wildlife passage. Toad tunnels, if required, will also function as movement corridors for furbearers, including marten. • Loss or alteration of moose, mountain goat, and grizzly bear habitat will be modelled at various stages of operation to ensure that total loss does not exceed the amount identified in the Application/EIS. Reclaimed land use objectives are to provide habitat for wildlife, and reclaimed sites will be monitored until they are free-growing.
Birds Mortality of birds, particularly protected species, will not be directly attributable to the Project	• Adaptive management will be implemented to keep birds out of hazardous areas. For example, wetland bird use of the TMF or WSF will be monitored during operation, and appropriate steps will be taken to deter birds from the TMF and WSF if deemed necessary. Deterrent systems will be adapted over time if necessary and the need to deter birds will be evaluated based on operating experience. • Minimize bird/vehicle mortality through the Traffic and Access Management Plan (Section 26.25). • The transmission line will be monitored by Proponent technicians for bird strikes and will be managed adaptively.
Species richness, abundance, and diversity of birds will not decline due to the Project	• Design and implement a monitoring program for wetland birds, terrestrial breeding birds, and raptors that will detect changes in abundance, species richness, and breeding success and that will evaluate the potential causes of such changes (Section 26.21.3).
Amphibians Mortality of amphibians, particularly protected species, will not be directly attributable to the Project	• If western toads are observed within the Project footprint, salvaging may occur at discrete times corresponding to each incremental increase in the footprint during operation. Adult western toads will be moved either to an unaffected suitable wetland within the regional study area (RSA) or to the wetland compensation area in order to augment the breeding population in that wetland. Whenever practicable, the 30-m minimum buffer area around toad breeding sites will be applied (BC MWLAP 2004a). • Minimize amphibian mortality along roads through the Traffic and Access Management Plan (Section 26.25).
Minimize loss of high-quality habitat and disruption to movement	• Loss of wetland habitat for western toads will be compensated for through the Wetland Habitat Compensation Plan (Appendix 16-B) and Fish Habitat Compensation Plan (Appendix 15-Q and 15-R), as these plans will integrate western toad habitat enhancement initiatives. • Western toad movement will be facilitated through the use of stream crossing designs including concrete box culverts and open bottoms culverts. Toad tunnels may be added if toad crossing sites are an issue and/or other strategies to facilitate movement (see Traffic and Access Management Plan, Section 26.25).

26.21.1.5 Monitoring

The WEMP is described in Section 26.21.3.

26.21.2 Ungulate Winter Range Management Plan

26.21.2.1 Objective

The objective of the Ungulate Winter Range Management Plan is to avoid adverse effects on mountain goat UWR u-06-002.

26.21.2.2 Legislation and Standards

Mountain goats are managed under provincial jurisdiction and are protected from unauthorized harvest or harassment by the BC *Wildlife Act* (1996q). Important habitat, specifically winter range deemed necessary to maintain populations, can receive legislative protection as a UWR and can be integrated with forest development under the BC *Forest and Range Practices Act* (2002c). UWR u-6-002 overlaps the KSM Project RSA. Mountain goat management is guided by the Management Plan for the Mountain Goat in British Columbia (BC MOE 2010b).

26.21.2.3 Targets

Specific targets related to achieving the objective are to incur no net loss of area that could be managed as occupied UWRs, and to incur no disturbance to goats within UWRs during the critical winter period.

26.21.2.4 Actions to Avoid, Control, and Mitigate

26.21.2.4.1 Design Criteria

During the design period, the proximity of legislated goat UWRs to the development infrastructure and transportation corridors was evaluated. High elevation haul road alignments near the pits were adjusted where possible to avoid UWRs.

26.21.2.4.2 Ungulate Winter Range Compensation

To mitigate for the potential loss and degradation of approximately 547 ha of approved provincial UWR u-06-002, alternative areas that could be used as UWR to compensate for area lost from development will be identified. Compensation areas will be identified as close to the affected area as possible, using a “like-for-like” compensation.

Habitat suitability models conducted for mountain goat winter habitat in the RSA (Appendix 18-B) will be compared with provincial UWRs to determine if the Rescan Environmental Services Ltd. habitat models of high (habitat suitability rating [HSR] 1) and moderately high (HSR 2) class-rated goat winter habitat can be used to identify replacement UWR areas within the RSA (i.e., “like-for-like”).

The following four criteria will be used to evaluate the suitability of potential compensation areas:

- Proximity to the existing UWR: Suitable mountain goat winter habitat within the same drainage or watershed as the existing UWRs (i.e., within the Mitchell/Sulphurets drainage that will be affected by the development will be rated high). The area will be connected to other areas of high-quality habitat to ensure the area will support the affected population. The initial effort to identify compensation areas will be directed at baseline survey units (SU) 5, 6, and 7 (Appendix 18-A).
- Observations of mountain goats confirming the potential compensation areas are occupied: Observations from existing baseline aerial surveys in the area will be used to determine goat use. Areas with the most goat use observed during winter will be rated highest.
- The area proposed for compensation will attempt to include contiguous units of greater than 100 ha (1 km^2) with the majority of area represented by HSR 1 and 2 goat winter habitat as modelled by Rescan Environmental Services Ltd. UWRs currently identified will not be included in the area calculation for compensation, although these polygons may be adjacent to the compensation area. Attempts will be made to ensure the compensation areas identified are not isolated and are proximal to other seasonal habitats (e.g., summer range) as identified by habitat models previously developed for the Project.
- The area will be far enough away from potential development to ensure that the habitat will not be degraded in the future. Optimally, the distance of selected areas will be greater than 2 km from any development that may degrade goat winter habitat.

The highest-rated candidate compensation areas will be selected to compensate for the effects on existing UWRs. The areas selected to be used as replacement UWRs will be presented to BC MFLNRO or the appropriate governing agency for approval.

26.21.2.5 Reporting

The areas selected to be used as replacement UWRs will be presented to BC MFLNRO, or the appropriate governing agency, for approval.

26.21.2.6 Responsible Person

The assessment of mountain goat UWRs and identification of candidate areas for replacement will be conducted by a qualified professional. The Environmental Superintendent is ultimately responsible for the Wildlife Management Plan and will coordinate consultants and contractors for the work. This work may be conducted in collaboration with BC MFLNRO, or with the appropriate government agency.

26.21.3 Wildlife Effects Monitoring Program

A WEMP will be implemented and conducted either annually (e.g., site-specific monitoring) or every five years (e.g., bears and ungulate local population monitoring), depending on the species (Table 26.21-3). Monitoring programs will be assessed and adjusted accordingly, where applicable.

The WEMP will contribute toward follow-up program monitoring requirements pursuant to the CEAA (1992), and as further described in Chapter 38, Follow-Up Program.

Table 26.21-3. Frequency of Monitoring Activities for the Wildlife Effects Monitoring Program

Type of Monitoring Activity	Focal Species	Monitoring	Frequency
Local Population Monitoring	Moose	Aerial surveys	Every 5 years
Local Population Monitoring	Mountain Goats	Aerial surveys	Every 5 years
Local Population Monitoring	Bears	DNA or other appropriate methods	Every 5 years
Local Population Monitoring	Hoary Marmots	Population monitoring	Every 5 years
Local Population Monitoring	Moose, Mountain Goats, Grizzly Bears, Black Bear, American Marten	Habitat loss models and maps	Every 5 years
Site Monitoring	Mountain Goats	Ground-based monitoring for disturbance, use of artificial mineral licks, and avalanche toes	Annually
Site Monitoring	Birds, Mammals, Amphibians	Incidental observations	Annually
Site Monitoring	Birds, Mammals, Amphibians	Incidents and mortality events	Annually
Site Monitoring	Birds, Mammals, Amphibians	Breeding evidence in or near infrastructure (e.g., nest in pit walls/infrastructure, western toad breeding ponds)	Annually
Site Monitoring	Birds, Mammals, Amphibians	Interaction with infrastructure (e.g., waterfowl and TMF, bats and tunnels, furbearers, and building skirting)	Annually

26.21.3.1 Moose Monitoring Program

26.21.3.1.1 Objectives

The primary objectives of the Moose Monitoring Program are to:

- monitor for changes in moose distribution and behaviour, and adaptively manage, where necessary; and
- monitor habitat loss to ensure total loss does not exceed the amount identified in the Application/EIS.

26.21.3.1.2 Site Monitoring

A site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on moose and to monitor the effectiveness of mitigation. The following site monitoring will be conducted for moose:

- Incidental observations of moose within the development and transportation infrastructure footprint will be monitored, recorded, and reported.
- Direct interactions of moose with infrastructure (e.g., roads and pits) will be monitored and recorded.
- Moose incidents will be monitored, recorded, and reported.
- Vehicle collisions with moose along Project-controlled access roads will be monitored and reported (Traffic and Access Management Plan).

Monitoring will occur throughout operation of the Project. High mortality or incidents due to the Project will trigger a review of management and mitigation.

Monitoring of moose occurrence, incidents, mortality, and movement will be conducted daily during construction, operation, and closure. Moose monitoring will be a component of the larger wildlife and environmental monitoring plan and will include recording moose observations within the development footprint and transportation infrastructure. All workers will be expected to participate in some capacity, as defined during their education process, while environmental monitors will be responsible for interpreting the information and conducting follow-up monitoring if required.

Vehicle collisions with moose or mortality by other means will be recorded by the designated environmental monitor and will receive further investigation.

26.21.3.1.3 Local Population Monitoring

A local population monitoring program will be conducted every five years to monitor the effects of the Project on moose and to monitor the effectiveness of mitigation. The following local population monitoring will be conducted for moose:

- Moose monitoring (aerial surveys) will be conducted every five years to track population, distribution, and productivity. If changes are detected, adaptive mitigation will be implemented.
- Loss of moose habitat will be modelled at various stages of operation (e.g., every five years).
- Water quality across the LSA will be monitored as part of the Aquatic Effects Monitoring Plan (Section 26.18.02). This information will then be used to evaluate potential effects on moose health and forage quality.

Monitoring will occur throughout the operation of the Project. Changes in winter population or distribution due to the Project or loss of high quality habitat greater than the amount identified in the Application/EIS will trigger a review of management and mitigation.

Moose population monitoring will be conducted every five years, following industry standard guidelines (e.g., BC MFLNRO Wildlife Branch guidelines for managing ungulates in the Skeena). Aerial surveys for moose will be conducted in the RSA during the winter to ensure population, productivity, and distribution remains constant within anticipated natural variation. Inventory methods will be similar to baseline data collection and will adhere to RISC standards. Survey units delineated during the baseline inventory will be used during the monitoring program. Data analyses will follow standard methods for moose population surveys (e.g., Demarchi 2011). Sex and production ratios will be calculated and compared over years. If a region-wide population survey led by the provincial government is initiated, the Proponent would consider contributing to this fund in lieu of conducting independent surveys, on condition that the population survey covers the KSM Project RSA.

High-quality habitat and the Project footprint will be modelled and mapped at various stages of operation to ensure that loss of high-quality habitat due to the Project does not exceed the amount identified in the Application/EIS. It is anticipated that with the current project design, these targets will be met. Mitigation may be needed if a change in area occurs; however, a substantial area of moose early winter habitat is anticipated to be created with the Closure Plan (Chapter 27).

The post-closure monitoring protocol will include monitoring moose habitat and habitat use, particularly in areas in and around the TMF that will be re-vegetated with winter browse. Water quality and vegetation quality will be monitored (Sections 26.8.12 and 26.20); if monitoring suggests that vegetation is not safe for wildlife consumption, wildlife will be prevented from accessing these particular areas. Monitoring for moose use will occur at regular intervals, and will include looking for evidence of tracks, trails, pellet groups, and browse.

26.21.3.2 Mountain Goat Monitoring Program

26.21.3.2.1 Objectives

The primary objectives of the Mountain Goat Monitoring Program are to:

- monitor for changes in mountain goat distribution and behaviour and adaptively manage, where necessary; and
- monitor habitat loss to ensure total loss does not exceed the predicted amount identified in the environmental assessment.

26.21.3.2.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases of the Project to monitor potential effects on mountain goats and to monitor effectiveness of mitigation. The following monitoring will be conducted for mountain goats:

- Mountain goats will be monitored in areas where blasting occurs to monitor the response of goats to noise disturbance.
- During the spring, the toe of avalanches will be monitored to identify dead goats to determine high mortality areas related to snow avalanches.

- Direct interactions of goats with infrastructure (e.g., roads and pits) will be monitored and recorded.
- Mountain goat use of artificial salt licks will be monitored.
- Incidental observations of mountain goats will be recorded and reported.
- Mountain goat incidents and mortality events will be monitored, recorded, and reported.
- Changes in goat use of UWR and high quality habitat will be monitored within the local study area (LSA), and reported.
- Goat monitoring will be conducted in relevant Project areas prior to activities that may disturb goats (e.g., avalanche control, and blasting in pits), where practical, recognizing that poor visibility conditions may prohibit monitoring during heavy snow accumulations.
- Vehicle collisions with mountain goat along Project-controlled access roads and haul roads will be monitored and reported (Traffic and Access Management Plan, Section 26.25).

Monitoring will occur throughout operation of the Project. High mortality or incidents due to the Project will trigger a review of management and mitigation.

Monitoring of mountain goat occurrence, incidents, mortality, and movement will be conducted during construction, operation, and closure. Mountain goat monitoring will be a component of the larger wildlife and environmental monitoring plan and will include recording mountain goat observations within the development footprint and transportation infrastructure. All workers will be expected to participate in some capacity, as defined during their education process, while environmental monitors will be responsible for interpreting the information and conducting follow-up monitoring if required. Protocol will be in place for modifying mine activity where possible, if goats are detected in the Mine Site, particularly during the kidding period (early May to mid-July).

Regular monitoring of goat behaviour and habitat use within areas that will be disturbed due to blasting noise will occur regularly. This may be in the form of remote camera monitoring or weekly monitoring by a biologist using a spotting scope. In addition, artificial salt licks will be monitored for mountain goat use (e.g., using remote digital cameras).

Vehicle collisions with mountain goats or mortality by other means will be recorded by the designated environmental monitor and will receive further investigation. More intensive monitoring will be conducted during sensitive periods in association with construction and avalanche control.

26.21.3.2.3 Local Population Monitoring

A local population monitoring program will be conducted every five years during the operation phase to monitor the effects of the Project on mountain goats and to monitor the effectiveness of mitigation. The following monitoring will be conducted for mountain goats:

- Mountain goat populations will be monitored (e.g., aerial surveys) in the RSA every five years.

- Loss of mountain goat habitat will be modelled at various stages of operation (e.g., every five years).

Monitoring will occur throughout operation of the Project. Identifying reduced kid to adult ratio due to the Project or loss of high quality habitat greater than the amount identified in the Application/EIS will trigger a review of management and mitigation.

Mountain goat population monitoring will be conducted every five years, following industry standard guidelines (e.g., BC MFLNRO Wildlife Branch guideline for managing ungulates in the Skeena). Aerial surveys for mountain goats will be conducted in the RSA during the winter and summer to ensure population, productivity, and distribution remains constant within anticipated natural variation. Inventory methods will be similar to baseline data collection and will adhere to RISC standards. Survey units delineated during baseline inventory will be used during the monitoring program. If a region-wide population survey lead by the provincial government is initiated, the Proponent would consider contributing to this fund in lieu of conducting independent surveys, on condition that the population survey covers the Project RSA.

High-quality habitat and the Project footprint will be modelled and mapped at various stages of operation to ensure that loss of high-quality habitat due to the Project does not exceed the amount identified in the Application/EIS. It is anticipated that with the current Project design, these targets will be met.

The post-closure monitoring protocol will include monitoring goat habitat and habitat use, particularly in the areas associated with the waste rock storage facility that will be re-vegetated to promote winter and summer goat habitat. Monitoring for goat use will include looking for evidence of tracks, trails, pellet groups, and browse.

26.21.3.3 Grizzly Bear and Black Bear Monitoring Program

26.21.3.3.1 Objectives

The primary objectives of the Grizzly Bear and Black Bear Monitoring Program are to:

- monitor for changes in grizzly and black bear distribution and behaviour and adaptively manage, where necessary; and
- monitor habitat loss to ensure total loss does not exceed the amount identified in the Application/EIS.

26.21.3.3.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on grizzly and black bears and to monitor the effectiveness of mitigation. The following monitoring will be conducted for bears:

- Incidental observations of grizzly and black bears within the development and transportation infrastructure footprint will be monitored, recorded, and reported.

- Direct interactions of bears with infrastructure (e.g., roads and pits) will be monitored and recorded.
- Bear incidents and mortality will be monitored, recorded, and reported.
- Vehicle collisions with bears along Project-controlled access roads will be monitored and reported (Traffic and Access Management Plan, Section 26.25).

Monitoring will occur throughout operation of the mine. High mortality or incidents due to the Project will trigger a review of management and mitigation.

Monitoring of grizzly and black bear occurrence, incidents, and mortality will be conducted during construction, operation, and closure. Bear monitoring will be a component of the larger wildlife and environmental monitoring plan and will include recording bear observations within the development footprint and transportation infrastructure. All workers will be expected to participate in some capacity, as defined during their education process, while environmental monitors will be responsible for interpreting the information and conducting follow-up monitoring if required. Detailed procedures will be developed for recording bear/human incidents, as well as decision-making criteria that will be used to determine responses to incidents. Responses will range from allowing a bear to continue its travel through the site without interference, to, in extreme situations, translocating or destroying a bear in consultation with the BC MFLNRO, or the appropriate regulators.

26.21.3.3.3 Local Population Monitoring

A local population monitoring program will be conducted every five years during the operation phase to monitor the effects of the Project on grizzly and black bears and to monitor the effectiveness of mitigation. The following local population monitoring will be conducted for bears:

- The local grizzly bear population will be monitored for changes in distribution or habitat use throughout the life of the Project using DNA investigation techniques approximately every five years, or using the best available scientific method.
- Loss of bear habitat will be modelled at various stages of operation (e.g., every five years).

A change in grizzly bear distribution due to the Project or loss of high quality habitat greater than the amount identified in the Application/EIS will trigger a review of management and mitigation.

A non-invasive population DNA study using genetic microsatellite markers on hair samples may be conducted in the RSA. The objectives of the DNA study would be to monitor grizzly bear occurrence and distribution in the RSA in the spring, and to monitor grizzly bear use of salmon streams in the fall. This program will build from the baseline grizzly bear DNA program conducted in 2008 and 2009 (Appendix 18-C). The spring and fall DNA sampling program will occur every five years, beginning prior to construction. The focus of the spring DNA program will be on important spring and summer foraging areas along valley bottoms and at higher elevations, and the fall DNA program will focus on salmon spawning areas. Baited stations will be set in the spring (mid-May for a normal snow year), and will be monitored bi-weekly for a

total of four hair collection sessions. The fall trail sets will be implemented in October and monitored through November. If a region-wide population survey lead by the provincial government is initiated, the Proponent would consider contributing to this fund in lieu of conducting independent surveys, on condition that the population survey covers the RSA.

High-quality habitat and the Project footprint will be modelled and mapped at various stages of operation to ensure that loss of high quality habitat due to the Project does not exceed the amount identified in the Application/EIS. It is anticipated that with the current Project design, these targets will be met.

The post-closure monitoring protocol will include monitoring grizzly and black bear habitat and habitat use, particularly in the areas associated with the TMF that will be re-vegetated. Monitoring for bear use will occur at regular intervals and will include looking for evidence of tracks and scat, and for den excavation for hibernating or marmot colony exploitation associated with the RSFs.

26.21.3.4 Furbearer Monitoring Program

26.21.3.4.1 Objective

The primary objectives of the Furbearer Monitoring Program are to:

- ensure that the Project does not cause unsustainable mortality or loss of furbearer productivity;
- monitor habitat loss to ensure that total loss does not exceed the amount identified in the Application/EIS; and
- minimize furbearer use of infrastructure, and adaptively manage where necessary.

26.21.3.4.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on furbearers and to monitor the effectiveness of mitigation. High mortality or incidents due to the Project will trigger a review of management and mitigation.

Incidental observations of furbearers and incidents will be recorded and reported. Mortality events will be reported to the Environmental Department. Effectiveness of skirting along buildings will be inspected regularly to ensure furbearers are prevented from accessing buildings, and skirting will be repaired as necessary. Detailed procedures will be developed for recording furbearer/human incidents, as well as decision-making criteria that will be used to determine responses to incidents.

26.21.3.4.3 Local Population Monitoring

High-quality habitat and the Project footprint will be modelled and mapped at various stages of operation to ensure that loss of high-quality habitat due to the Project does not exceed the amount identified in the Application/EIS. It is anticipated that with the current Project design these targets will be met.

26.21.3.5 Hoary Marmot Monitoring Program

26.21.3.5.1 Objective

The primary objective of the Hoary Marmot Monitoring Program is to monitor for changes in hoary marmot distribution and behaviour near the Project and adaptively manage, where necessary.

26.21.3.5.2 Local Population Monitoring

Monitoring will occur when new areas within hoary marmot habitat become active in the mine plan and/or every five years. Aerial and/or ground surveys will be conducted for hoary marmot colonies proximal to the mine and in the LSA control sites identified during baseline surveys to ensure population, productivity, and distribution remain constant within anticipated natural variation. Inventory methods will be similar to baseline data collection and will adhere to RISC standards. Survey units delineated during baseline inventory will be used during the monitoring program.

26.21.3.6 Bat Monitoring Program

26.21.3.6.1 Objective

The primary objectives of the Bat Monitoring Program are to:

- monitor bat mortality and adaptively manage where necessary; and
- monitor interactions of bats with infrastructure (e.g., tunnels and buildings).

26.21.3.6.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on bats and to monitor effectiveness of mitigation. High mortality or infrastructure use due to the Project will trigger a review of management and mitigation.

Incidental observations of bats will be recorded and reported. Mortality events will be reported to the Environmental Department, and carcasses of unidentified bat species will be sent to the Royal British Columbia Museum as voucher specimens, when possible. Bat interactions with Project infrastructure (e.g., TMF, buildings, and lighted areas) and artificial habitat structures (e.g., tunnels) will be monitored regularly for bat use. Adaptive management may be required if bats start using infrastructure.

The post-closure monitoring protocol will include monitoring infrastructure such as tunnels to ensure that bats are not using them if they are to be decommissioned. Most of the tunnels at the KSM Project will not be decommissioned and will remain in operation post-closure.

26.21.3.7 Bird Monitoring Program

26.21.3.7.1 Objectives

The primary objectives of the Bird Monitoring Program are to:

- monitor water bird and raptor use of infrastructure (e.g., TMF, WSF, transmission line, and pits) and adaptively manage (e.g., deterrents) if deemed necessary; and
- monitor for changes in raptor abundance and habitat use and adaptively manage if significant changes are detected.

26.21.3.7.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on birds, and to monitor the effectiveness of mitigation. The following monitoring will be conducted for birds:

- monitor bird mortality as a result of vehicle strikes (e.g., crossbills and pine siskins) along access roads and record incidents and incidental observations of species at risk and/or nests;
- monitor for wetland birds in the TMF, WSF, and near other Project infrastructure, and adaptively manage where necessary; and
- monitor for raptor use of Project infrastructure, and adaptively manage where necessary—raptor use of on-site pits and transmission line towers for nesting will be monitored.

Monitoring will occur throughout operation of the Project. High mortality due to the Project will trigger a review of management and mitigation.

Bird monitoring will be a component of the larger Wildlife Environmental Management and Monitoring Plan and will include recording notable sightings (e.g., large or unusual concentrations, incidences of rare birds or birds at risk, and nests) within the development footprint and infrastructure, including the access corridors and near supporting infrastructure such as power lines. Bird mortalities will be recorded by the Environmental Department and will be subject to further investigation. All workers will be expected to participate in some capacity, as defined during their education process, while the Environmental Department and delegates will be responsible for interpreting the information and conducting follow-up monitoring, if required.

Wetland bird use of the TMF and WSF will be monitored through the migration and breeding periods during operation, and appropriate steps will be taken to attempt to deter birds from the TMF and WSF if deemed necessary by the Aquatic Effects Monitoring Plan (Section 26.18.2) and the Water Management Plan (Section 26.17.7). Deterrent systems will be adapted over time, if necessary, and the need to deter birds will be evaluated based on operating experience.

A raptor nest monitoring program will be conducted to record use of the pits and other infrastructure such as transmission line posts for nests, and mitigation measures will be implemented if required. The transmission line will be monitored for electrocution hazards and bird strikes and will be managed adaptively (Demarchi, Bentley, and Sopuck 2005; APLIC 2006).

26.21.3.8 Western Toads

26.21.3.8.1 Objective

The primary objectives of the Western Toad Monitoring Program are to:

- monitor the effectiveness of mitigation measures (e.g., clear span bridges, concrete box culverts, open bottom culverts, tunnels, and salvage programs); and
- monitor western toad breeding and migration activities if they occur in areas that are affected by the Project.

26.21.3.8.2 Site Monitoring

An on-site monitoring program will be initiated during the construction and operation phases to monitor the effects of the Project on western toads and to monitor effectiveness of mitigation. The following monitoring will be conducted for western toads:

- The success of salvage programs (if implemented) will be monitored.
- The effectiveness of the Wetlands Compensation Plan and Fish Habitat Compensation Plan to support western toads will be monitored.
- The effectiveness of methods used to facilitate toad migration through road corridors will be monitored and adaptively managed.
- If western toad breeding ponds are observed, they will be monitored for success if they are adjacent to Project infrastructure, or may be salvaged.

Monitoring will occur throughout operation of the Project. Mortality due to the Project or loss of western toad breeding habitat will trigger a review of management and mitigation.

If a salvage program is implemented, the wetland will be monitored during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad use of salvage recipient breeding ponds. Monitoring will also occur at wetland compensation sites and fish habitat compensation sites that incorporated western toad habitat into the design. These sites will be monitored for western toads during the breeding (May) and emergence periods (mid-July to mid-August), as part of the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R).

Because western toads are known to occur in the LSA near the TCAR, the road will be monitored for toad migrations during periods of peak toad post-breeding movement (August). As there are no identified high-quality breeding ponds immediately adjacent to the road route, monitoring will focus on stream crossings as the most likely locations for toad migration. If migration routes cross the road, and mitigation measures incorporated into the road design, including open bottom culverts or concrete box culverts are not sufficient to protect migration routes, additional mitigation measures will be implemented. All incidental observations and mortalities (if any) of western toads will be recorded and reported.

26.21.3.9 Reporting

A summary of the data collected will be reported in the WEMP report. The report will summarize wildlife encounters and will identify any adaptive management strategies that were employed.

For Local Population Monitoring, the results will be presented in the years they are conducted (e.g., every five years). For example, the total area of habitat lost (if any) and the area that was reclaimed and re-vegetated (if any), will be presented in the WEMP report during the years in which habitat modelling is conducted (e.g., every five years). Results of the grizzly bear DNA monitoring program and the ungulate population monitoring programs will be presented in the WEMP report as they are conducted (e.g., every five years). The WEMP will include analyses of the results with comparisons to findings from earlier years (i.e., baseline and previous monitoring years) and will include recommendations (if any) for changes to wildlife monitoring and management practices.

26.21.3.10 Responsible Person

WEMP reporting will be the responsibility of the Environmental Department, ultimately the wildlife effects monitoring program will be the responsibility of the Environmental Superintendent. Consultants and contractors hired to implement aspects of the WEMP will be experienced wildlife biologists.

26.22 Noise Management Plan

No significant adverse effects were identified for the construction or operation phases of the Project if mitigation options for sleep disturbance at worker camps are followed. However, it is important that noise levels are monitored to ensure that operational Project requirements do not result in noise levels that are higher than estimated in this study.

26.22.1 Legislation and Standards

26.22.1.1 Potential Effects

26.22.1.1.1 Sleep Disturbance

From the Health Canada guideline (2011): "Sleep disturbance includes the following effects of noise: difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep."

Health Canada (2011) advises that the recommendations and guidelines of the World Health Organization (WHO; 1999) regarding sleep disturbance be taken into consideration in the environmental assessment. In quiet rural areas and for susceptible populations such as those in hospitals, or convalescent or senior homes, Health Canada suggests that WHO guideline levels not be exceeded. WHO's *Guidelines for Community Noise* (1999) report a threshold for sleep disturbance of an indoor nighttime sound level (L_n) of no more than 30 dBA for continuous noise.

Health Canada (2011) also quotes the WHO (1999) for individual noise events: "For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dBA L_{AFmax} more than 10 – 15 times per night."

Sound is attenuated as it is transmitted indoors and the amount of reduction mostly depends on whether windows are open. Health Canada (2011) suggests to assume an outdoor-to-indoor noise reduction of 15 dBA if windows are open, and 27 dBA if windows are closed. The actual reduction depends on construction materials, geometry, etc. of the room.

Generally, noise effects are only assessed at human receptors not employed by the Project. However, Health Canada (2011) also recommends the assessment of sleep disturbance at on-site mine camps.

26.22.1.1.2 Interference with Speech Communication

If continuous Project noise indoors or outdoors is high enough, the Project could interfere with speech communication such that speakers will need to increase their vocal effort or move closer to each other. Health Canada (2011) advises that an indoor level of 40 dBA or an outdoor level of 55 dBA or greater would be required for good speech comprehension.

26.22.1.1.3 Complaints

Health Canada (2011) suggests: "The likelihood of a complaint is directly linked to the ability or willingness of an individual to make a complaint and his or her expectation that the complaint will result in noise reduction." Therefore, there is not always a strong link between the disturbance and the complaint. However, Health Canada suggests that "widespread complaints" become more likely above an L_{dn} of 62 dBA and that "several threats of legal action or strong appeals to authorities to stop noise" should be expected if the Project L_{dn} is greater than 75 dBA.

26.22.1.1.4 High Annoyance

The response to noise is subjective and is affected by many factors, such as the:

- difference between the specific sound (sound from the Project) and the residual sound (noise in the absence of the specific sound);
- characteristics of the sound (e.g., if it contains tones or impulses);
- absolute level of sound;
- time of day;
- local attitudes to the Project; and
- expectations of quiet.

The "Percent Highly Annoyed" or "%HA" metric, which is calculated using the adjusted L_{dn} (or Rating Level) – pre- and post-project, is "an appropriate indicator of noise-induced human health effects for project operational noise and for long-term construction noise exposure" (Health Canada 2011).

When assessing potential impacts, adjustments should be made to account for more annoying sound characteristics: specifically if the sound at the receiver location can be characterized as having tones, impulses, or strong low-frequency content (Health Canada 2011). The penalty for tones and regular impulsive sound is a + 5 dBA adjustment to the sound pressure level.

The penalty for highly impulsive noise is a + 12 dBA adjustment. The penalties for high-energy impulsive sound (e.g., blasting) and sound with strong low frequency content are variable and calculated according to the American National Standards Institute (ANSI) standard S12.9-2005/Part 4 (ANSI 2005). The penalty for sound with strong low-frequency content should only be considered if the C-weighted sound pressure level is more than 10 dB higher than the A-weighted sound pressure level.

Health Canada (2011) advises that "noise mitigation measures be considered when a change in the calculated %HA at any given receptor exceeds 6.5%" or if the project L_{dn} exceeds 75 dBA.

26.22.1.1.5 Noise-induced Rattling

Health Canada (2011) references the ANSI standard S12.9-2005/Part 4 (ANSI 2005), stating, "To prevent rattles from low-frequency noise and the associated annoyance from this effect, ANSI indicates that the (energy) sum of the sound levels in the 16-, 31.5- and 63-Hz octave bands be less than 70 dB." Health Canada (2011) advises implementing feasible mitigation measures if this criterion, based on if the low frequency sound level, or L_{LF}, is exceeded.

26.22.1.1.6 Noise-induced Hearing Loss

Health Canada (2011) advises: "When the human ear is exposed to excessive sound levels over long periods of time, permanent damage may occur (WHO 1999). There is no known risk of hearing loss associated with sound levels below 70 dBA regardless of the exposure duration. However, as sound levels increase, the duration of daily exposure becomes an important risk factor for hearing loss."

Noise-induced hearing loss concerns are normally most efficiently addressed in a project's detailed design phase due to the high variation in actual occupational noise exposures depending on design details. Therefore, assessing the potential for noise-induced hearing loss has not been included in this assessment.

26.22.1.1.7 Loss of Wildlife Habitat (Sensory Disturbance)

The potential effects on wildlife are described in terms of the following responses resulting in a functional loss of habitat" and/or sensory disturbance:

- reduction in biodiversity and population numbers due to "above threshold" continuous noise levels; and
- flight response, freezing, or strong startle response due to event noise levels (e.g., helicopter and blasting).

Project-related noise was considered and assessed based on noise levels assessed during construction and operation. The following limits were identified:

- continuous Project noise during the day (55 dBA);
- continuous Project noise during the night (45 dBA);
- helicopter overflight A-weighted sound exposure levels (L_{AE}; 75 dBA); and

- peak blasting noise levels (108 dB Lpeak).

26.22.1.2 Noise Impact Criteria

Based on the previous identification of potential effects, seven criteria have been chosen to rate potential effects (Table 26.22-1). All of these criteria are for offsite human receptors except for sleep disturbance, where on-site mine camps were assessed with the assumption that windows would be closed. A significant effect is likely to occur if any of the following occur at any receptor outdoors:

Table 26.22-1. Project Criteria

Project Metric	Description	Limit
L_d	Daytime noise level for assessing speech interference and wildlife habitat loss	55 dBA
L_n	Nighttime noise level for assessing sleep disturbance *outside* the Project boundary and wildlife habitat loss	45 dBA
	Night-time noise level for assessing sleep disturbance *inside* the Project boundary	57 dBA
L_{dn}	Assessing the likelihood of complaints	62 dBA
	Legal action / Project noise mitigation required	75 dBA
Δ %HA	Increase in %HA metric before and after Project initiation	6.5%
L_{LF}	Using the sum of low-frequency energy content to assess the likelihood of noise-induced rattling	70 dB
	Assessing low-frequency noise annoyance: sum of low-frequency energy content > 65 dB and C-weighted L_{dn} exceeds A-weighted L_{dn} by 10 dB	65 dB 10 dB
L_{AE}	Sound exposure level for assessing wildlife sensitivity to helicopter noise	75 dBA
L_{peak}	Peak sound pressure level for assessing wildlife sensitivity to impulsive blasting noise	108 dB

The maximum nighttime sound level (L_{AFmax}) was not included because no nighttime blasting, or aircraft traffic is expected. Therefore, the nighttime equivalent sound level, L_n, should provide a better assessment of sleep disturbance.

26.22.1.3 Mitigation Criteria

If the noise impact assessment criteria are exceeded at any receptors, noise mitigation options using the Best Available Techniques Not Entailing Excessive Cost (BATNEEC) approach will be investigated to avoid significant adverse effects. The interpretation of "excessive cost" will depend on the significance of the noise impact. This approach is not to be confused with the approach commonly implemented in industry: the Cheapest Available Technique Not Incurring Prosecution (CATNIP).

26.22.2 Objective

The objectives of this Noise Management Plan are to:

- ensure all relevant regulatory requirements and published best practice recommendations are met;
- manage and minimize the impact of noise from mining operations on the community and environment;
- maintain an effective response mechanism to deal with issues and complaints; and
- ensure the results of noise monitoring comply with applicable criteria.

26.22.3 Targets

Noise levels at sensitive receptors identified in Section 7.1 of the Noise Technical Report (Appendix 19-A) should be controlled to comply with those limits identified in Section 26.22.1.2.

There are three main mitigation strategies for noise control. These noise mitigation strategies should follow a hierarchy of control, with source control always being the preferred option where reasonable and feasible, and control at the receiver the least favourable option.

- **Controlling noise at the source.** There are two approaches:
  - Best Management Practice; and
  - Best Available Technique Not Entailing Excessive Cost (BATNEEC).
- **Controlling the transmission of noise.** There are two approaches:
  - the use of barriers; and
  - land use controls, which attenuate noise by increasing the distance between source and receiver.
- **Controlling noise at the receiver.** This is the least-preferred control option and is applied when all other methods of noise control have been evaluated and implemented and further improvements are still required for the receptor. If further controls are required, the most effective options should be evaluated by a noise specialist in order to maximize the effectiveness of mitigation; this would be undertaken on an as-needs basis. Implementation of each of the three strategies for the Project is addressed in the following sections.

26.22.4 Actions to Avoid, Control, and Mitigate

The BATNEEC approach involves the assessment of all factors that contribute to the resulting noise impact. The major noise sources contributing to levels at or near the thresholds identified comprise mobile equipment and blasting activities. The most sensitive receptors within the Mine Site are the worker camps and mountain goat population points. The following factors identified using the BATNEEC approach should be considered during detailed design and operation to minimize affecting these receptors.

26.22.4.1 Mobile Equipment

The following recommendations should be followed concerning mobile equipment operating near worker camps during sleeping hours (sleeping hours are defined as any time workers are sleeping, and are not limited to nighttime due to the continuous production nature of the mine):

- using the quietest available equipment;
- maintaining equipment to minimize noise;
- optimizing the site layout to minimize noise impact, e.g., through the use of natural screens such as buildings, open doors facing away from noise sources, etc.;
- maximizing the distance between roads servicing mobile equipment and worker camps;
- optimizing site procedures to minimize the noise impact, e.g., keeping doors closed, conducting noisy procedures indoors;
- optimizing hours of operation for noisy procedures to minimize noise impact and/or restricting to specific hours so that workers know when to expect particularly annoying noise events during sleeping hours;
- conscious application of other site operations to minimize noise; and
- using barriers to minimize noise impact.

26.22.4.2 Stationary Equipment

- Ensure that stationary equipment such as generators, light plants, power plants, incinerators, etc. are not placed in close proximity to worker camps.
- Generators should be located within a noise enclosure, if possible.
- Cladding of bins, crushers, and conveyors is recommended.
- Low noise conveyors should be specified throughout.

26.22.4.3 Blasting

- Avoid blasting configurations that could result in more than seven holes detonating simultaneously.
- Ensure blast holes are stemmed to at least 6 m.
- Publish blasting schedule for workers so earplugs may be worn if this coincides with sleep times.

26.22.4.4 Indoor Equipment

All equipment located indoors, such as at the OPC, should not exceed an interior reverberant level of 85 dBA, or as specified by occupational noise limits.

26.22.5 Mitigation Plans

Operational noise-mitigation plans should be developed based on the above best practice guidelines. These will be triggered if the noise monitoring program records levels that exceed the relevant criteria or if complaints have been received by the community or stakeholders.

26.22.6 Monitoring

The objective of noise monitoring is to make sure that noise levels propagated from the Project will meet human health and wildlife standards and guidelines as identified in Section 26.22.1.2, and to provide relevant stakeholders with timely and concise information that indicates whether the EMPs developed to mitigate any negative effects are on track to achieve stated objectives. Periodic noise monitoring should be performed to assess noise levels at sensitive receptor locations.

26.22.6.1 Noise Monitoring Locations

26.22.6.1.1 Nightime Mine Noise at Worker Camps

Overnight noise monitoring should be periodically conducted at worker camps to ensure that limits for sleep disturbance are not exceeded.

26.22.6.1.2 Blasting Noise Monitoring

Instantaneous noise levels as a result of blasting activities should be monitored at a position anywhere along the 120 dB L_{peak} contour line as per the wildlife assessment in Section 18.7.3 of Chapter 18. Monitoring instrumentation should be placed in an exposed area such that local shielding effects of noise are minimized.

26.22.6.1.3 Helicopter Noise Monitoring

Sound exposure levels as a result of helicopter overflights should be monitored at a position representative of mountain goat habitat as per the wildlife assessment in Section 18.7.3 of Chapter 18. Monitoring instrumentation should be placed in an exposed area such that local shielding effects of noise are minimized and where there is direct line of site to the helicopter flight track.

26.22.6.1.4 Interior Noise Levels at Production Facilities

Noise monitoring should be conducted indoors to ensure that occupational noise limits are met.

26.22.6.2 Sampling Techniques

The internationally recognized International Organization for Standardization (ISO 2007; ISO 1996-2:2007) standard provides guidelines for the measurement of environmental sound, and encompasses the following aspects:

- instrumentation system;
- calibration;
- monitoring locations;

- evaluation of measurement results;
- measurement uncertainty; and
- documentation.

Noise monitoring measurements should be performed in compliance with this standard. Noise monitoring should be coordinated so that measurements can be conducted during representative conditions. Noise monitoring occurring over a short period of time (such as with blasting) should be attended; however, monitoring occurring over longer time periods may be unattended. Representative conditions include source operating conditions and weather conditions. Noise monitoring should be conducted at least once per year during active construction and operation and during blasting periods.

26.22.6.3 Noise Monitoring Equipment

The acoustic instrumentation system—consisting of a microphone, wind screen, cable, and recorder—should conform to class 1 or class 2 requirements as defined by the International Electrotechnical Commission (IEC) 61672-1 (IEC 2002-05). The sound level meters should be field calibrated immediately before and after each measurement with a class 1 calibrator in accordance with IEC 60942:2 (IEC 2003-04).

Windscreens should always be used during outdoor measurements and should be clean, dry, and in good condition.

26.22.6.4 Placement of Monitoring Equipment

The number of monitoring locations should be chosen to adequately assess the varying noise environment of the human and wildlife receptors within the study area.

Microphones should normally be located outdoors, approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., a wall). Nighttime monitoring at worker camps should be performed indoors to compare with the recommended WHO indoor noise criteria (WHO 1999). The microphone location should represent where a person's head would be while sleeping.

26.22.6.5 Safe Work Procedures

Personnel performing the noise monitoring will follow Health and Safety guidelines for the KSM Project.

Personnel will:

- prepare a site work plan, emergency response plan, and identify hazards prior to each monitoring program;
- wear personal protective equipment (eye protection, hard hat, and steel-toe boots);
- make sure to have stable footing on steep slopes;
- be aware of loose branches, falling branches, and shrubs when working in the woods;
- not work alone;

- maintain scheduled communication with the designated Site Environmental Officer;
- avoid excess exposure to sun;
- wear insect repellent;
- reduce or avoid monitoring during lightning and thunderstorms; and
- wear flotation devices when near waterbodies.

26.22.7 Documentation and Record Keeping

Records of noise-monitoring activities and associated management action, including operational controls and mitigation, shall be retained to ensure the continued safe and economical management of noise-generating activities.

Data to be collected during monitoring should be as described in the reporting section below.

26.22.7.1 Complaints Procedure

Upon receipt of a complaint from the community, preliminary investigations should commence as soon as practicable to determine the likely causes using information such as prevailing climatic conditions, the nature of activities taking place, and recent monitoring results. A response will be provided as soon as practicable, which may include the provision of relevant monitoring data, if requested.

When specific complaints are received in relation to noise at a particular residence, noise monitoring may be undertaken at or near the complainant's residence if the Environmental Manager (or designate) deems the complaint likely to be valid.

Every effort will be made to ensure that concerns are addressed in a manner that facilitates a mutually acceptable outcome for both the complainant and the Project.

26.22.7.2 Complaints Register

The Environmental Manager (or designate) will record all community complaints into a site event management database. The database should be maintained to include reporting, incident/event notification, close out action tracking, risk management, inspection, audits, and document management.

The following information related to noise complaints from the public should be recorded:

- name;
- address;
- contact telephone number;
- date and time of registering complaint;
- date and time when noise occurred;
- subjective assessment of magnitude; and
- detailed description of noise.

26.22.7.3 Noise Monitoring Exceedance

In situations where attended noise results are identified as exceeding the impact assessment criteria, the following actions should be undertaken:

- The Environmental Coordinator must be notified as soon as practicable of any exceedance identified during noise monitoring.
- The Environmental Coordinator and noise consultants will investigate the results of the noise monitoring for the potential causes of the exceedance.
- Workers will be notified as soon as possible when an exceedance is identified.
- The Environmental Manager (or designate) will initiate investigations as to the cause of the exceedance and will prepare a detailed report of the incident.
- The Environmental Manager (or designate) will prepare a detailed report as a result of the investigation and will provide workers and any other relevant agencies with the report within a respectable timeframe of not more than 10 days.
- If no recognizable causes can be identified, further investigations may be undertaken to identify the cause—e.g., specific weather or atmospheric conditions.
- Where the cause is identified, additional controls will be implemented or the operational method will be altered.
- Additional follow-up monitoring may be required to determine the effectiveness of any corrective actions implemented.
- Any corrective action will be recorded and reported to the Environmental Coordinator, who will keep a record of all significant proactive and reactive actions.
- The Environmental Coordinator will be informed of any complaint and details must be recorded in the site event management database, in addition to response and actions taken.

26.22.8 Reporting

An appropriate measurement report should be used to:

- demonstrate compliance with the Noise Management Plan;
- demonstrate compliance with calibration standards in case the measurement is challenged by an external party;
- permit repeating the measurement in the future to evaluate a change in source or propagation conditions or in case the measurement is challenged by an external party;
- permit comparison with similar situations; and
- permit an external party to perform more detailed measurements and/or analyses without needing to repeat the original measurement.

26.22.8.1 Measurement Reports

Measurement reports should be completed after each monitoring session. Templates should be created for the different measurement scenarios in order to provide a method for producing reports efficiently and consistently. Templates may be useful in word processing and measurement analysis software.

The measurement report contents should minimally include:

- the relevant noise limit (if applicable);
- the reference time interval(s), e.g., eight-hour period, as per the criteria;
- a description of the sound source(s) included in the reference time intervals;
- a description of the operating conditions of the sound sources;
- a description of the assessment site including the topography, building geometry, ground cover, and condition and locations, including height above ground, of the microphone(s) and source(s);
- the time, day, year, and place for the measurements;
- the instrumentation used (i.e., models and serial numbers) and calibration results;
- the measurement time intervals;
- a description of weather conditions during the measurements, particularly wind direction and speed, cloud cover, and whether precipitation was present, as well as temperature, barometric pressure, humidity, and the location of the weather instrumentation;
- a description of the residual sound;
- a description of any procedures used to correct for contamination by residual sound, including a description of any noise modelling performed, including prediction standard and calculation settings;
- the rating level and the components, including acoustic levels contributing to the rating level;
- whether the measurement demonstrates compliance with the noise limit (if applicable);
- a figure showing measurement positions on a map; and
- a photograph of microphones as set up.

Many of these items can be recorded while at the site on a field data sheet. All measurement data, photographs, and field data sheets should be stored electronically to permit future access as required.

26.22.8.1.1 Blasting

The following records for each blast event shall be recorded:

- date and time of blast;
- name and signature of Certified Blasting Engineer supervising the event;

- environmental conditions (e.g., temperature, cloud conditions, and wind speed and direction) that may affect the noise/vibration characteristics of the blast;
- location of blast (mine coordinates, elevation, and description);
- sketch of blast pattern, including depth and diameter of holes, number of holes in blast and holes per delay, spacing of holes, burden on rows and direction of throw, and the type and dimensions of decking and stemming in blastholes;
- type, product name, package dimensions, and density of explosives;
- distribution and weight of explosive per hole;
- maximum weight of explosive per delay;
- delay type, sequence, pattern, and timing;
- initiation system description; and
- mats, padding, or other mitigation measures employed.

26.22.8.2 Evaluation of Measurement Results

There is the chance that atypical events will be captured during the monitoring period, which can then reduce the overall validity of the monitoring program. Atypical events are not representative of the wide-area noise environment being assessed. The risk of capturing these occurrences is increased when the noise environment is relatively quiet. These events typically result from sound created close to the microphone by humans, plants and trees (due to wind), rain, or animals.

In order to reduce the chance of including atypical events in the measurement results, class 1 sound level meters that simultaneously record audio files will be used. Once the measurement data are downloaded to the computer and exported to the post-processing software, suspect noise events can be quickly reviewed and listened to in order to determine whether they should be included in the measurement results.

A noise model can also be used to estimate the baseline noise level at other locations, based on the results of the monitoring program, if discrete sound sources and setback distances have been identified (e.g., roadways).

26.22.8.3 Measurement Uncertainty

Measurement uncertainty can be attributed to instrumentation, sound source operating conditions, and weather and ground conditions. These should be assessed and summarized.

26.22.8.4 Reporting

Reports (frequency to be determined) should be submitted to the Environmental Manager (or designate) using a consistent template for the first year of construction. An annual report will be circulated at the end of the first year to relevant stakeholders for review and comment. A meeting will follow, at which time recommendations for the revision and refinement of management plans will be made.

The reports will include:

- noise-monitoring results and comparison to performance criteria;
- noise-related complaints and management/mitigation measures undertaken;
- management/mitigation measures undertaken in the event of any confirmed exceedance of performance criteria; and
- review of the performance of management/mitigation measures and the monitoring program.

The Environmental Manager (or designate) will perform routine inspections and audits to document compliance with the Noise Environmental Management Plan. Should non-compliance be observed, a corrective action notification will be issued that outlines what measures will need to be undertaken within a given timeframe to bring the work back into compliance with this plan. The audit and checking concept associated with this plan is crucial in ensuring that potential effects to the environment from waste produced during construction are minimized.

26.22.8.5 Review

This Noise Management Plan will be reviewed, and, if necessary, revised to the satisfaction of stakeholders and regulatory authorities within three months of the following:

- submission of the annual report;
- modification to the conditions of the original Project approval;
- changes to Project approval or licence conditions relating to noise management or monitoring;
- significant incidents at the Project related to noise;
- an independent environmental audit that requires changes to the Noise Management Plan or to the noise-monitoring practices; or
- if there is a relevant change in technology or legislation.

26.23 Heritage Management and Monitoring Plan

Heritage sites are non-renewable resources, very susceptible to disturbance, and are finite in number. They are an important resource that is protected for their historical, cultural, scientific, and educational value to the general public, local communities, and First Nations. The Heritage Environmental Management Plan is designed to minimize adverse effects to archaeological sites by the Project.

26.23.1 Legislation and Standards

Protection of heritage sites in BC is granted under the terms of the Heritage Conservation Act (HCA; 1996g). Studies conducted for the Project are done in accordance with the *British Columbia Archaeological Impact Assessment Guidelines* (Archaeology Branch 1998) and the *British Columbia Archaeological Inventory Guidelines* (BC Ministry of Small Business Tourism

and Culture 2000). Alteration to protected heritage sites requires a site alteration permit issued under Section 12 of the HCA (1996). Archaeological impact assessments, monitoring, and site inventory are conducted under permits issued through Section 14 of the HCA (1996). A Section 12 Permit is issued once adequate curation of the archaeological site has taken place under a Section 14 Permit.

26.23.2 Heritage Protection of Known Archaeological Sites

26.23.2.1 Objective

The objective of Heritage Protection is to manage known archaeological sites within the KSM LSA as defined for this VC, which may be affected by the Project to avoid or reduce adverse effects during construction and operation.

26.23.2.2 Targets

The target for the archaeological sites within the LSA is to reduce the Project effects to negligible levels. The preferred option to achieve this is through avoidance; however, if avoidance is not possible, mitigation measures can also reduce the residual effects to negligible levels. Mitigation, if necessary, will be carried out under HCA Permit and determined in consultation with the Archaeology Branch. Possible mitigation measures may include systematic data recovery, construction monitoring, and/or site capping amongst others.

26.23.2.3 Actions to Avoid, Control, and Mitigate

26.23.2.3.1 Design Criteria

The baseline study identified seven archaeological sites within the LSA. The preferred option is to avoid known archaeological sites during the design phase of the Project.

26.23.2.3.2 Construction

If avoidance through Project redesign is not an option, known archaeological sites in conflict with the design must be mitigated by measures developed in consultation with the Archaeology Branch and conducted under Section 12 Site Alteration permits prior to the construction phase.

Effects due to construction have been assessed within the LSA. Five known archaeological sites (HcTo-1, HdTk-4, HdTn-1, HdTn-2, and HdTo-7) located within 50 m of the Project footprint have a high probability of being affected by ground altering activity during Project construction. For archaeological sites HcTo-1, HdTn-1, HdTn-2, and HdTo-7, where avoidance is not feasible, mitigation measures, determined in consultation with the Archaeology Branch, will be used to reduce residual effects to not significant. It is anticipated that mitigation measures at these sites will include systematic data recovery or preservation through site capping. Archaeological site HdTk-4, located within 50 m of the transmission line corridor, will be avoided. To ensure that no adverse effects to HdTk-4 take place during construction, mitigation measures, to be determined in consultation with the Archaeology Branch, may be required. These measures may include fencing or site capping. It is anticipated that avoidance will be possible for sites HdTl-1 and HdTo-6, which are located within the LSA and more than 50 m from Project developments. To protect archaeological sites within the LSA, mine employees and contractors will be educated about site

avoidance, and sites within the LSA will be marked as "no work zones" on Project construction maps.

26.23.2.3.3 Operation

Two archaeological sites (HdTl-1 and HdTo-6), located within 500 m of the Project footprint, will not be affected by direct disturbance; however, they may be indirectly affected through increased human presence. To protect these archaeological sites, mine employees and contractors will be educated about site avoidance, and sites within the LSA will be marked as "no work zones" on Project construction maps.

26.23.2.3.4 Closure

No adverse effects are anticipated during closure.

26.23.2.3.5 Post-closure

Roads will be decommissioned following closure, except where they are required to be maintained for long-term monitoring and worker safety, to limit indirect adverse effects on archaeological sites due to increased human presence in the area in the post-closure phase.

26.23.2.4 Reporting

If mitigation is necessary, the requirements will be determined in consultation with the Archaeology Branch and will require a Section 12 Site Alteration Permit, issued by the Archaeology Branch. Reports will be submitted to, and require approval from, the Archaeology Branch prior to the commencement of construction activities of developments in conflict with archaeological sites.

26.23.2.5 Responsible Person

Mitigation measures must be conducted by a qualified archaeologist.

26.23.3 Heritage Protection of Unknown Archaeological Sites

26.23.3.1 Objective

The objective of Heritage Protection is to use a reliable, proven, methodology for discovering, identifying, and managing archaeological sites identified construction and operation in order to reduce adverse effects. The KSM Project Chance Find Procedures will be used to protect unknown sites.

26.23.3.2 Targets

The target for the Heritage Protection of Unknown Archaeological Sites is to identify potential unknown archaeological sites within the LSA prior to adverse effects from Project activity.

26.23.3.3 Actions to Avoid, Control, and Mitigate

26.23.3.3.1 Design Criteria

Even the most thorough study may not identify all archaeological resources that may be present, and a framework for the avoidance or mitigation of archaeological sites, if present, that were not identified during the Archaeological Impact Assessment (AIA) will be provided.

26.23.3.3.2 Construction

An Archaeological Chance Find Procedure will be implemented prior to the commencement of construction activities, and all mine employees and contractors will be made familiar with the procedure. Any revisions to the currently proposed Project footprint should be reviewed by a qualified professional archaeologist to determine if additional AIA work is required.

26.23.3.3.3 Operation

An Archaeological Chance Find Procedure will be implemented prior to the commencement of construction activities, and all mine employees and contractors will be made familiar with the procedure.

26.23.3.3.4 Closure

No adverse effects are anticipated during closure.

26.23.3.3.5 Post-closure

Roads will be decommissioned following closure, except where they are required to be maintained for long-term monitoring and worker safety, to limit indirect adverse effects on archaeological sites due to increased human presence in the area in the post-closure phase.

26.23.3.4 Reporting

If additional AIA work is required due to changes to the Project footprint during construction an archaeologist will conduct the work under a HCA Permit. If a chance find is located during construction or operation, the Archaeological Chance Find Procedure will be followed.

26.23.3.5 Responsible Person

Chance finds will be reported to the company, the nearest Environmental designate, by workers. The Environmental Department will be responsible to contact an archaeologist familiar with the KSM Project. The archaeologist will work with the KSM operating company to manage any additional archaeological investigations required based on Project design changes or chance finds.

26.24 Visual Quality Management Plan

The Project has the potential to alter the visual quality at locations around the visual quality local study area for several types of land users, primarily recreation users. The intent of the Visual Quality Management Plan is to mitigate these alterations by limiting effects for land users.

26.24.1 Legislation and Standards

The Cassiar Iskut-Stikine Land and Resources Management Plan (CIS LRMP; BC ILMB 2000) directs the management of public lands and resources for the Canadian portions of the Stikine and Unuk River watersheds. The CIS LRMP (BC ILMB 200) includes management guidelines for mining activities within its boundaries and management direction statements related to visual quality. The LRMP's General Management Direction guides resource activities on all Crown land outside of protected areas. Visual quality is one resource value addressed in the General Management Direction (BC ILMB 2000). The visual quality objectives were designed for forestry activities and are not necessarily a reasonable standard for non-forestry activities such as mining. However, those performing non-forestry activities can be aware of and try to follow the visual quality objectives where feasible.

26.24.2 Objective

The objective of the Visual Quality Management Plan is to maintain visual quality for recreational users.

26.24.3 Targets

The Visual Quality Management Plan focuses on limiting effects of Project activities on visual quality for land users at locations they are likely to visit. The Visual Quality Management Plan defined a target establishing that, at post-closure, the visual quality effects will be similar to those predicted in the visual and aesthetic resources effects assessment (i.e., equivalence in HASSELL matrix values; see Chapter 24).

26.24.4 Actions to Avoid, Control, and Mitigate

The actions identified under the Visual Quality Management Plan apply to the construction, operation, closure, and post-closure phases of the Project. During the construction and operation phases, Project components will be built to lessen visual alteration of natural landscapes where practicable.

During the first three phases:

- The design of the CCAR and the TCAR will reduce effects on appearance of natural landscape, as practical. A tree buffer will be left around the road when possible.
- Tree buffers will be maintained around other access roads, where possible, with consideration to the safety of road users.
- Tree buffers will be maintained around major infrastructure where possible, when infrastructure is potentially in view of heli-ski areas.

During closure, non-essential roads will be re-vegetated. During closure and post-closure, the dam faces will be covered either with an erosion protection layer or with till and will be re-vegetated.

26.24.5 Monitoring

Monitoring will consist of a surveillance and analysis at the end of construction and end of closure to assess the changes in visual quality for recreational users.

26.24.6 Reporting

Visual quality monitoring results will be reported at the end of construction and closure. Requirements for reporting will be determined during the permitting of the KSM Project. Responsible agencies may be the British Columbia Ministry of Forests, Lands and Natural Resources Operations and the Skeena-Stikine Forest District Office in Smithers, BC.

26.24.7 Responsible Person

The development and implementation of the Visual Quality Management Plan will be the responsibility of the Environmental Superintendent.

26.25 Traffic and Access Management Plan

The KSM Project will have two separate access roads, the CCAR that will connect the Mine Site to Highway 37 via the Eskay Creek Mine road, and the TCAR that will connect the Treaty OPC to Highway 37 directly. Furthermore, a third access road will be developed for seasonal (i.e., winter) use during construction following the glaciers between the Granduc Mine road and the head of the Ted Morris Creek Valley. The intention is to bring equipment over the glacier, like other Projects in this region, to begin construction on the CCAR from both ends.

The identified Project effects on Land Use (Chapter 23) include a potential to increase access to land areas within the LSA and RSA due to the construction of Project roads, thereby opening up resources to increased pressure from unregulated fishing, hunting, and trapping activities. Vehicular collisions associated with increased access from unauthorized land users could elevate direct and indirect wildlife mortality and disruption of movement.

26.25.1 Coulter Creek Access Road

The Eskay Creek Mine operated until 2008. The Eskay Creek Mine site is accessed by a resource road that starts at Highway 37, south of Bob Quinn Lake, and travels west across the Ninginsaw River and parallel to the south bank of the Iskut River for about 37 km. From that point, the road climbs the valley of Volcano Creek to the Eskay Creek Mine site. The first 37 km of the road now provides access to newer resource development projects such as AltaGas's Forrest Kerr hydroelectric development. The CCAR will start at about km 56 of the Eskay Creek Mine road and will extend about 35 km down Coulter Creek, across the Unuk River along the Sulphurets Creek Valley to the KSM Project Mine Site.

Traffic levels on the CCAR during Project construction will vary. It is estimated that there will be a total of 2,883 one-way trips, with an average of about 8 trips per day, to deliver equipment, materials, and personnel required for construction of the Mine Site infrastructure. Vehicle types will include flat deck trucks, vans, buses, passenger vehicles, lowboys, and tankers (for fuel and lime).

Traffic levels during mine operation are estimated at about three one-way trips per day, consisting primarily of B-train trucks hauling ammonium nitrate used for explosives manufacturing. The CCAR will also be used to deliver or remove major mining equipment, such as haul trucks, as Project demands vary over time.

26.25.2 Treaty Creek Access Road

The TCAR will leave Highway 37 approximately 19 km south of Bell II, cross the Bell-Irving River, and will follow the north side of the Treaty Creek Valley for approximately 17 km (Figure 4.5-7). A junction will occur at this point, and the North Treaty lower road will turn north and follow the west side of the North Treaty Creek/Teigen Creek Valley for approximately 12 km to the Treaty OPC site. At this same junction, the TCAR will transition into the Treaty Saddle road and head east. It will provide access to the east portal of the Mitchell-Treaty Saddle Area. The Treaty Saddle road will extend beyond the Mitchell-Treaty Saddle Area to the construction adit. This part of the road will be called the Treaty Adit road.

The TCAR will provide access to the Treaty OPC and MTT during the construction phase, and will provide permanent access to the KSM Project during the operation, closure, and post-closure phases.

Traffic levels on the TCAR during Project construction will vary. It is estimated that there will be a total of 5,362 one-way trips, with an average of about 14 trips per day, to deliver equipment, materials, and personnel required for construction of the Treaty OPC, the TMF, and the MTT infrastructure. Traffic types will include flat deck trucks, vans, buses, passenger vehicles, lowboys, and tankers (for fuel).

Traffic levels during mine operation are estimated to average about 82 one-way trips per day (30,154 per year). These trips will include B-train trucks hauling copper concentrate, enclosed trailers with lime and reagents, flat deck trucks with grinding media, parts and machinery, tank trucks with fuel and lime, buses and passenger vehicles carrying personnel, and other miscellaneous loads.

26.25.3 Temporary Frank Mackie Glacier Access Route

The Temporary Frank Mackie Glacier access route will be used to mobilize water treatment supplies and mobile equipment, as well as supplies for construction of access roads and water diversions, during the first three seasons of construction until the CCAR has been completed. The route will begin near the re-activated Granduc Mine at the end of an existing all-season road. It will start at the toe of the Berendon Glacier, accessing the Frank Mackie Glacier from the Berendon Glacier, and then proceed up and over the glacier into the valley of Ted Morris Creek, which is a tributary of Sulphurets Creek. It is estimated that 250 to 300 loads, using tracked equipment and sleighs, will be hauled over the glacier for each of the three winters of use.

26.25.4 Highway 37 and Highway 37A

All vehicular traffic to and from the Project will travel along Highway 37. Highway 37 is designed for commercial traffic and has historically carried volumes of traffic in excess of that anticipated for the KSM Project. Copper concentrates from the Project will be hauled along

Highways 37 and 37A to the port facilities at Stewart. The estimated volumes, types, and potential effects of KSM Project traffic on highways 37 and 37A are discussed in Appendix 22-C, Highways 37 and 37A Traffic Effects Assessment. Specific actions to mitigate the potential effects are summarized in Section 26.25.10 of this plan.

26.25.5 Legislation and Standards

The KSM Project access roads will be permitted, constructed, operated, and deactivated under permits issued under the *Mines Act* (1996j) and the Provincial Forest Use Regulation (BC Reg. 176/95) under the *Forest Practices Code of British Columbia Act* (1996e). Roads located on mineral claims registered to the Proponent under the *Mineral Tenure Act* (1996i) will be permitted under the *Mines Act* (1996j). Other roads or sections of roads will require special use permits under the Provincial Forest Use Regulation (BC Reg. 176/95) subject to the *Mining Right of Way Act* (1996k). Both types of permits may contain conditions regarding the design, construction, maintenance, use, and deactivation of the relevant roads.

Fisheries implications of access roads are regulated under the federal *Fisheries Act* (1985c). The *Navigable Waters Protection Act* (1985g) applies where waterways may be subject to waterborne traffic. The *Wildlife Act* (1996q) and the federal *Species at Risk Act* (2002d) regulate road and traffic effects on wildlife. The *Wildlife Act* (1996q) and the *Species at Risk Act* (2002d) require mitigation of potential effects on specific wildlife species.

26.25.6 Objectives

The objectives of this management plan are to ensure that the KSM Project access roads are:

- designed and maintained in a manner that assures the safety of road users and minimizes adverse effects on the environment and wildlife; and
- used in a manner that avoids adverse worker and public health and safety effects and minimizes adverse social and environmental effects.

26.25.7 Targets

The Traffic and Access Management Plan has the following goals:

- to design, construct, and maintain Project access roads so that they are safe for designated uses;
- to avoid the possibility of Project access roads becoming barriers to wildlife movement;
- to minimize wildlife mortality due to vehicle collisions along access roads and public highways;
- to avoid adversely affecting mountain goats due to Project avalanche control measures;
- to prevent access roads from becoming wildlife attractants;
- to ensure that all authorized users of roads behave in accordance with company policies;

- to protect workers and the public and minimize potential adverse effects of increased human presence on the environment by controlling access along Project access roads (working towards zero unauthorized users);
- to minimize adverse effects on fish and fish habitat by complying with the *Fish-stream Crossing Guidebook* (BC MFLNRO, BC MOE, and DFO 2012) for the construction, maintenance, and deactivation of Project access roads; and
- to minimize adverse effects on wetlands.

26.25.8 Actions to Avoid, Control, and Mitigate Potential Effects of Project Access Roads

26.25.8.1 General Design and Maintenance

The KSM Project access roads will be designed, constructed, and maintained with user safety and environmental stability in mind. The CCAR and TCAR will be classified as resource-development roads and constructed as single-lane, 5- or 6-m wide roads, depending upon terrain and anticipated traffic types and volumes. The roads will be radio controlled and will have turnouts and widening to allow access by the largest expected vehicles and loads.

Road cut and fill slopes will be specified by a geotechnical engineer based on site conditions. Cut slopes will vary between 0.25H:1V in solid bedrock to 2H:1V in soil, and fill slopes will generally vary between 1.25H:1V in rock fill to 2H:1V in soil fill. All road subgrades or constructed sub-base will be covered with a 300 mm layer of surfacing gravel. Culvert locations will be selected following detailed road design, with a nominal spacing of four per kilometre.

Where the alignment is proposed to cross steep terrain, road widths will be 5 m wide with full bench cuts in rock, and excavated rock and organics will be end-hauled to an approved disposal area. Cut slopes will vary between 0.25H:1V in solid rock to 0.5H:1V in rippable rock. Construction of a partial bench in rock and a fill slope may be considered where the topography provides sufficient width to place angular rock at a slope of 1.25H:1V to 1H:1V.

Roads crossing wet or swampy terrain will be 6 m wide. They will be constructed with special overland techniques using geotextile and/or geogrid soil reinforcement with a minimum 1,200 mm select sub-base and 2H:1V side slopes.

Except for a few control sections, the nominal minimum design speeds for these roads will be 50 km per hour, and the maximum design speeds will be 60 km per hour, where feasible. The Treaty Adit road will have a nominal design speed of 40 km per hour.

Bridge locations will be selected to offer the least disturbance to the wetted area of the channel with consideration of stable abutments. Bridges will be designed for 100 t loading (BCFS-L100) and for a 1.5 m clearance above the 100-year flood level (Q100). Bridge construction is not expected to interfere substantially with navigation; however, if approval is required under the *Navigable Waters Protection Act* (1985g), all terms and conditions of the approval will be followed.

Where practicable, alignments will be placed to avoid areas subject to geohazards, such as potential landslides, debris flows and floods, and snow avalanches. Where hazard areas cannot be avoided due to terrain constraints, mitigation and monitoring will be initiated.

Most snow avalanche mitigation will be handled by active measures including monitoring (by the Canadian Avalanche Centre or by contractors), road closures, no-stopping zones, helicopter bombing, howitzers, GasEx exploders, etc.

The CCAR and TCAR will be key components of the overall site infrastructure and will be subject to a comprehensive and ongoing maintenance program. This program will include regular inspection of the road surface, culverts and bridges, grading, snow ploughing, application of granular material for traction control in the winter, dust control (water sprays) in the summer, ditch cleaning, and shoulder vegetation management. The roads will have appropriate signage to establish speed limits and warn of road use hazards.

Where practicable, road construction will be managed to minimize the visibility of the roads from key viewpoints, such as the Unuk River, to preserve the current experience of the land by other users. Visibility will be managed by preserving vegetation buffers.

The glacier access will be constructed using snow cats, Challengers, and composite mats (where required). It will be rebuilt, as required, to deal with snow accumulation. An avalanche control crew will monitor the route continually throughout the construction and hauling periods.

Vehicles hauling on the glacier will travel in convoys in case of breakdowns. Several "survival shacks" will be located on the glacier in case rapid changes in weather force the convoys to stop before they reach the end of the road. Haul equipment will have GPS navigation devices and will remain in radio communication with other haul equipment and the camps. The trail will be marked with regular, highly visible stakes for visual guidance in case of whiteout conditions.

Detailed safety and environmental spill response plans will be developed in advance to support the operation of Project access roads. Measures such as using double-walled "envirotanks" for storage and transport of hydrocarbons will prevent spills. All equipment will be in good working order and will be equipped with appropriate spill collection and cleanup equipment.

Access roads will be deactivated when no longer required. The glacier access will be deactivated during the construction phase. The CCAR will be deactivated during the closure phase.

26.25.8.2 Design and Maintenance Features to Protect Wildlife

A range of design and maintenance features for access roads will be used to mitigate potential adverse effects on wildlife. Some of these features are discussed in the following section.

26.25.8.2.1 Barrier to Movement

- Refuge areas will be ploughed along the road during winter; gaps in snow banks on roads will be created at best spacing to allow an escape for wildlife.

- High, or arched, bridges over river and creek crossings will be installed to allow wildlife to move underneath, where practical.
- Clear span bridges, open bottom culverts and toad tunnels will also function as movement corridors for furbearers, including marten, thereby reducing the barrier effect of roads on these species.
- Toad tunnels and related infrastructure will be constructed under the roads in known or suspected western toad migration corridors to facilitate toad movement without risk of collisions if required.

Drainage culverts have been reported as effective wildlife passages for marten and other small mammals, and provide habitat connectivity and greatly reduce the risk of mortality of amphibians on roads (Fahrig et al. 1995; BC MWLAP 2004a). In general, drainage culverts assist in mitigating the potentially harmful effects of roads by providing a vital habitat linkage (Clevenger, Chruszcz, and Gunson 2001).

Several design features can be factored into culvert selection and placement to increase the likelihood that marten, small mammals, and western toads will use them as passages under the road. For marten and small mammals, these factors include high through-culvert visibility (e.g., diameters more than 1 m), the presence of at least one culvert within an individual's home range, and abundant vegetative cover near culvert entrances (Clevenger, Chruszcz, and Gunson 2001).

Similarly, amphibians are more likely to use large, short, well lit and ventilated tunnels with natural vegetation. The materials used in tunnel construction for amphibians are also critical for tunnel effectiveness. Steel is an undesirable construction material because of its high conductivity, coldness during spring, and possible leaching of toxic metals (Fitzgibbon 2001). Amphibians will avoid using tunnels that promote change in interior microclimatic conditions, including moisture, temperature, and light. A large (more than 1 m diameter) box culvert design with a concrete bottom is recommended. These structures help to maintain natural airflow and moisture and contain natural and permanent vegetation for predator avoidance.

Drift net fencing is also a critical feature of amphibian underpass systems and serves to guide or funnel animals to tunnel entrances. The fencing must be at least 0.5 m high, extend a sufficient distance along the road, and be constructed with sturdy materials to withstand ploughing and snow buildup (BC MWLAP 2004a).

Wildlife may congregate on ploughed roads in the winter to avoid deep snow. Wildlife may then become trapped on the roads if the roadside snow banks are too high or continuous to permit escape from approaching traffic. This concern will be addressed by ensuring that wildlife refuge areas or escape routes are created in critical areas of the access roads.

26.25.8.2.2 Avalanche Control

Specific procedures will be developed for snow avalanche control in areas where mountain goat occupation and mountain goat habitat have been identified. These procedures will be developed in consultation with the BC Ministry of Environment (or other appropriate regulators) to minimize or mitigate the effects of avalanche control on mountain goats.

26.25.8.2.3 Speed Limits and Signage

Access road speed limits will be determined based on user safety and wildlife considerations. Speed limits will be posted clearly, and adjusted to reflect experience regarding safety concerns and wildlife interactions.

Coordination will occur with the BC Ministry of Environment (or the appropriate governing agency) to identify areas with higher risk of wildlife collisions so that appropriate warning signs may be posted. Locations identified as having a higher likelihood for vehicle collisions with wildlife will be managed adaptively. Signage will identify potential hazard areas such as avalanche-prone areas.

26.25.8.2.4 Road as an Attractant

Use of road salts for winter road management will be avoided to reduce the potential of attracting ungulates to the road. Sand or stone chippings will be used as the preferred methods to provide winter traction.

Vegetation management will be incorporated to reduce site attractiveness or road verges will be cleared to increase visibility of wildlife to drivers (e.g., a cleared buffer zone of appropriate size, such as 3 m). Clearing will be site specific to ensure a balance between low vegetation and maintaining high value and sensitive habitat and minimizing effects on visual quality. To reduce herbivore use of corridor vegetation in areas where concerns exist for vehicle collisions and high quality browse is present (e.g., willow, birch), vegetation maintenance activities (e.g., brush cutting) will be conducted following best practices (e.g., Rea et al. 2010) to minimize attractiveness to herbivores such as moose and deer. Pre-clearing surveys for bird nests will be conducted prior to brush cutting to ensure nests are not destroyed if it is nesting season.

To minimize potential collisions between wildlife and vehicles along the roadside, the verge will be seeded with a low diversity of native species that are not attractive as forage to wildlife, especially to moose, mountain goats, and black bears. In accordance with BC's BMPs for raptors (BC MWLAP 2005), vegetation will be managed through manual and mechanical mowing and brushing without the use of herbicides where possible.

Ditches and culverts will be designed to minimize pooling of water. Free draining roadside ditches will eliminate pools that may be attractive as toad breeding areas. Roadside pools that are formed will be drained before they can become habitat for wildlife. Pools will be monitored for toad breeding activities. Carrion will be removed from roads to minimize attracting wildlife to the road, thereby reducing the risk of conflicts between vehicles and wildlife.

Dust production from moving vehicles will be managed through enforced speed limits and through the use of dust suppressants if required. Water will be used as the preferred dust suppressant. If this approach is not successful, alternatives will be investigated taking into account the risk of other suppressants acting as wildlife attractants.

26.25.8.2.5 Traffic Noise

During the construction and operation phases, wildlife may be disturbed by traffic noise. The objective of the noise management plan is to ensure that noise levels during all phases of the Project are acceptably low for human and wildlife receptors as well as receptors of concern in the vicinity of the Project. The following noise mitigation measures will be implemented:

- Noise specifications will be considered when selecting equipment to purchase.
- Vehicles will be maintained regularly.
- Speed limits will be imposed.
- Mufflers will be installed and maintained on vehicles.
- Noise dampening measures will be applied where possible.
- Noise will be monitored periodically at various human and wildlife receptor locations, results will be reported, and, if required, mitigation strategies will be adjusted accordingly. Noise monitoring locations will be determined on location to enable confirmation of noise modelling and effects assessment.

Noise management strategies are described in more detail in Section 26.22, and in Chapter 19.

26.25.8.3 Design and Maintenance Features to Protect Fish and Fish Habitat

A thorough assessment of the access road alignments has identified numerous fish-bearing and potentially fish-bearing streams. Crossings of these streams will be designed, constructed, maintained, and deactivated in a manner consistent with the *Fish-stream Crossing Guidebook* (BC MFLNRO, BC MOE, and DFO 2012). Measures to be applied include:

- applying for and obtaining all required permits prior to starting work;
- completing the work during the appropriate instream fisheries work windows;
- preferentially selecting clear-span bridges or open-bottom culverts as crossing structures;
- eliminating or reducing sediment-related problems during installation;
- preventing deleterious substances from entering streams;
- minimizing or avoiding disturbance of fish habitat above and below the area required for actual construction of the stream crossing;
- ensuring that the design specifications for safe fish passage are achieved;
- re-vegetating and stabilizing the site to prevent post-construction erosion;
- minimizing clearing width at the crossing site and retaining streamside vegetation within the stream crossing right-of-way wherever possible, recognizing operational requirements; and
- inspecting and maintaining stream crossing structures regularly.

26.25.9 Traffic Management along Project Access Roads

Traffic management activities will be implemented to address the human aspect of access road-related mitigation efforts. These activities will be targeted at road users to avoid or mitigate potential adverse social, environmental, economic, heath, and heritage effects, including navigable waters.

26.25.9.1 Avoid Wildlife/Vehicle Interactions

26.25.9.1.1 Adherence to Speed Limits

Speed limits will be actively enforced. Enforcement may be in the form of radar guns, vehicle monitoring systems, or other similar methods.

26.25.9.1.2 Wildlife Right-of-Way

- An education program will be developed to ensure drivers know that wildlife have the right-of-way along Project access roads.
- Any encounter with wildlife (including observations or interactions) will be reported and records will be kept. Reports will be made over the radio to alert other operators that there is wildlife in the area and to travel with caution. These records will provide a basis for identifying locations of considerable risk for collisions between wildlife and vehicles, if they occur, and for developing appropriate mitigation strategies for those areas. When large numbers of wildlife (e.g., moose) are present on or adjacent to the road, a temporary road closure may be instigated at the discretion of the Environmental Superintendent.
- Collisions between vehicles and wildlife will be documented and will include information on the location of the collision along the access roads and along the highway. Employees and drivers working for regular contractors hauling concentrate and materials for the Project will be trained on reporting in the event of a collision. All information on collisions will be shared with relevant government agencies. Truck drivers will be actively monitored to ensure that they accurately record all wildlife sightings and incidents along the roads. Locations where wildlife collisions take place will be prioritized for adaptive mitigation.

26.25.9.2 Avoid Adverse Effects from Spills

The traffic along the access roads will include trucks hauling fuel, concentrate, reagents, and explosives components. Spills of these materials, if not addressed competently, may have adverse environmental effects. The Project's Spill Prevention and Emergency Response Plan will address accidental spills along the access roads. Road users will be trained in relevant spill-response techniques and protocols. Spill kits will be available on vehicles transporting dangerous goods or hazardous materials, and mobile spill response kits will be available at the Treaty and Mitchell OPCs.

26.25.9.3 Avoid Increased Wildlife Pressures due to Public Access

Public access will be restricted along sections of the Eskay Creek Mine road, required exclusively for access to the KSM Project, and along CCAR and TCAR. Access restrictions are necessary for worker and public safety due to the narrow road widths and the heavy vehicle

traffic that is anticipated. Access restrictions will also minimize incremental harvesting of fish, wildlife and vegetation, harassment of wildlife, and disturbance of archaeological sites.

Control of access points and minimization of the number of unauthorized users of Project roads and corridors will also be achieved through corporate policies, including the following actions:

- Install gates, signs, and other security measures at entranceways to TCAR and CCAR as well as at the transmission line where it leaves the TCAR corridor, to prohibit entry by non-authorized vehicles, including snow machines and all-terrain vehicles.
  - Glacier route access is by nature temporary. Signage along the route and safety sheds will be removed following construction. Due to the nature and seasonality of the terrain, temporary and limited access via this route is unlikely to have a large effect in the RSA.
  - Controls for the TCAR road will also mitigate access to the transmission line due to existing natural barriers (Bell-Irving River) along this corridor.
- Users of roads are to immediately report any observed unauthorized users to security, and security to respond by assigning appropriate personnel to notify unauthorized users of trespass.
- Deactivate all non-essential roads (e.g., TCAR and CCAR) at closure.

The behaviour of authorized land users (i.e., Project staff and contractors) will be controlled through the following actions:

- implement and enforce a no hunting and no fishing policy for employees and contractors;
- prohibit the possession of personal firearms within the Project area by employees and contractors;
- set and enforce speed limits along Project-controlled roads; and
- bus personnel from communities or central collection sites at the start and end of each shift during mine construction and operation.

26.25.10 Actions to Avoid or Mitigate Potential Effects of Project Traffic on Highways 37 and 37A

This section identifies the measures that will help minimize and mitigate potential risks of Project-related traffic activities along provincial highways near the Project.

26.25.10.1 Traffic and Access Road Management Plan Risk Mitigation Measures

The following actions will be implemented to address potential adverse effects of Project traffic on highways 37 and 37A:

- Posted speed limits will be enforced.
- All heavy vehicles travelling to and from the Project area will follow dedicated heavy vehicle routes.

- Vehicle load rates will be optimized to minimize the number of trips.
- Noise suppression technologies will be used where possible.
- Speeds will be reduced to 50 km/hour in designated residential areas, or as otherwise directed. Along the travelled portion of Highway 37, the only residential area is within Kitwanga Village near the gas station, speed limits are posted accordingly.
- Use of engine brakes and reversing (use of reverse -alarm) will be avoided in residential areas.
- Vehicle idling will be minimized.

Vehicle specification and maintenance activities will include:

- Project trucks will meet or exceed Transport Canada's minimum requirements (e.g., maximum allowable noise levels from heavy duty trucks).
- Vehicle manufacturers' procedures and maintenance schedules will be followed.
- Vehicles will undergo regular, scheduled maintenance to ensure proper engine, brakes, and other wear and tear mechanical parts are in an acceptable working condition.
- Regular vehicle inspections (for leaks, secure cargo, etc.) will be conducted.
- Excess dust and dirt will be removed from vehicles before leaving site, if necessary.

Other traffic-related mitigation measures related to general safety procedures:

- Contractors and workers will be required to adhere to a zero-tolerance policy on alcohol and drugs on the Project site and while transporting goods and materials to and from the site.
- Policies regarding proper disposal of smoking materials will be implemented to prevent forest fires.
- A driver fire watch and reporting program as well as a response plan will be implemented.
- Workers and contractors will follow a specified journey management procedure, including departure and arrival check-ins.
- Information on weather and highway conditions will be made available to all drivers before departure. Drivers will be required to check road conditions prior to departure and adjust driving styles to conditions.
- Drivers and personnel will receive appropriate training (e.g., safe driving practices such as maintaining appropriate distances between vehicles, adjusting driving styles to suit road conditions, and noise awareness training).

Other mitigative measures to be implemented relate to communication with community and governments:

- If required, traffic control and/or temporary road closures will be used on Highway 37 near the entry to Project access roads during peak construction periods.
- Project traffic plans will be communicated to the provincial and local governments to ensure adequate signage is posted beside public roads.
- Local communities will be advised of driving routes, peak transportation periods, and potential road shutdowns when Project-related activities involve transporting heavy/wide loads.

26.25.10.2 Wildlife and Terrestrial Ecosystems Specific Risk Mitigation Measures

The following measures will be undertaken to minimize interactions between wildlife and vehicles, reduce disruption to wildlife movement, and mitigate potential effects on terrestrial ecosystems:

- Project drivers will yield to wildlife observed along the highways.
- Project drivers will comply with signage in areas of wildlife crossings.
- Project personnel (including drivers) will communicate locations of observed wildlife to drivers in the area.
- Locations of collisions between wildlife and vehicles will be documented.
- Vehicle inspection stations will be established on site for vehicles entering and exiting the Project area as required and appropriate action will be taken where risk of invasive plant introduction is identified.

26.25.10.3 Climate and Air Quality Specific Risk Mitigation Measures

The following measures will be taken to minimize potential traffic effects on climate and air quality:

- Diesel vehicles will use low sulphur content fuel, as required by law.
- Use of more efficient fuel blends will be considered.

26.25.11 Monitoring

Monitoring will be implemented to track the effectiveness of the proposed mitigation, including:

- tracking of road safety incidents to determine trends and to identify areas requiring further mitigation;
- observation of toad tunnels, drift nets, and bridges to confirm whether they are an effective option for the protection of migrating western toads and furbearers;
- observation of ungulate use of access roads during periods of deep snow to assess the effectiveness of refuge areas and escape routes;
- observation of wildlife use of road verges to assess effectiveness of browse management and visibility;

- inspection of road ditches and maintenance to prevent ponding in ditchlines, and decrease the attractiveness of ditches for toad breeding and effectiveness for dispersing runoff;
- periodic monitoring of noise at various human and wildlife receptor locations to assess effectiveness of mitigation strategies;
- monitoring of sediment release from construction and operation of stream crossings to identify any additional remedial measures required;
- tracking of re-vegetation success at stream crossings;
- tracking of unauthorized use of access roads and transmission line corridors;
- monitoring of unauthorized fish, wildlife, and plant harvesting by Project employees and contractors;
- enforcement of access road speed limits;
- tracking of wildlife observations and incidents to identify wildlife sensitive areas;
- tracking of results of vehicle inspections to identify necessary improvements;
- use of inspections, as required, for excess dirt and invasive plants on vehicles entering or leaving the Project site;
- inspection of access gates for signs of effectiveness or forced entry;
- occasional monitoring of irregular access use during road inspections; and
- periodic development of reports of unauthorized access by authorized users.

26.25.12 Reporting

Details of the monitoring will be reported internally on an annual basis according to the adaptive management framework of the EMS and will be available in the event that natural resource agencies conduct inspections. The report will provide results of monitoring, including but not necessarily limited to maintenance/repairs required of controls at access points, as well as numbers, locations, and timing of unauthorized user access.

26.25.13 Responsible Person

Responsibility for the environmental, social, and heritage aspects of this plan will rest with the Environmental Superintendents for their respective areas of the Mine Site and PTMA. The Health and Safety Superintendents for their respective areas, including the Mine Site and PTMA, will be responsible for the health and safety aspects of the plan.

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