Joint Application Information Requirements

for

Mines Act and *Environmental Management Act* Permits

Prepared By:

British Columbia Ministry of Energy and Mines
&
British Columbia Ministry of Environment

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Abbreviations

AIA	Archaeological Impact Assessment
BACI	Before-After-Control-Impact
BAT	Best Achievable Technology
CABIN	Canadian Aquatic Bio-monitoring Network
EIA	Environmental Impact Assessment
EMA	BC *Environmental Management Act*
EPD	Environmental Protection Division
IDZ	Initial Dilution Zone
MEM	Ministry of Energy and Mines
Code	Health, Safety and Reclamation Code for Mines in British Columbia
ML/ARD	Metal Leaching and Acid Rock Drainage
MOE	Ministry of Environment
MRC	Mine Review Committee
QA/QC	Quality Assurance/Quality Control
SBEB	Science-Based Environmental Benchmark
TAR	Technical Assessment Report
TMF	Tailings Management Facility
WQG	Water Quality Guideline
WQO	Water Quality Objective

Preface

This Application Information Requirements document sets out the information that is required to support a joint application for a *Mines Act* (MA) permit issued by the Ministry of Energy and Mines (MEM), and (if required) an effluent discharge permit issued under the *Environmental Management Act* (EMA) by the Ministry of Environment (MOE). This document is intended for both new and existing major mines, including proposed major expansions/extensions of mining projects. The combined technical information requirements are intended to reduce overlap in technical information required by both ministries and enable one application, or bundled applications, to be submitted for review.

Mining project proponents should to seek early additional guidance from agency advisors, MEM's Regional Mine Development Review Committees, and/or the Major Mines Project Office for new mining projects, regarding more specific information requirements for their project prior to submitting applications. MOE and MEM strongly encourage "pre-application" meetings to discuss the scope and detail of information requirements.

Mines Act Permitting

Applications for MA permits must include detailed designs for all project components and phases of mine life. Proponents are expected to provide detailed engineering designs, management plans and monitoring programs. Planning needs to be sufficiently detailed in order to ensure the health and safety of mine personnel and the public, and the protection and reclamation of the land and watercourses affected by the mining activities.

In addition to providing the technical information described in this document, proponents must ensure that *Mines Act* permit fees[1] are provided with the submission of an application, as applicable.

Environmental Management Act Permitting

This document includes the information requirements of a Technical Assessment Report (TAR) with particular emphasis on the environmental impact assessment (EIA) normally required as part of the application (found in "Technical Guidance 1 – *Environmental Management Act* Applications TERMS OF REFERENCE Environmental Impact and Technical Assessment Report"[2]) and builds upon the generic guidance related to TAR preparation found in "Guidance on Applications for Permits under the *Environmental Management Act* – Technical Assessment"[3].

In cases where construction significantly precedes operation, a proponent may submit an application for an EMA permit[4] associated with construction effluent discharges prior to an application for operational effluent discharge permits. The application information requirements outlined in this document should be modified specifically for each project (single- or two-phase application) after discussion with and advice from the project-specific MRC, specifically the MOE representatives.

[1] www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/permitting/mines-act-permit-inspection-fees
[2] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/eia__ta_tor.pdf
[3] www2.gov.bc.ca/assets/gov/environment/waste-management/waste-discharge-authorization/assessment.pdf
[4] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/mining_operations_fs.pdf

Providing the information specified in this document will help ensure that TAR requirements have been met. It is essential that applicants also follow the "Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators "[5], which provides detailed direction regarding collecting and presenting baseline data, and assessing and predicting the potential effects of a project on the aquatic environment. While written for the mining sector, the baseline guidance document can also be used to inform EMA applications for other industrial sectors.

Each qualified professional must provide a signed statement, specifying the component(s) of the TAR or EIA for which they are responsible. This statement should confirm that all required information has been provided and is true and complete based on the professional knowledge and judgment of the signatory. Signed statements should be included in an Appendix in the application and should contain professional association affiliations and membership numbers.

In addition to providing the technical information described in this document, the proponent must submit an application form for authorization to discharge effluent[6] under EMA and ensure that application fees are included.

To expedite review of EMA effluent discharge permit applications for new or significantly expanded mines, each proponent must submit a completed checklist as per "Technical Guidance 2 – *Environmental Management Act* Applications TABLE OF CONCORDANCE"[7] as part of the application package to the Environmental Protection Division (EPD) of MOE. Completion of the checklist will indicate that the project proponent(s) and agents have:

- developed an adequate understanding of existing environmental baseline conditions;
- identified contaminant pathways and potential impacts of disturbance or contaminants on sensitive receptors or assessment endpoints;
- assessed the risks to the environment from the proposed project;
- developed plans to prevent or mitigate environmental effects; and
- identified measurement endpoints and other monitoring and surveillance processes to judge the effectiveness of the proposed environmental protection measures.

The application checklist provides a log of these component steps, identifies where this information is provided in the accompanying report(s), and documents the qualified professionals participating in the process. Applications with each component prepared and signed/sealed by a suitably qualified licensed professional are preferred.

[5] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

[6] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/mining_operations_fs.pdf

[7] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/toc_mine_effluent_applications.pdf

These information requirements address effluent-related discharges only. For other waste discharges related to project activities, such as air emissions, or solid waste or hazardous waste disposal, separate applications may be required. EPD's fact sheet on waste authorizations and best practices for industrial camps[8] identifies the requirements for disposal of putrescible wastes (food wastes), solid waste and hazardous waste for exploration, construction and industrial camps.

The information requirements presented in the following pages are considered necessary for joint applications for MA and EMA permits. Where an application references previously submitted information, a brief summary of that information should be provided under the appropriate section or subsection of the application, and hyperlinks to the corresponding sections of the previously submitted document(s) provided. Applicants may also be asked to provide such information on CD, DVD or USB memory stick.

[8] www2.gov.bc.ca/assets/gov/environment/waste-management/sewage/mwr/workcampsfs.pdf

Executive Summary

Joint applications for MA and EMA permits should include an executive summary that briefly describes the proposed project, identifies the authorizations being applied for, and describes how the application meets the requirements developed with advice from the project-specific MRC and any additional input from technical agencies.

1 Introduction and Project Overview

This section provides contextual background information on the proposed mining project, including proponent identification, application background, mine overview and development proposal, regulatory framework, and the mine design and assessment team.

1.1 Proponent Information

The application should include the following information about the proponent(s):

- overview including the name, organization and structure of the operating company;
- a description of the operating (and, if applicable, parent) company proposing to develop and operate the mine;
- the registered legal name and registered address of the operating company;
- the name of the company representative managing the proposed project;
- the head office address and applicable contact names, phone and fax numbers and email addresses; and
- contact information for key corporate health and safety, environmental affairs, community relations, etc. staff.

1.2 General Application Background

The "Introduction and Project Overview" section should also include:

- the purpose and scope of the application;
- a general introduction to the application and its structure;
- a summary of the regulatory environmental assessment (EA) process completed to date, and any approvals received and conditions of those approvals, where applicable; and
- a summary of key commitments applying to the project development.

1.3 Project Overview

1.3.1 Project History

Describe the project history leading up to the application, including activities at the mine and a list of previous related reports, studies and designs, etc.

1.3.2 Overview of Products and Markets, and Projected Project Benefits

Describe the product(s) that would be mined, market need, production volume and rate, projected mine life, number of new direct and indirect jobs created, estimated capital investment and projected tax revenue.

1.3.3 Location, Access and Land Use

This sub-section should include a description and figure of the site showing all mining tenures, project location and access. The figure should reference latitude/longitude or NTS coordinates. An overview of current land uses, surrounding land uses and downstream users should also be provided.

1.3.4 Mine Components and Off-Site Infrastructure

Provide introductory descriptions and associated detailed maps of the key mine components and off-site infrastructure. Key components could include, but are not necessarily limited to, the following:

- open pits
- underground workings
- processing facilities, including crushing and conveying systems and concentrate handling
- tailings storage facilities
- waste rock management facilities
- site water management facilities
- water treatment facilities
- ore and low-grade ore stockpiles
- overburden and soil stockpiles
- access and mine site roads
- power supply and distribution
- explosives facilities
- ancillary buildings and other infrastructure (camps, loadout facilities, etc.)

1.3.5 Mine Development and Operations

Briefly outline the proposed mine development and operations, including proposed discharges and discharge locations.

1.3.6 Regulatory Framework

This sub-section should provide:

- an outline of required licences/permits/authorizations needed for development and/or operation, and any applicable regulations; and
- reference to a generic list of licences, permits, authorizations and regulations that may be applicable to the mining project.

1.3.7 Mine Design and Assessment Team

Identify the consultants and individuals comprising the design and assessment team, and their responsibilities and application contributions. Relevant sections of the application must be signed and stamped by a qualified licensed professional registered in the province of British Columbia.

1.3.8 Maps, Figures, etc.

The application should include up-to-date maps (plan and section), diagrams, photographs and graphs, as appropriate, that:

- outline current conditions;
- are at an appropriate scale for interpretation; and
- provide sufficient design information to assist with the evaluation of the adequacy of proposed works and monitoring programs.

All maps should include projection details (mine grid, geo-reference, etc.), scale, north arrow and legend.

1.3.9 Environmental Assessment Conditions

The application should provide a summary table of all EA Certificate conditions (if applicable) and identify where in the application document relevant conditions have been addressed.

2 Baseline Information

Characterization and presentation of baseline environmental conditions is a critical element in applying for permits under the MA and EMA. A baseline program must collect and assess sufficient physical, chemical and biological information to:

- describe meteorological and climatic conditions;
- describe geology, geochemistry and topography;
- characterize surface water hydrology and groundwater hydrogeology;
- establish a water balance for the drainage area;
- document surface and groundwater uses within and downstream of the project area;
- determine surface water, groundwater and sediment quality prior to disturbance; and
- describe aquatic ecosystem attributes such as fish and fish habitat, tissue residues, periphyton and benthic invertebrate communities.

It is required to have a minimum of 12 to 18 months of data to support the work and recommended to have at least two years of data collection to support these assessments. The application should also identify which sites will serve as reference or control sites throughout the life of the project. The proponent should be able to compare sites that are impacted by the project with sites that are not impacted, in addition to comparing impacted sites to the baseline data to determine if an unacceptable impact or change has occurred.

The proponent is advised to follow the detailed guidance provided by the "Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators"[9] and by the "B.C. Field Sampling Manual"[10].

The joint MA/EMA application must describe in detail:

- sampling methods;
- sample preparation and hold times;
- analytical methods;
- analytical detection limits;
- quality assurance/quality control procedures;
- data analysis methods; and
- any assumptions.

It is essential that a draft of the mine baseline-monitoring program be distributed to the MRC early in the review process to ensure that the program will meet permitting requirements.

While the type and quantity of baseline data collected will vary by site, an application should include the information outlined below.

[9] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

[10] www.env.gov.bc.ca/wsd/data_searches/field_sampling_manual/field_man_03.html

2.1 Summary

Provide an overview of the existing baseline environmental conditions. Highlight key physical, chemical and biological characteristics of the receiving environment, focusing on sensitive receptors (including humans) or conditions that are relevant to the potential impacts during construction, operation, closure and post-closure phases of the mine. The summary should identify how baseline-sampling locations have been coordinated among the various media types (air, water quality and quantity, benthic invertebrates, fish, etc.).

Raw data should be included in appendices, provided on CD, DVD or USB memory stick with the application, and, if applicable, uploaded for storage in MOE's EMS (Environmental Monitoring System) database.

2.2 Meteorology and Climate

The proponent is expected to demonstrate an understanding of how weather and climate will affect all aspects of the project. The application should summarize all available meteorological and climate information relevant to the mine property. Detailed guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[11].

Joint applications for MA and EMA permits should:

- be based on a recommended two years of complete site meteorological data;
- describe relevant meteorological and climate information sources for parameters such as wind speed and direction, precipitation, snowpack, temperature, evaporation and evapotranspiration;
- demonstrate a reasonable relationship between precipitation, snowpack and streamflow, on a monthly basis and on an average annual basis;
- predict normal and extreme ranges of climatic parameters such as temperature, rainfall and snow melt relevant to mine facility design and operations including descriptions of techniques used to determine them (i.e., focusing on factors affecting hydrological parameters);
- identify information gaps and describe site-specific meteorological data collection methods proposed to augment existing regional data; and
- provide air quality dispersion modeling, where applicable.

2.3 Geology

2.3.1 Regional Geology

Joint MA/EMA applications should:

- describe the regional geological setting;
- provide an overview of the geology of the area, with emphasis on the regional framework—this should include a description of the tectonic belt(s), terrain(s), physiography, and regional metamorphism and structure;

[11] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

- describe geologic units or lithology in key areas of the project property, such as tailings dam(s), waste rock storage areas, open pit, underground workings and mill site—include the depth to bedrock, overburden type, etc.;
- characterize the bedrock structures from the viewpoint of their potential to act as groundwater pathways or barriers for contact water; and
- characterize the respective bedrock lithologies from the viewpoint of their relative capability to conduct groundwater seepage.

2.3.2 Deposit (Ore) Geology

Summarize the mine site geology, including descriptions of major rock units, stratigraphy, structure, metamorphism, paleontology and geochemistry (see Section 2.3.4: Metal Leaching/Acid Rock Drainage).

This part of the application should also provide a detailed stratigraphic description describe ore deposit information, including:

- ore mineralogy including alteration type, deposit character, deposit classification and age of mineralization;
- general ore controls; and
- average assay values and reserve information (proven, probable and possible).

2.3.3 Surficial Geology and Terrain Mapping

Provide a summary of the surficial geology and terrain mapping for the mine site completed at a scale of 1:5,000 or as appropriate using the "Terrain Classification System for British Columbia"[12]. This summary should discuss the potential for the respective surficial deposits to act as groundwater pathways or barriers for contact water.

2.3.4 Terrain Stability and Natural Hazards

Provide information regarding any natural hazards such as snow avalanches, landslides and earthquakes specific to the proposed mine. Also provide a terrain stability assessment for the mine site and access roads, as required.

2.3.5 Soil Survey and Soil Characterization for Reclamation

Provide a brief summary of the soil survey for the mine "footprint". The summary should include supportive technical data including soil classification and soil profile descriptions. Soil survey information should include:

- identification and mapping of soil units;
- characterization of topsoil and subsoil for suitability as growth media for reclamation;
- location, depth and volumes of soil types;
- potential soil and subsoil salvage locations;
- discussion of potential for erosion;

[12] www.for.gov.bc.ca/hts/risc/pubs/teecolo/terclass/terclass_system_1997.pdf

- baseline soil metal concentrations; and
- baseline soil nutrient information (or lack thereof).

2.3.6 Metal Leaching/Acid Rock Drainage Geochemistry

The geochemistry of all geologic materials to be disturbed or created during mining must be characterized. Materials to be investigated for metal leaching and acid rock drainage (ML/ARD) potential may include overburden, construction materials, waste rock, ore and low-grade ore, tailings streams, and any treatment by-products. Mine components to be assessed may include pit walls, underground workings (roof, floor, walls and gob), dumps and stockpiles, tailings-impoundment facilities, borrow areas, plant site and road cuts.

Characterization programs must be developed in accordance with the following:

- "Policy for Metal Leaching and Acid Rock Drainage at British Columbia Mine Sites"[13] (1998)
- "Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia"[14]
- "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials"[15], MEND Report 1.20.1 (December 2009)

Key information that should be provided as part of the characterization program includes, but is not limited to:

- ML/ARD characterization for all materials and mine components, ensuring that geochemical and spatial variability is captured and that test work is relevant to the proposed storage environment;
- assessment of the lag times to ARD onset for all potentially acid-generating materials and assessment of metal leaching potential/behaviour for all materials to be generated;
- site-specific geochemical criteria defining potentially acid-generating and/or metal-leaching materials, as required to support waste management/handling; and
- clear presentation of all ML/ARD characterization data, analyses and interpretations.

2.4 Topography, Surface Drainage Features and Natural Hazards

Joint MA/EMA applications should:

- describe pre-mine topography and surface drainage features of the mine site and surrounding area; and
- provide information regarding any natural hazards relevant to the mine, such as snow avalanches, landslides and earthquakes.

Proponents should also provide maps at a suitable scale to:

- depict drainage divides, areas of groundwater discharge, locations of groundwater seeps, wetlands and notable topographic features;

[13] www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/permitting/ml-ard_policy.pdf

[14] www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/permitting/ml-ard_guidelines.pdf

[15] mend-nedem.org/mend-report/prediction-manual-for-drainage-chemistry-from-sulphidic-geologic-materials

- show the range of pre-mine slope configurations and typical slope cross-sections (include accompanying descriptions); and
- show the entire drainage basin(s) in which the mine will be located.

2.5 Water Quantity

2.5.1 Surface Water Hydrology

Summarize results of the surface water hydrology study of the mine property. A minimum of two years of data is recommended. Detailed guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[16].

Joint MA/EMA applications should:

- provide a detailed hydrologic analysis of key surface drainages within the project area, including streams, seeps, and standing waterbodies;
- identify existing regional hydrometric data that may be relevant to the project and identify gaps in data relative to the project site;
- identify which data reflect un-impacted baseline versus conditions affected by former development (e.g., exploration activities, historical mining activities);
- establish continuous hydrometric data collection for drainages potentially affected by effluent discharge, water diversions, and/or seepages from waste rock and/or tailings facilities;
- document methods of hydrometric station installation, sampling methods and Quality Assurance/Quality Control (QA/QC) procedures;
- provide detailed maps showing hydrometric stations relative to proposed effluent discharge locations, seepages, points of diversion, and water quality or other aquatic monitoring site locations;
- include a database of manual low-flow streamflow measurements at an appropriate number of stations, including estimates of measurement uncertainty, that can be used to inform the conceptual hydrogeological interpretation, estimates of groundwater recharge and the numerical groundwater model calibration, including the methodologies and analysis used as well as the resulting conclusions (see the "Water and Air Baseline Monitoring Guidance Document"[17]);
- determine critical low-flow metrics such as 7dQ10 for surface waters of importance to aquatic life, drinking water, wildlife, irrigation and other water users, including mine operation;
- develop a quantitative water balance model for the study area that includes
    - justification of all water balance components that have been included and excluded, and the method used to estimate each of these components,
    - estimates of upper and lower bound, and expected groundwater recharge; and
    - worst-case scenarios for low and high flows that might affect mine operation or effluent discharge or mine impact on the environment and flows; and
- identify spatial and/or temporal gaps in the database.

[16] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf
[17] Ibid.

2.5.2 Groundwater Hydrogeology

Summarize the results of the groundwater study of the mine property. One year of monthly groundwater levels and a credible database of low-flow streamflow measurements over two years is recommended. Guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[18].

Joint MA/EMA applications should:

- identify which data reflect un-impacted baseline versus conditions affected by former development (e.g., exploration activities, historical mining activities);
- characterize aquifers and aquitards within and downstream of the mine property, including major bedrock structures that could influence flow directions and seepage rates;
- provide plan-view maps showing groundwater monitoring well locations, interpreted groundwater elevation contours and inferred directions of groundwater flow for baseline, operations, end of mining and post-closure;
- include hydrogeological cross-sections showing groundwater elevation measurements, interpreted groundwater elevation contours and inferred directions of groundwater flow;
- describe existing and potential uses of groundwater downstream of the property boundary;
- develop a conceptual hydrogeologic model (considering seasonal variation) of the mine area with groundwater elevations, flow direction and rate estimates, recharge/discharge boundaries, groundwater divides and impermeable boundaries, and interaction with surface waters;
- identify and justify the assumptions in the conceptual hydrogeologic model;
- follow the "Water and Air Baseline Monitoring Guidance Document"[19] if a numerical groundwater model is developed;
- describe the surficial and bedrock hydrogeological units in the conceptual model, including lithology, orientation, thickness, hydraulic conductivity, storage and anisotropy;
- characterize the scale at which an equivalent porous medium model would be insufficient for practical assessment of groundwater effects, and whether the groundwater assessment is limited by this factor;
- estimate the total recharge rate and the geographic distribution of recharge for the study area, and ensure that this recharge rate is consistent with the site-wide water balance model
- identify and estimate relevant seepage rates between groundwater and surface water;
- identify surface water features that depend on groundwater discharge, and areas of groundwater that are under the direct influence of surface water; and
- identify spatial and/or temporal gaps in the database.

2.6 Groundwater and Surface Water Quality

All joint MA/EMA applications must include a detailed summary of water quality. The water-quality baseline study characterizes conditions present before project development. For groundwater, collecting eight samples quarterly (i.e., within each of the four seasons) over two years is recommended before submitting a permit application. Installation of groundwater monitoring wells often perturbs the groundwater chemistry in proximity to the well such that the groundwater samples initially do not represent baseline conditions. Over time, the groundwater chemistry in proximity to the well will re-

[18] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf
[19] Ibid.

equilibrate with surrounding system. The perturbation of the groundwater chemistry tends to affect concentrations of trace elements much more than major ions. Equilibration of the groundwater samples with ambient conditions must be demonstrated, particularly for parameters of concern related to the project, because concentrations measured during operations will be assessed relative to baseline. In many cases, the groundwater will re-equilibrate over the course of several weeks or months, but sometimes more than one year of sampling may be required before this occurs.

For surface water, a minimum of monthly sampling for a period of two years is recommended, and more is preferred to assess trends and seasonal variation. To determine water quality guideline (WQG) or water quality objective (WQO) attainment, 5 samples in 30 days during critical flows (high and/or low) or biologically relevant periods are necessary. To assess inter-annual variation, or to prepare WQOs or science-based environmental benchmarks (SBEBs)[20], multiple years of water quality data is required. More detailed guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[21] and in "Guidance for the Derivation and Application of Water Quality Objectives in British Columbia"[22].

For SBEB development, it is recommended that proponents contact MOE for further information and requirements on SBEBs and/or WQOs.

2.6.1 Groundwater Quality

Joint MA/EMA applications should:

- identify groundwater use downstream of the mine site (e.g., drinking, irrigation, livestock watering, industrial, etc.);
- document and describe the rationale for baseline study design, including
    - parameters analyzed,
    - collection methods,
    - field instrumentation,
    - sampling frequency and period,
    - site locations,
    - depth of screen completions, and
    - statistical considerations and QA/QC protocols;
- report turbidity and suspended solids with groundwater chemistry data;
- name the certified laboratories used to analyze samples;
- demonstrate that the groundwater quality database is credible with respect to data quality, including field parameters, duplicate sample analysis, outlier identification, etc.;
- demonstrate that the groundwater quality database is credible with respect to choice of groundwater sampling locations (i.e., that the sampling locations include areas where the groundwater may be impacted by contact water, where contact water might discharge to surface water, where groundwater may impact sensitive environmental receptors, etc.);
- include a summary table listing
    - sample site locations,
    - screened interval,

[20] See Appendix B

[21] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

[22] www.env.gov.bc.ca/wat/wq/pdf/wqo_2013.pdf

    - monitoring zone interval,
    - lithology of monitoring zone,
    - sample dates,
    - sample size, and
    - rationale/purpose of each site;
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities);
- include a detailed map of groundwater quality sampling locations, and proposed or existing effluent discharge points to surface water, areas of contact water recharge to groundwater, and the arrangement of mine elements;
- evaluate the quality of the groundwater sampling results, including ion balance, relative percent difference of duplicate samples, correlation of trace elements with suspended solids, correlation of conductivity with TDS, and correlation of theoretical TDS with measured TDS;
- describe the groundwater chemistry, including summary tables organized by parameter, site and date—include detection limits and any QA/QC concerns related to the data, and tabulate chemical data and flag values greater than provincial WQGs[23] (samples with turbidity values greater than 200 NTU should be flagged in the database prior to interpretation, and the influence of turbidity on groundwater concentrations, if any, should be incorporated into the interpretations);
- illustrate spatial and temporal variation(s) in key parameters and among sites using maps, cross-sections and graphs that illustrate data variability (e.g., box and whisker, time series, Piper Plot, etc.);
- identify critical parameters, locations and time windows or seasonality when baseline groundwater quality may exceed WQGs
- by comparing surface water and groundwater sampling results, assess the degree to which surface water quality is influenced by groundwater quality during periods of low flow, and the amount of flow that is being contributed by groundwater discharge; and
- prioritize the environmental receptors according to their potential sensitivity to groundwater discharge that could potentially include contact water; and
- identify spatial and/or temporal gaps in the database.

2.6.2 Surface Water Quality

Joint MA/EMA applications should:

- identify downstream surface water uses (e.g., aquatic life, drinking, irrigation, livestock watering, industrial, etc.) and water licences;
- document and describe the rationale for baseline study design, including
    - collection methods,
    - parameters analyzed (for a recommended list refer to the Water and Air Baseline Monitoring document),
    - field instrumentation,

[23] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

    - sampling frequency and period, noting that sampling timing should include high, medium and low flow period,
    - site locations,
    - statistical considerations,
    - and QA/QC protocols;
- use the principles of mass balance, as required, to establish the degree to which groundwater quality influences the surface water quality throughout the range of flow rates, and the degree to which groundwater contributes to streamflow, supported by the data, methods, analysis and conclusions;
- name the certified laboratories used to analyze samples;
- provide a summary table listing sample site locations, sample dates, sample size and rationale/purpose of each site;
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities);
- include a detailed map showing water quality sampling locations, and proposed or existing discharge locations and areas of disturbance;
- describe water chemistry and summarize data in tables organized by parameter, site and date (include detection limits and any QA/QC concerns related to the data);
- illustrate spatial and temporal variation(s) in key parameters among sites using graphs that show variability in data (e.g., box plots);
- compare existing water quality conditions to the provincial WQGs[24] and/or existing WQOs, making sure to
    - tabulate and flag water quality values that exceed WQGs or WQOs, and
    - clearly document the frequency and magnitude of exceedances;
- identify critical parameters, locations and time windows or seasonality when baseline surface water quality may exceed WQGs[25];
- conduct surface water toxicity tests if required (this may be needed if WQGs are exceeded due to historic mining or site disturbance and should be discussed with EPD staff); and
- identify spatial and/or temporal gaps in the database.

2.7 Sediment Quality

All joint MA/EMA applications must provide a detailed summary of sediment quality. Sediment sampling should occur at a minimum of once per year during summer low-flow periods. Detailed guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[26]. Consider, and discuss with the appropriate EPD contact, the need to simultaneously conduct extracted metals/acid volatile sulfides analyses and sediment toxicity testing when baseline sediment conditions exceed guidelines, or in situations where historic mining or other development may be contributing to current sediment toxicity.

[24] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines
[25] Ibid.
[26] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

Applications should:

- document and describe the rationale for baseline study design, including
    - parameters analyzed, (for a recommended list refer to the "Water and Baseline Monitoring Guidance Document"),
    - field instrumentation,
    - sampling frequency and period,
    - site locations,
    - statistical considerations, and
    - collection methods and QA/QC protocols (note: selection of size fraction of sediment for analyses may depend on objectives of the study and whether sediments are collected from lotic or lentic environments—there may be reason to analyze both the <63 µm and <2mm fraction in a baseline program);
- identify those sample sites that appear to be influenced by groundwater discharge, and/or those sites that could potentially receive contact water via groundwater discharge in the future;
- name the certified laboratories used to analyze samples;
- provide a summary table listing sample site locations, sample dates, sample size and rationale/purpose of each site;
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities);
- include a detailed map of sampling locations, and proposed or existing discharge locations and areas of disturbance;
- illustrate spatial and temporal variance in key parameters among sites using graphs;
- compare, tabulate and map existing sediment quality conditions relative to provincial WQGs[27], or the Canadian Council of Ministers of the Environment (CCME) Ministers Sediment Quality Guidelines for the Protection of Aquatic Life[28] (threshold or probable effect levels); and
- identify spatial and/or temporal gaps in the database.

2.8 Fisheries and Aquatic Resources

Aquatic life baseline studies determine ecosystem health and contribute to a weight-of-evidence approach to assessing the potential impact(s) of discharges to the receiving environment during mine development, operation and closure. Study components may include, but are not necessarily limited to, plankton, periphyton, benthic macroinvertebrates, shellfish, fish and fish habitat, macrophytes and biological tissues. The complexity and types of aquatic and marine habitats potentially impacted and the nature of the mine operation will inform which aquatic organisms are identified for study. Appropriate biological monitoring tools must be used, and sufficient data must be collected and presented to demonstrate that the program will be able to detect pre-determined changes considered to be biologically significant. In some cases, data collected during a single year may constitute sufficient data, but multiple years of data are recommended and preferred to help determine inter-annual variability and to provide a suitable characterization of biological communities prior to development. Detailed guidance is provided in the "Water and Air Baseline Monitoring Guidance Document"[29].

[27] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

[28] ceqg-rcqe.ccme.ca/

[29] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

EMA permit applications for discharges to streams should contain the information outlined below at a minimum. Lake and marine environments will require additional data collection.

2.8.1 Periphyton and Benthic Invertebrate Community Measures

For periphyton sampling, natural or artificial substrates may be used; in either case it is critical that sufficient replicates be collected to characterize variability of the site. For benthic macroinvertebrates, MOE recommends using the Reference Condition Approach sampling design using Canadian Aquatic Biomonitoring Network (CABIN)[30] protocols, outlined in the CABIN field manual[31]. Most regions of the province have a predictive model within the CABIN database that can be used for data assessment. A Before-After-Control-Impact (BACI) design using replicate samples (e.g., using a Hess sampler) is also a common approach.

Joint MA/EMA applications should:

- document and describe the rationale for study design, including
    - collection methods,
    - organisms or communities analyzed,
    - sampling frequency and period,
    - site locations,
    - statistical considerations, and
    - QA/QC protocols;
- name the certified laboratories used to analyze samples;
- provide maps of sampling sites relative to disturbance areas, seepage and discharge locations, and water quality and quantity sampling locations;
- summarize periphyton and benthic invertebrate community data—for BACI designs, demonstrate that sufficient data has been collected to enable detection of biologically significant changes post project development (proponents are responsible for reporting the *a priori* statistical power of their sampling plan to provide reviewers with an understanding of the program's strengths and weaknesses);
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities); and
- identify spatial and/or temporal gaps in the database.

2.8.2 Fish and Fish Habitat

Resident fish populations and habitat are under the provincial jurisdiction of the Ministry of Forests, Lands and Natural Resource Operations (FLNRO). Proponents must contact regional FLNRO fisheries staff for scientific collection permits and ensure study methods are consistent with regional and provincial protocols.

In addition to information requested by FLNRO, joint MA/EMA applications should:

- document and describe the rationale for study design, including

[30] www.ec.gc.ca/rcba-cabin/
[31] http://www.for.gov.bc.ca/hts/risc/pubs/aquatic/cabin/CABIN_field_manual.pdf

    - collection methods,
    - organisms or communities analyzed,
    - sampling frequency and period,
    - site locations,
    - statistical considerations, and
    - QA/QC protocols;
- provide maps of sampling and stream reach survey locations;
- identify the areas, if any, where groundwater discharge is higher than normal and whether this groundwater discharge is potentially influencing fish habitat;
- describe fish populations and determine the presence of provincially listed species and ecological communities (red or blue-listed), federally listed species (Committee on the Status of Endangered Wildlife in Canada, and *Species at Risk Act*), and populations that are genetically distinct;
- describe the current and potential use of the fish resources by First Nations, sport or commercial fisheries;
- assess and describe fish habitat (spawning, over-wintering, rearing, etc.) relative to access roads and utility corridors, waste rock piles, and effluent discharge or seepage locations;
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities);
- provide a brief description and rationale for a conceptual Fish Habitat Compensation Plan, if applicable; and
- identify spatial and/or temporal gaps in the database.

2.8.3 Tissue Residues

The baseline study should develop a tissue residue database for fish and/or other organisms for metals and metalloids and, if appropriate, organic contaminants. When selecting a fish species (or other organisms) for tissue residue analyses, the animal's life history should be considered. Species with high site fidelity are preferred for environmental impact assessment. However, if human health risk assessments are the focus, species and tissues humans consume should also be analyzed.

Within the application:

- document
    - study design,
    - species and tissue types analyzed,
    - collection methods and frequency,
    - site locations,
    - statistical considerations,
    - QA/AC protocols, and
    - the use of certified laboratories;
- identify which data reflect un-impacted baseline versus conditions affected by previous development (e.g., exploration activities, historical mining activities);
- provide maps illustrating sampling sites relative to disturbance areas, seepage and discharge locations;

- provide a summary table of the concentrations of contaminants in fish tissues, and compare baseline conditions relative to provincial WQGs[32] or Canadian Tissue Residue Guidelines[33];
- illustrate graphically the spatial and/or temporal variance(s) in key parameters among sites; and
- identify spatial and/or temporal gaps in the database.

2.9 Vegetation and Wildlife

Joint MA/EMA applications should provide a brief summary of the Terrestrial Ecosystem Mapping, Predictive Ecosystem Mapping, the location of rare plants and ecosystems, and invasive plants. Wildlife information should include wildlife habitat suitability mapping, results of aerial wildlife surveys, and a description and location of any key wildlife features or habitats, including any species or ecological communities at risk. Bioterrain Mapping and Vegetation Metals analyses should also be included in this section of the application, which should also provide:

- a description of onsite and adjacent terrestrial and aquatic ecosystems;
- an inventory of potential biological receptors, including human populations; and
- evidence of consultation with First Nations with particular regard to use, wildlife and vegetation.

2.10 Land Status and Use

Joint MA/EMA applications should include:

- mapping and a summary of pre-mine land surface and mineral rights, and licensed or permitted users such as forestry, guides, outfitters, and trappers;
- descriptions of
    - existing transportation routes (e.g., roads or waterways) within or adjacent to the minesite (also show these on maps/figures),
    - any known First Nations use and interest
    - any informal users who are not necessarily licensed (e.g., recreational users),
    - any known local land use and settlement patterns, and
    - onsite and adjacent terrestrial and aquatic ecosystems; and
- an inventory of potential biological receptors, including human populations.

2.11 Land Capability

Mapping and descriptions of existing land capabilities which will be used to describe potential end land use(s) following reclamation should be provided.

2.12 Archaeology

Maps and descriptions should be provided for all identified archaeological sites in the project impact zone. Maps based on those provided in the final Archaeological Impact Assessment (AIA) report may be adequate as overview maps. Detailed maps at a 1:500 scale should be provided for any sites that are to

[32] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

[33] www.ccme.ca/publications/ceqg_rcqe.html

be subjected to additional systematic data collection under *Heritage Conservation Act* (HCA) Section 14 permits.

The site descriptions can be provided in table form, and should include Borden number, general location, previous work (whether an AIA was completed, site collected completely, or site avoided), and proposed mitigation (no further work, alteration under HCA Section 12, or mitigation under Section 14).

A description of the required HCA permitting and concurrent archaeological activity should be provided, including (where applicable) the main terms and conditions of HCA Section 14 investigation permit(s) and the methodologies for HCA Section 14 inspection permit(s), the proposed HCA Section 12 Alteration Permit(s), and the Section 14 inspection permit for incidental finds during construction.

A description of (and a commitment to) a chance-finds procedure and education of the construction crew should be provided. Terms of Section 12 site alteration permits and Section 14 inspection permits for incidental finds during construction, state that no land alteration may occur without an archaeologist on site as monitor, and the archaeologist on site will have the authority to stop excavation as deemed necessary so that any archaeological resources can be handled under the terms of the permit.

2.13 Cultural Use

Joint MA/EMA applications should provide a brief summary of the cultural use of the area. Maps and descriptions should be provided for all identified cultural sites (if known) in the project impact zone.

3. Mine Plan

Joint applications for MA and EMA permits must include a detailed mine plan, including the following sections.

3.1 Mine Plan Overview

Provide a brief overview of the mine plan and proposed mining methods and production rates, along with supporting mapping as described in Part 10.1.4 of the Health, Safety and Reclamation Code for Mines in British Columbia (Code).

3.2 Development Sequence and Schedule

Joint MA/EMA applications should:

- provide the proposed mine development sequence and schedule for all mine components for all phases of mine development, including construction, operation, closure, and post-closure;
- provide an inventory of all mining waste materials, including type, volume, and storage location (waste rock and tailings); and
- identify volumes and types of construction material and provide an inventory of these.

3.3 Existing Development

Describe any previous/existing disturbance, developments and/or infrastructure currently in place within the mine area as a result of previous and ongoing activities.

3.4 Detailed Five-Year Mine Plan

Provide a detailed year-by-year five-year mine plan.

3.5 Conceptual Life of Mine Plan

Briefly describe the conceptual life of mine plan.

3.6 Mine Facility Designs and Development

This section of the application should contain facility designs and construction specifications for all major mine structures, including open pits, underground workings, processing facilities, , tailings or water management facilities, water treatment and waste facilities, and containment ditches, in accordance with Mine Code requirements. Show the locations and configurations of these facilities, and describe proposed construction materials and methods. All mine site infrastructure should be at the "detailed" design stage for MA permit review.

Mine plans and designs must be developed based on the results of ML/ARD characterization programs. Iterative geochemical assessment and mine planning is expected. Supporting data from the geotechnical field investigations and stability analyses should be provided in an appendix.

Provide the results and an assessment of condemnation drilling for permanent mine facilities (e.g. tailings impoundments, large waste rock dumps) to ensure that mineral resources will not be sterilized.

3.6.1 Open Pits

Joint MA/EMA applications should provide:

- details on pit limits, pit slope geometry and pit slope design criteria (reference to Read & Stacey's *Guidelines for Open Pit Slope Design* is recommended);
- supporting information obtained from geotechnical and other site investigations, including laboratory testing, design methodology, stability analyses, sensitivity analyses and design criteria in a separate report for geotechnical review (in an appendix)—a comprehensive analysis of relevant failure mechanisms (including kinematic and rock mass failure) is required;
- pit slope designs (bench face angles, inter-ramp angles, bench heights, berm widths, etc.), including designs for phased pit expansions using detailed geology and geotechnical information obtained from existing pit slopes (if any), rock outcrops, and geotechnical boreholes;
- descriptions of equipment to be used;
- a description of proposed water management, including inflow diversions and dewatering methods, providing information on
    - the number, location, spacing and design of dewatering wells,
    - the proposed construction, operation and closure of detwatering wells,
    - volumes to be pumped,
    - predicted area of drawdown,
    - expected water quality of the pumped water,
    - where water will be discharged to, and
    - expected impacts and how to address them;
- a description of any geohazard influences to the pit and mitigation measures;
- a conceptual design for controlled blasting; and
- a preliminary monitoring plan for the pit walls, including proposed instrumentation, movement thresholds and response.

3.6.2 Underground Workings

Applications should also provide:

- design details specific to the method of underground development proposed;
- details on proposed monitoring of the underground workings;
- details on proposed water management in the underground workings;
- estimates of aerial extent and degree of expected subsidence;
- geological, hydrogeological, and geotechnical characterization of the rock mass;
- ventilation plans for all proposed underground workings;
- a Ground Control Management Plan (GCMP), including proposed support in typical ground, for large openings, and areas with poor ground, as well as the associated QA/QC program—reference to Workplace Safety North's (formerly the Mines and Aggregates Safety and Health Association) "Ground Support Manual"[34] is encouraged.

[34] www.workplacesafetynorth.ca/products/ground-support-manual

3.6.3 Processing Plant (Mill) and Associated Facilities

Joint MA/EMA applications should:

- provide a process description, including inputs, products and non-product outputs for all stages of operations (non-product outputs may include materials sent to offsite facilities, or lost to the environment);
- provide process design criteria;
- provide flow sheets showing process streams, quantities and significant equipment;
- describe all process reagents;
- identify and provide descriptions of hazardous products, with reference to relevant sections of the Environmental Management Plan that address the safe handling and storage of these products;
- describe the foundation design criteria and rationale;
- provide a facility location drawing and description;
- provide supporting information obtained from site investigations, including laboratory testing, design parameters, design criteria, foundation requirements and a summary of construction specifications in a separate report for geotechnical review (in an appendix)—the geotechnical report should include an assessment of bearing capacity and expected settlement, and a comparison with allowable settlements for the structure involved; and
- include civil, building and mechanical drawings, electrical drawings, standard details and specifications (may be submitted separately to the Inspector of Mines, Mechanical or Electrical).

3.6.4 Tailings Management Facility (TMF) and Associated Infrastructure

Design of tailings management facilities (TMFs) and associated infrastructure is to be consistent with the Canadian Dam Association (CDA) Dam Safety Guidelines[35], including Inflow Design Flood and Earthquake Design Ground Motion, required freeboard, required factors of safety, consequence classification and consideration of both operational and closure conditions. Designs should consider aspects specifically related to mining dams as outlined in the 2014 CDA technical bulletin: "Application of Dam Safety Guidelines to Mining Dams"[36].

Joint MA/EMA applications should:

- provide TMF plans and sections at appropriate scales, showing the proposed tailings impoundment facility (dam heights, dam slopes, foundation slopes, construction materials, etc.) and dam profiles projected over the life of the mine;
- provide descriptions of the main construction materials, method of construction, and characteristics of the foundation materials;
- provide results of the geotechnical site investigation program, confirming primary design features and foundation conditions at the dam locations;
- identify any findings that are significantly different from what was predicted during the Environmental Assessment—if there are significant differences, explain whether or not design modification(s) or other forms of mitigation are proposed to address this;

[35] www.cda.ca
[36] Ibid.

- provide supporting data from the geotechnical field investigations, associated laboratory work, and stability/sensitivity analyses demonstrating input parameters and associated factors of safety in an appendix;
- provide descriptions of
    - any water diversion structures and spillways,
    - tailings properties,
    - seepage rates and seepage management, addressing any potential for groundwater contamination and plans to monitor and mitigate, and
    - geohazards that could influence the TMF and how these have been accommodated in the design;
- provide a monitoring plan for all embankments, including number and type of instrumentation, movement and piezometric thresholds and response; and
- demonstrate that the Expert Panel's[37] conclusions and recommendations contained in parts 9 and 11 of the January 30, 2015 final report on the Mount Polley tailings dam[38] breach have been evaluated for their relevance and applicability to the proposed project, and provide a summary of how these recommendations were considered and incorporated into the proposed TMF design, construction, and operation.

3.6.5 Waste Rock Storage Facility

Applications should also:

- provide plans and sections detailing proposed waste rock dumps, projected over the life of mine (information on lift heights, maximum dump heights, storage capacity, slope angles, and foundation angles should be provided);
- describe final post-mine waste rock dump configurations following resloping;
- summarize results of geotechnical and other site investigations, including foundation conditions and laboratory testing;
- provide geotechnical stability assessment and sensitivity analyses, including factors of safety and associated strength parameters;
- provide failure modes effects assessments for each facility, including potential for generation of debris flows or flow slides if dumping in or near channels, and assessment of run-out potential with consideration of Part 6.10.1(7) of the Code;
- describe how waste rock dumps will be designed and constructed, including method(s) of disposal and any proposed cover and/or drainage collection system(s) to address potential ML/ARD with cross references to the relevant ML/ARD subsections of the application that address this in greater detail;
- describe operating practices, including any proposed special handling, with cross-references to relevant ML/ARD subsections if applicable;
- ensure that all waste dumps are designed for geotechnical stability with reference to the Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee[39], and provide the risk classification (these guidelines are dated and should be considered minimum criteria);
- address potential for groundwater contamination, and present and discuss plans to monitor and mitigate groundwater contamination;

[37] www.mountpolleyreviewpanel.ca/
[38] www.mountpolleyreviewpanel.ca/final-report
[39] www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/permitting/geotechnical-information

- describe stripping requirements of topsoil and organics to enhance spoil stability and to accommodate reclamation efforts—if topsoil or organics must be left in the footprint of the spoil, this decision must be rationalized, and stability analyses must account for potential sliding on the topsoil layer (if applicable); and
- provide a preliminary monitoring plan for all waste rock storage facilities, including proposed instrumentation, movement thresholds and response.

3.6.6 Sediment Ponds and Diversion Structures

A memorandum of understanding[40] between MEM and the Ministry of Forests, Lands and Natural Resource Operations exists regarding the regulation of impoundments and diversion structures at mine sites. This document provides clarification about which agency is responsible for the various types of impoundments, ponds and diversion structures that may be required on a mine site and when a licence under the *Water Act* may be required.

Applications should provide:

- descriptions of embankment heights/excavation depths, slope angles, storage capacity and method of construction for all dams and impoundments;
- results of geotechnical and other site investigation including foundation conditions and soil properties;
- descriptions of embankment construction materials and borrow source locations;
- stability assessment(s), including factors of safety and associated strength parameters;
- a plan for any proposed instrumentation or monitoring;
- reference to the Canadian Dam Association, Dam Safety Guidelines where appropriate, including consequence classification, seismic design criteria, inflow design flood, etc.;
- sediment pond design consistent with the technical guidance on "Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining"[41];
- descriptions of the depth, width, slope angles and materials for any diversion ditches and channels;
- hydraulic capacity and confirmation that all ditches/channels can safety convey the design flood in accordance with CDA Dam Safety Guidelines[42] (minimum 1:200 years) without overtopping, side slope failure or significant erosion;
- descriptions of any required lining or armouring of ditches or channels; and
- an assessment of geohazards that could influence the diversion ditches or channels and proposed mitigation measures.

3.6.7 Low-Grade Ore Stockpile

If a separate dump will be required to store low-grade ore for possible future processing, the application should:

[40] www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/developing-a-mine/mou_impoundments_diversions.pdf

[41] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/assessing_design_size_and_operation_of_sediment_ponds.pdf

[42] www.cda.ca/

- address any potential for groundwater contamination from this activity, and present and discuss plans to monitor and mitigate groundwater contamination;
- ensure that long-term stockpiles meeting the definition of a major dump (see Part 10 of the Code) meet all of the criteria established above for waste rock storage facilities; and
- provide geotechnical assessments and stability analyses.

3.6.8 Soil Stockpiles

Joint MA/EMA applications should:

- identify soil storage locations, configurations, and anticipated volumes; and
- provide geotechnical assessments and stability analyses for all soil stockpiles.

3.6.9 Maintenance Shop, Fuel Stations and Associated Support Facilities

Applications should include civil, building, mechanical and electrical Drawings with standard details and specifications for maintenance, fueling and associated facilities (may be submitted separately to the Inspector of Mines, Mechanical or Electrical).

3.6.10 Proposed Mine Access and Mine Haulage Roads

Joint MA/EMA applications should:

- provide general descriptions of proposed mine access roads;
- provide general descriptions of mine site haulage roads;
- describe methods to be followed in the construction of mine site haulage roads;
- describe methods to be followed in the selection of construction materials for haulage roads to prevent the use of potentially acid generating rock, and cross-reference ML/ARD subsections that describe identification and operational separation methods;
- provide typical sections illustrating cut and fill slope angles, road widths, and berm heights; and
- reference Part 6.9 of the Code (“Mine Haul Road Design”).

As no specific guidelines exist for mine access road design, reference to FLNRO’s Engineering Manual would be appropriate.

3.6.11 Power Supply and Distribution

Applications should provide:

- descriptions of any proposed powerline(s) to the mine site;
- descriptions and mapping of utility corridors;
- descriptions and mapping of the onsite substation; and
- descriptions of the onsite power distribution system.

3.6.12 Explosives

Joint MA/EMA applications should:

- provide a description of any onsite operational explosives storage and/or manufacturing facility(ies), along with a description of any plans to retain a licensed explosives contractor;
- include a description of any plans for explosives use during mine construction;
- describe the plans for explosive use during mine operation; and
- provide an evaluation of explosives residuals in the discharge(s) from the site.

3.6.13 Additional Ancillary Facilities

Applications should:

- describe all additional mine site structures, including on-site accommodation and offices, in terms of location and construction; and
- describe items of particular relevance to the reclamation plan regarding locations, foundations, and nature of construction (e.g., movable modular units or “permanent” structures).

3.6.14 Fish Habitat Compensation Works

Joint MA/EMA applications should include a general description of all works related Fish Habitat Compensation Plans as approved by the federal Department of Fisheries and Oceans where applicable.

4. Reclamation Planning and Effective Mine Closure

4.1 End Land Use and Capability Objectives

End land use objectives for the minesite should be clearly identified and mapped in all joint applications for MA and EMA permits. The map should overlay the pit, tailings impoundment, waste rock dumps, and any other facilities that are to remain following closure. Target eco-sites should be identified, and a general description of how the proposed reclamation program will achieve the end land use objectives should be provided. These objectives should be clearly described in the reclamation and mine plans, and will form an integral part of operations throughout the mine life.

Capability objectives and how they will be achieved, as well as descriptions of how reclamation success will be measured, should be provided for each of the specified end land use objectives.

4.2 Reclamation Approaches

The general reclamation approaches to be used should be well established in the early stages of mine design in order to proactively anticipate opportunities to incorporate reclamation requirements into mine planning. Applications should include considerations for:

- soil management;
- monitoring;
- long-term stability;
- erosion control;
- landform design;
- surface preparation;
- coarse woody debris;
- re-vegetation; and
- projected research programs required to assess the adequacy of the reclamation approach to address long-term objectives of end land use, erosion control and re-vegetation sustainability.

4.2.1 Soil Management Strategy

The soil management strategy should be presented as part of the reclamation plan and should include the soil salvage, stockpiling, and replacement approaches. Soil salvage, storage and replacement, based on information collected in accordance with baseline data, should be described in detail, and a map should be provided showing soil ratings and proposed salvage depths.

In addition to the overall soil management plan, which is a critical part of the overall reclamation approach, it is necessary to develop a separate standard operating procedure that will direct implementation of best management practices during soil salvage and stockpiling operations, and guide salvage monitoring and stockpile maintenance provisions, such as training, supervision, and QA/QC.

Joint MA/EMA applications should include the following information related to soil salvage:

- descriptions, including physical and chemical suitability, of soils (or suitable overburden) to be salvaged;

- identification of materials or layers to be stripped separately and how to operationally distinguish them;
- total depth to be salvaged and anticipated volumes of each soil type;
- equipment to be used and constraints (e.g., slopes, etc.) on stripping;
- erosion-control and sediment-retention measures required for exposed surfaces; and
- proposed training or supervision of operators by a qualified professional.

Applications should include the following information related to soil storage/stockpiling:

- description of soil stockpile locations, volumes, depths and anticipated storage times;
- identification of layers or materials to be stored separately, and justification for doing so;
- storage requirements, including erosion and sediment control, and marking/identification of stockpiles according to the soil handling plan; and
- descriptions of stockpile treatments during the storage period.

Applications should include a soil replacement strategy that addresses:

- timing, sequencing and methods of soil replacement, including equipment to be used, and materials and depths to be replaced on a facility-specific basis;
- requirements for amendments such as fertilizer and limestone;
- methods to monitor/alleviate compaction during and following re-application; and
- volumes of materials available for replacement, and methods to address any material shortfalls.

4.2.2 Landform Design and Erosion Control

Joint MA/EMA applications should provide conceptual plans for landform design and watershed mapping for drainage-control planning, including consideration of future erosion, creep, mass wasting, and compatibility of final landforms with the surrounding landscape.

It is expected that reclamation and/or erosion control activities will be proposed for areas that are not required for further mining activities (progressive) or will not be required for mining for a period of time (temporary).

An erosion and sediment control plan should be developed to address construction and operation activities required to minimize erosion and sediment delivery from disturbed areas (as described in Section 7.5 below). This plan should provide the results of a risk assessment that addresses erosion potential and drainage patterns; these results will inform reclamation planning, such as site-specific contouring and drainage control (i.e., landform design), and re-vegetation requirements.

4.2.3 Re-vegetation Strategy

Information sources used to develop re-vegetation strategies should include:

- a baseline vegetation assessment, including Predictive Ecosystem Mapping and/or Terrestrial Ecosystem Mapping;
- site characteristics and plant succession patterns;
- end land use objectives;
- soil characteristics; and

- a review of current reclamation practices (particularly pertaining to the local area).

The re-vegetation strategy should include:

- information regarding end land use objectives;
- information on the re-establishment of functional soil conditions and natural plant succession as a means to achieving ultimate site reclamation; and
- maps indicating areas that will be addressed by different prescriptions to meet site-specific end land use objectives and/or diverse environmental conditions.

4.3 Trace Element Uptake in Soils and Vegetation

The reclamation plan should outline a proposed program to assess trace element uptake in soils and vegetation and the potential for food chain amplification, during both life of mine and closure/post-closure. This program may be re-iterated in greater detail and provided in the Vegetation Management Plan (see Section 7 below).

4.4 Disposal of Toxic Chemicals

A list of chemicals or reagents to be used on site and information on how these will be managed at closure should be provided.

4.5 Contaminated Site Requirements

Joint MA/EMA applications should provide site profiles and describe site investigations to be conducted according to the Contaminated Sites Regulation[43] (EMA) that will inform closure plans for particular mine components or areas.

Joint MA/EMA applications should:

- Provide an inventory of known or suspected site contamination and the potential for further soil or groundwater contamination on or near the site.
- Provide water use determination as per "Technical Guidance 6 on Contaminated Sites"[44] and the Contaminated Sites Regulation[45] (EMA).
- Identify remedial strategies to be used to mitigate and/or remediate contamination.
- Propose site decommissioning or planned site remedial activities including information required for the completion of a site profile as described in the Contaminated Sites Regulation[46].

4.6 Groundwater Well Decommissioning

Applications should address how and when wells will be closed (e.g., water supply, monitoring, remediation, dewatering, geotechnical boreholes, test pits). Closure should be done in accordance with

[43] www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/375_96_00
[44] www.env.gov.bc.ca/epd/remediation/guidance/technical/pdf/tg06.pdf
[45] www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/375_96_00
[46] ibid.

requirements under the *Water Act* and minimum requirements in the Ground Water Protection Regulation (Parts 12, 12.1-12.2).

4.7 Detailed Five-Year Mine Reclamation Plan

A reclamation plan for the next five years of mine development must be provided, with a detailed schedule and specific milestones for implementing progressive reclamation plans and developing reclamation research programs. Content requirements of the reclamation plan will be determined on a project-specific basis between technical reviewers and project proponents.

4.8 Conceptual Final Reclamation Plan

A conceptual final reclamation plan for the closure or abandonment of the mining operation must be provided. This plan should be in reference to, and consistent with, Part 10 of the Code. The following minimum requirements for inclusion in the plan should be addressed in all joint MA/EMA applications.

4.8.1 Treatment of Structures and Equipment

Provide a description of decommissioning activities for site infrastructure and utilities, including identification of structures and/or equipment to remain in place following mine decommissioning and proposed reclamation treatments for each area/feature.

4.8.2 Waste Dump Reclamation

Joint MA/EMA applications should:

- describe in detail proposed waste rock dump reclamation, including
    - anticipated final configurations,
    - proposed re-sloping,
    - post-closure water management,
    - surface treatment to alleviate compaction and erosion control,
    - details of soil replacement, and
    - a description of proposed re-vegetation methods;
- provide conceptual post-mine cross-sections along with a map illustrating section locations;
- demonstrate how waste dumps will be optimized for snow/water retention (where appropriate), habitat diversity and aesthetic consistency with the adjacent landscape; and
- demonstrate how the long-term stability of exposed slopes of all major dumps meet the criteria provided in the "Operation and Monitoring of Mine Dumps – Interim Guidelines"[47] as required under Part 10.6.6 of the Code.

4.8.3 Tailings Reclamation

Joint MA/EMA applications should:

- describe proposed tailings reclamation in detail, including
    - anticipated final impoundment configuration,

[47] mssi.nrs.gov.bc.ca/Geotechnical/operationmonitoring_minedumps.pdf

    - any proposed re-sloping, and
    - post-closure water management, including spillways;
- describe methods of soil replacement and proposed re-vegetation methods on tailings dam faces;
- address concerns related to trace element uptake in vegetation; and
- demonstrate how the long-term stability and maintenance of exposed slopes in all major impoundments meet the criteria provided in the Canadian Dam Association Dam Safety Guidelines as required under Part 10.6.7 of the Code.

4.8.4 Pit Reclamation

Conceptual final reclamation plans should describe whether or not pits will be flooded at closure and, if so, provide details of water quality and any discharges to the receiving environment. Details of reclamation/re-vegetation measures to be undertaken within pit areas should also be provided along with geotechnical stability assessments required for any pit flooding proposals.

4.8.5 Watercourse Reclamation

Provide details on minesite water management and the re-establishment of watercourses post-mining. Conceptual final reclamation plans should detail the volumes of water that will potentially be affected by ML/ARD and/or other mine effluents, and how potentially affected water will be collected and treated to meet discharge water quality criteria. Similar details for diversion systems of clean water that does not require collection and treatment should be provided. Long-term operational and maintenance requirements should also be included.

4.8.6 Road Reclamation

Address road reclamation, including re-contouring and re-vegetation where applicable (i.e., for most locations unless there is a specific elevation, terrain or other exemption agreed to by the Chief Inspector of Mines) and decommissioning to ensure geotechnical and hydraulic stability. De-compaction and surface preparation requirements should also be addressed.

4.9 Reclamation Cost Estimates

This section of the application should describe methods to be used to determine reclamation cost estimates for various phases of mine development and closure. These cost estimates will form the basis of the timing and amounts of securities required as conditions of MA permits. The following procedures for calculating costs should be applied:

- All costs should be based on third-party blue-book costs.
- Contingencies should be applied to all costs and be clearly indicated in the calculations.
- Decommissioning and removal costs must be provided for all equipment, buildings, the mill, etc. (Salvage value should not be incorporated for offsetting costs.)
- Present costing should be included in a spreadsheet (i.e., in XLS format), with annual costs incurred throughout the mine life.
- Detailed rationale and assumptions of analyses should be clearly laid out in the cost estimates,

- If the mine site will require long-term monitoring and maintenance, a net-present-value (NPV) model must be run for 100 years. (Note that short-term costs are not discounted and long-term costs are discounted.)
- Liability cost estimates should be signed by a qualified professional with expertise in liability costing estimation. A final document is required (i.e., non-draft).
- Costs may be submitted, with the approval of the Chief Inspector, in a separate confidential report as per Part 10.1.4(8) of the Code.

4.9.1 Post-closure Monitoring

Provide a brief description of requirements for post-closure monitoring. Periodic reporting of inspections and environmental monitoring need to be stipulated, including annual dam safety inspections, water quality monitoring, vegetation monitoring, etc. Post-closure monitoring information needs to be linked to closure and management planning.

4.9.2 Post-closure Maintenance (excluding water treatment)

Provide a brief description of the requirements for post-closure maintenance. This may include, but is not necessarily limited to, the following:

- Soil/engineered cover maintenance
- Spillway maintenance
- Periodic road maintenance
- Diversion ditch maintenance
- Slope remediation on dams and waste dumps
- Geotechnical instrumentation repair or replacement
- Wells closure

4.9.3 Post-closure Maintenance – Water Treatment

Conceptual final reclamation plans should describe the construction and operation of water treatment facilities. Information required for costing includes, but is not limited to, the following:

- Capital costs of water treatment plants
- Personnel costs (include information on how many people are needed to operate water treatment plants and conduct monitoring programs).
- Lime and reagents costs (including costs of delivery to site)
- Lime and reagents use (note decay curves for lime and reagent use should not be used)
- Power (including plant operation, pumping of seepage, heating of buildings, etc.)
- Costs of sludge handling and storage
- Costs of maintenance and equipment (e.g., keeping road open, plant, ditches, pumps, parts etc.)
- Costs of all monitoring programs (geotechnical, surface and groundwater, vegetation, etc., including Environmental Effects Monitoring programs for MOE).

5. Discharges and Treatment

Detailed waste treatment and discharge information must be included in all joint applications for MA and EMA permits. This information should establish the location, quality and quantity of

- each of the proposed contact and process water storage facilities; and
- each waste discharge anticipated over the life of the mine.

The design and intended use of any proposed pollution control works also must be described. Mine proponents are expected to select works, management practices and/or systems adequate to meet or exceed the statutory requirements and industry standards for preventing or minimizing adverse impacts to the environment and human health.

The evaluation of potential pollution control works should consider:

- capital and operating costs;
- design capacity;
- effectiveness, reliability and weaknesses (i.e., with respect to dealing with issues such as fires, power outages, floods, etc.);
- waste products,
- maintenance,
- and personnel training.

Information specified in these joint application requirements largely fulfills the requirements of Sections 4 and 5 of the TAR described in "Technical Guidance 1 – *Environmental Management Act* Applications TERMS OF REFERENCE Environmental Impact and Technical Assessment Report"[48]. Nonetheless, proponents should review TAR Sections 4 and 5 to ensure all relevant information is included in their applications.

5.1 Summary

Joint MA/EMA applications should provide an overview characterizing project components and the expected contaminant sources, as well as the planned water management and pollution control works or best management practices requirements for each. For a mine site, this should include:

- pit and/or underground development;
- tailings impoundment, seepage collection ponds and related groundwater seepage, including characterization of tailings quality, sediment control ponds and stormwater control structures;
- waste rock, low-grade ore and soil and overburden stockpiles;
- ancillary components for stormwater management (e.g., plant site, explosives site, camp, etc.); and
- an overview of the project and construction schedule.

Information should be summarized by media and location using tables. Illustrate locations and zones of concern using maps or other graphics. Raw data should be included in appendices, provided on CD, DVD

[48] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/eia__ta_tor.pdf

or USB memory stick with the application, and if applicable, uploaded for storage in the Ministry of Environment's Environmental Monitoring System (EMS) database.

5.2 Specific Information Requirements for Storage and Effluent Discharges

Joint MA/EMA applications should:

- Provide detailed designs of effective stormwater drainage collection, conveyance and storage systems that can handle peak climatic and hydrologic events (supported by site hydrology and geotechnical information).
    - See "Guidance for Assessing the Design, Size and Operation of Sedimentation Ponds Used in Mining"[49].
- Describe the location, quantity and quality (chemistry and toxicity) of contaminated waters and seepages. Sources may include:
    - waste rock run-off;
    - ore stockpiles;
    - (coal) refuse;
    - pit water;
    - underground portal drainage;
    - sediment and tailings pond water seepage or discharge; and
    - wastewater treatment plant discharges.
- Describe the methods used to determine the quality and quantity of contaminated waters or seepage (i.e., baseline data including ML/ARD potential, bench scale tests, pilot plant results, manufacturer's design specifications and performance guarantees, etc.).
- Describe the timing (e.g., seasonal, continuous, intermittent) of discharges to the environment.
- Discuss options for contaminant source control, containment or mitigation methods and describe how best management practices and MOE's Best Achievable Technology (BAT) have been applied.
- Provide detailed designs of all proposed discharge works (e.g., outfalls, spillways, channels).
- Compare proposed discharge quality to known discharge criteria, guidelines and/or industry practices.
    - Include an evaluation of end-of-pipe effluent limits. This evaluation should be based on meeting or exceeding water quality guidelines in the receiving environment during the most sensitive times of the year.
- Describe in detail all locations of effluent and seepage discharge, and in each case, determine the appropriate initial dilution zone (IDZ) in surface waters.
    - Include rationale for the proposed IDZ, along with supporting information and assessment work relating to the above points.
    - The IDZ is the initial portion of a larger mixing zone applied to a specific effluent discharge. The concept recognizes the role of dilution in mitigating the effects of effluents and that there is an accepted area of higher concentrations of contaminants prior to where full mixing occurs. The BAT policy puts requirements on dischargers for treating effluents to a high standard and does not rely on dilution alone to mitigate potential impacts. IDZs are typically only allowed when BAT has been applied.
    - The extent of the IDZ is defined on a site-specific basis, with due regard to water uses, aquatic life (including migratory fish), and other waste discharges. IDZs are normally

[49] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/assessing_design_size_and_operation_of_sediment_ponds.pdf

relatively small (e.g., should avoid creating an effluent dominated water body, and should not extend across the entire width of a channel or water body). The following generic guidance in setting an IDZ can be found in the Canadian Council of Ministers of the Environment (CCME) Ministers Sediment Quality Guidelines for the Protection of Aquatic Life[50]:

- IDZ dimensions should be restricted to avoid adverse effects on the designated uses of the receiving water system (i.e., the IDZ should be as small as possible).
- The IDZ should not impinge on critical fish or wildlife habitats (e.g., spawning or rearing areas for fish, overwintering habitats for migratory water fowl).
- Conditions outside the IDZ should be sufficient to support all of the designated uses of the receiving water system and should not result in long-term (chronic) toxicity to aquatic organisms.
- Wastewaters that are discharged to the receiving water system must not be acutely toxic to aquatic organisms.
- Conditions within the IDZ should not cause acute or short-term chronic toxicity to aquatic organisms. (Note: MOE policy allows some chronic toxicity within an IDZ.)
- Conditions within an IDZ should not result in bio-concentration of contaminants to levels that are harmful to the organism, aquatic-dependent wildlife or human health.
- A zone of passage for migrating aquatic organisms must be maintained.
- Placement of mixing zones must not block fish migration into tributaries.

5.3 Information Requirements for Wastewater Treatment Plants

Joint MA/EMA applications should:

- Describe treatment methods, treatment capacity, retention times, materials and reagents to be used, reagent sourcing and transport, etc.
- Describe and illustrate schematically the tracking of all inputs at each stage in the process through to output.
- Identify volumes and characteristics of by-product waste produced at each stage of the process (including chemicals and reagents used, contaminants liberated or created, etc.).
    - Describe long-term disposal plans for secondary waste/spent substrate that addresses long-term geochemical and physical stability. Include an assessment of whether the material is deemed hazardous waste, as well as reclamation and closure issues. (Note: This is most often included as a sludge management plan.)
- Assess performance risks for collection and treatment of wastewater—e.g., extreme weather (icing, snow loading, flows, etc.), power outages, wearing of parts, scaling, reagent supply interruption, plugging, bypassing/short circuiting, etc.).
- Provide time schedule for construction and commissioning.
- Provide estimates of capital costs and anticipated operating and maintenance costs.
- Describe operating requirements such as power, pumping, number of personnel required, volumes of materials and reagents, etc.
- Assess potential public health and safety risks and management plans for these risks.

[50] ceqg-rcqe.ccme.ca/en/index.html

- If treatment is a contingency and not part of normal operations, include thresholds that would trigger wastewater treatment plant construction and use.

- Describe maintenance and replacement plans for collection and treatment systems.

5.4 Site Contamination

Joint MA/EMA applications should include management plans as set out in Section 7.8 of this document relating to contaminated sites. Applications must also include reclamation plans for areas of the mine that will require assessment under the Contaminated Sites Regulation as described in Section 4.5.

5.5 Requirements for Sewage Disposal

Although these application requirements primarily address the main effluent discharge, sewage and solid waste disposal also require authorizations under EMA and may require separate applications.

- For sewage discharges greater than 100 persons, or where discharge is to surface waters, registration under the Municipal Wastewater Regulation (MWR) is desirable.
    - For more information on registering under the MWR, see the Ministry of Environment website[51].
- Alternatively, the sewage discharges may be included with the overall effluent permit for the site. Additional direction on how best to include sewage disposal information in the application package should be sought from MOE EPD staff.

[51] www2.gov.bc.ca/gov/content/environment/waste-management/sewage/municipal-wastewater-regulation

6 Environmental Effects Prediction for MA and EMA Permit Applications

Applicants must assess potential residual environmental effects and evaluate the risks of the mine project on human health and water users including aquatic and terrestrial resources. This predictive work considers the mine plan and proposed mitigation techniques, and builds on the available baseline environmental data and waste discharge characteristics anticipated over the life of the mine and post-closure. The environmental effects assessment should also consider cumulative effects within the watershed.

Environmental effects prediction should:

- identify spatial and temporal boundaries for effects prediction;
- identify contaminants of potential concern;
- develop or refine conceptual ecological models or frameworks to define and illustrate all exposure pathways or mechanisms linking contaminants or conditions of potential concern to the assessment endpoints (receptors)—the models aid in designing monitoring programs and facilitate the establishment and testing of hypotheses regarding the predicted relationships between stressors and assessment endpoints;
- propose site-specific assessment endpoints (e.g., drinking water quality, fish health/survival, etc.)—assessment endpoints are similar to Valued Components as described in "Guideline for the Selection of Valued Components and Assessment of Potential Effects"[52] "(B.C. Environmental Assessment Office, 2013);
- propose measurement endpoints for each assessment endpoint (chemical, toxicological or biological), for example:
    - for fish survival this might be toxicity as measured in a lab toxicity tests or based on existing water quality guidelines,
    - for water quality this might be chemical concentrations of particular contaminants, and
    - for benthic invertebrates this might be community metrics or indices, etc.;
- predict the incremental changes in parameters or measurement endpoints over existing receiving environment conditions using mass balance modelling or other techniques;
- compare predicted quality of ambient water and sediment, tailings water, effluent and seepage concentrations to provincial WQGs[53] or existing WQOs to estimate the potential severity of impact(s)—in some cases, it may be necessary to develop WQOs (for watersheds with multiple land use pressures) or science-based environmental benchmarks (for specific sites associated with a permit decision) to complete an effects assessment (see Appendix A for further information);
- consider the potential for synergistic effects of mine disturbance and cumulative effects of other environmental stressors external to the mine or from previous exploration and/or mining activities;
- identify risk(s) to aquatic resources compared to baseline and evaluate risk reduction options (see Appendix B) for further information;
- use scientifically defensible monitoring and impact assessment tools in a weight-of-evidence approach, where the range of tools is commensurate with the level of risk;
- acknowledge uncertainties in the assessment due to data gaps or model assumptions; and

[52] www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf
[53] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

- develop a safe discharge plan.

6.1 Summary

Describe the predicted residual effects on receiving environment components or assessment endpoints. Residual effects are those effects remaining after implementation of all mitigation techniques evaluated and proposed in a joint MA/EMA application. Also describe the predicted effects that would occur if the mitigation measures proved to be ineffective. Summarize potential impacts by media and location using tables, and illustrate graphically the pathways from contaminant sources to receptors. Summarize risks to surface and groundwater and aquatic resources.

Raw data should be included in appendices, provided on CD, DVD or USB memory stick with the application, and if applicable, uploaded for storage in MOE's Environmental Monitoring System database.

6.2 Groundwater Quantity and Quality

Joint MA/EMA applications should:

- describe study boundaries and assessment endpoints (e.g., drinking water quality, stream recharge, etc.);
- develop and display a conceptual model or framework to describe contaminant transport through groundwater from source to receptors, and establish a risk-assessment process;
- estimate how groundwater quantity and quality may be affected within, and downstream of, the property, including estimates of the following:
    - location(s) of contact water discharge from tailings impoundments, open pits, waste rock storage areas and underground workings via groundwater pathways,
    - seepage rates of contact water from each of these sources,
    - for mine workings that create groundwater sinks during operations (e.g., pits and underground workings), the time required to convert to groundwater sources, and
    - travel time from the source area to the discharge zone;
- include predictive uncertainty analysis that illustrates the range of uncertainty in each aspect of the predicted effects;
- explicitly consider the potential for changes to the groundwater flow regime due to mine infrastructure such as pits, underground workings, waste rock storage areas and tailings impoundments;
- consider the contribution of cumulative effects on groundwater resources within the project area and further downstream during mine operation and following mine closure;
- use empirical means, professional judgment, models and past experience to estimate
    - the risk(s) to groundwater use downstream of the property and/or to in-stream flows, and
    - the amount of contact-water seepage via groundwater and the potential for dilution of effluent by background groundwater discharge;
- estimate probabilities of occurrence of each pathway/exposure combination, and develop a matrix or other process to set priorities and manage risk;
- discuss risk-reduction options and adaptive management strategies; and

- identify data gaps, and quantify uncertainty in models, and describe how these gaps and uncertainties would be addressed in the monitoring program.

6.3 Surface Water Quantity and Quality

6.3.1 Water Quantity

Joint MA/EMA applications should:

- assess how the mine operation will affect stream flow(s) throughout the range of flows as a result of withdrawal, diversion, induced losses to groundwater and effluent discharge;
- develop a water balance model for the site to predict the impacts of mine site drainage and erosion control, tailings pond water balance, waste rock seepage, effluent and contaminated seepage dilution ratios, etc.;
- assess potential impacts of mining and waste discharge on the water balance at the mine site (including impacts on surface water, groundwater, and water-dependent features, how these potential impacts were determined and the uncertainties with the assessment, and how the uncertainties will be addressed);
- predict how in-stream flows for aquatic life may be affected during all mine phases;
- assess whether current regional trends or projected changes in stream flow(s) could potentially affect permit conditions (dilution, water management scenarios, etc.); and
- consider climate, land use, and water allocation and withdrawal.

6.3.2 Water and Sediment Quality

Joint MA/EMA applications should:

- describe study area boundaries and assessment endpoints (e.g., aquatic life, drinking water quality, etc.);
- identify key discharges, seepages, and/or disturbance regimes and associated contaminants;
- develop a conceptual model or framework to describe the transport of key contaminants from source(s) to receptors;
- identify the times of year when effluent or seepage quality is expected to be of concern, and thus when adaptive management strategies/contingency measures may be necessary—these times could be periods of low flow and/or times that are coincident with high biological sensitivity;
- evaluate worst-case water quality scenarios such as base flow and low dilution (7dQ10 flow) and high runoff conditions that may lead to increased contaminant concentrations;
- consider the potential effects of contact-water discharge via groundwater pathways, if any;
- use mass balance modelling to estimate receiving environment water (and where appropriate, sediment) quality within the IDZ, at the edge of the IDZ, and at critical points downstream (near field and far field) based on water use—information on mass balance modelling is provided in the "Water and Air Baseline Monitoring Guidance Document"[54];
- demonstrate that effluents and seepages will not be acutely toxic within the IDZ and will not cause long-term (chronic) toxicity outside the IDZ—where predicted contaminant

[54] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf

concentrations approach or exceed water or sediment quality guidelines or other water quality thresholds, the effects assessment should include an augmented set of assessment tools within a weight-of-evidence approach (additional adaptive management actions may be necessary to reduce contaminant loading);
- provide a comprehensive review and discussion of management and mitigation options (e.g., selective discharge, diffusers, etc.) that reduce potential effects and impacts;
- evaluate the contribution of upstream disturbance and resulting cumulative effects on surface water quality within the project area and further downstream during all stages of mine life;
- use empirical means, professional judgment and past experience to estimate probabilities of occurrence of each pathway/exposure combination, and develop a risk-assessment matrix or other process to prioritize and manage risk(s); and
- identify data gaps and uncertainties in conceptual models, and describe how they would be addressed in adaptive management and environmental monitoring programs.

6.4 Aquatic Resources and Other Receptors

Joint MA/EMA applications should:

- describe study boundaries and assessment endpoints (e.g., loss of habitat, fish or invertebrate tissue concentrations, abnormalities, benthic invertebrate, periphyton or fish community metrics, etc.);
- develop conceptual models or frameworks to describe the contaminant transport or mine disturbance factors linking sources to receptors, and establish a risk-assessment process;
- describe and discuss the potential for bio-accumulation or bio-concentration of contaminants, and the associated risk to assessment endpoints (e.g., fish health, consumers of fish flesh, etc.);
- predict changes in aquatic resources and other receptors (where appropriate) at species, community and/or ecosystem levels as appropriate;
- consider the potential effects of contact-water discharge via groundwater pathways, if any;
- propose measurement endpoints and discuss the relevance of these measures in a weight-of-evidence approach to increase confidence in impact prediction for the site;
- consider the contribution of cumulative effects on the aquatic resources and other receptors (where appropriate) from disturbances outside the project area and further downstream during mine operation and following mine closure;
- identify data gaps and uncertainties in models, and describe how they would be addressed in adaptive management and environmental monitoring plans; and
- assess potential human health risks.

7. Mine Management Plans

This section of a joint application for MA and EMA permits should describe the key mine management plans required to address environmental, operational and health and safety issues described throughout the application. The manner in which these plans are presented should reflect site-specific operational management and monitoring requirements. Note that additional plans may be required to reflect site-specific management objectives.

Mine management plans are considered living documents and are expected to be kept up to date, reviewed routinely, and be made available at the mine site at all times. These plans shall reference relevant policies and establish proactive procedures and standard operating procedures to provide direction for management, mine site employees and contractors. These plans shall also include provisions for training requirements to ensure that all personnel involved in implementing the respective management plans are competent to fulfill their roles.

Given that the environmental aspects of all mining projects include considerable uncertainty, it may be necessary to incorporate an adaptive management approach into development of key environmental management plans to demonstrate how the environmental predictions are going to be tracked, and how the mitigation measures and/or mine plan will be adapted to accommodate the differences between the predicted and actual environmental outcomes. The following guiding principles for adaptive management should be considered and incorporated into plans as appropriate:

- measurable objectives for each of the potential environmental effects;
- management alternatives (i.e., specific actions that could be taken, if necessary);
- predictive models that will be used inform the decision-making process;
- monitoring protocols for collecting the data required to determine whether the objectives are being met;
- provisional triggers that would be used to initiate a change in management practices; and
- actions that would be taken if the triggers are reached.

The implementation of the iterative phase of adaptive management should also be described, including the following components:

- the decision-making process;
- follow-up monitoring after any adaptive management decision, particularly the rationale for whether to implement new monitoring and/or to discontinue existing monitoring;
- provision for any additional site characterization that might be required;
- the nature and timing of the assessment and analysis (e.g., water quality model, site-wide water balance, groundwater model, etc.) that will be done after follow-up monitoring and/or site characterization has been completed; and
- how the assessment will be used to inform the understanding of present and future environmental effects, and the implementation of pragmatic management strategies.

7.1 Mine Emergency Response Plan

The Code requires all mines in British Columbia to have a Mine Emergency Response Plan (MERP). The Province has developed an MERP Guidelines[55] document that suggests approaches for preparing, training and organizing personnel for managing a mine emergency.

7.2 Occupational Health and Safety Plan

Health and safety aspects of the project should be described in this section of the application. The Occupational Health and Safety Plan should address issues with respect to water supply and treatment, sewage treatment and handling, air quality, explosives storage and handling, and occupational health and personal safety. More information is available on MEM's website[56].

7.3 Environmental Management Plan

Provide a brief summary of an overall Environmental Management Plan that will be applicable during all phases of the project (i.e., from pre-construction to construction, operation, closure and post closure/reclamation.) The detailed environmental management plan will be a living document and should be updated as appropriate during mine life.

Joint MA/EMA applications should provide:

- an environmental policy statement;
- context on environmental management roles and responsibilities;
- information on statutory requirements, including applicable local, provincial or federal environmental standards and guidelines, permit requirements, regulations, and orders;
- information on environmental standards and procedures, including all applicable sector-specific standards, guidelines, best management practices, and codes of practice (e.g., Responsible Care, CSA, ASTM, RISC, GWPR);
- a description of the mine's organizational structure; and
- a description of proposed training programs.

7.4 Construction Management Plan

Joint MA/EMA applications should describe:

- the project schedule;
- a plan for the co-ordination and management of the construction workforce; and
- proposed phases of the project, including site preparation and construction (e.g., sediment control, open burning, waste rock handling, soil salvaging, interim domestic effluent and solid waste treatment during construction, etc.).

[55] www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/merpguidelines.pdf

[56] www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/health-safety/occupational-health

7.5 Surface Erosion Prevention and Sediment Control Plan

Joint MA/EMA applications should provide conceptual methods for prevention of erosion and sediment discharge during the construction, operational and closure phases. Proponents will need to submit a more detailed, site-specific stand-alone plan prior to construction. Further guidance on developing sediment and erosion control plans is available in "Technical Guidance 3 – *Environmental Management Act*: Developing a Mining Erosion and Sediment Control Plan"[57]

The Surface Erosion Prevention and Sediment Control Plan should include the following specific areas:

- the mine site (plant sites, pits, waste dumps, tailings impoundments, etc.);
- all access roads; and
- any utility corridors.

The plan should also provide:

- information on roles, responsibilities, and training requirements;
- an assessment of erosion potential (i.e., risk) and consequence;
- a description of how erosion and sediment control will be managed during construction and throughout the mine life;
- descriptions of methods to be used;
- drawings and/or maps of where prescriptions will be applied;
- erosion control/sediment control plans for disturbed surfaces and soil stockpiles;
- a detailed event-based effectiveness monitoring program including locations and frequencies; and
- a response plan including specific triggers, actions to be taken, and reporting protocols.

The potential for sediment release from internal sloped structures such as waste rock dumps and any segments of pit walls should be addressed through the Water Management Plan.

7.6 Fuel Management and Spill Control Plan

This plan should outline the following:

- fuel handling;
- dispensing and storage facilities and related equipment; and
- procedures regarding fuel management and spill control to be followed at the mine site during construction and operation.

The Fuel Management and Spill Control Plan should include an Emergency Response Plan in accordance with regulatory requirements, including a Spill Response Plan for prevention and management of spills and fugitive emissions onsite and on product transportation routes.

[57] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/erosion_sediment_control_plan_guide.pdf

A contingency plan should be developed for preventing, minimizing and containing emergencies. The contingency plan should also include plans for process upsets and non-compliant discharges (e.g., collection ponds with pump-back systems; back-up treatment systems).

7.6.1 Further Guidance on Contingency Planning

- Guidelines for Industry Emergency Response Plans (Ministry of Environment)[58]
- CSA-Z731-03 (R2014) Emergency Preparedness and Response[59]
- Spill Reporting Regulation, EMA (BC Reg. 263/90)[60]
- Environment Canada's "Implementation Guidelines for Part 8 of the *Canadian Environmental Protection Act, 1999* – Environmental Emergency Plans"[61]

7.7 Mine Site Water Management Plan

Geotechnical stability and hydraulic capacity assessments should be provided for all water storage structures, water diversions, interceptors and sediment-retention structures. Proposed monitoring and maintenance programs should also be described.
""

Part 10.1.8 of the Code requires water management facilities to be designed by a professional engineer. Further, as per Part 10.1.5 of the Code, major impoundments must be designed in accordance with the Canadian Dam Association Dam Safety Guidelines[62].

The primary goal of the Mine Site Water Management Plan is to manage clean water and contact water. This plan should include or reference the following:

- a water balance for each relevant structure;
- geotechnical, hydrologic, and hydraulic stability assessments for all water diversions, interceptors and sediment retention structures;
- preliminary designs of sediment control ponds and diversion structures;
- details on use of existing drainages;
- surveillance and maintenance of the water-management structures;
- proposed water sources for the mine, detailing the watershed or source area boundary for the water supply, and providing hydro-geologic information (location, capture zone, yield, water quality, etc.) for all groundwater sources to be utilized;
- design of conveyance system for the water treatment plant;
- design of any groundwater seepage mitigation or interception structures;
- description of any flow augmentation measures that might be required during low-flow periods to compensate for any induced streamflow losses to groundwater;
- appropriate contingency planning;
- analysis of impacts if the contingencies fail;

[58] www2.gov.bc.ca/gov/content/environment/air-land-water/spills-environmental-emergencies/planning-prevention-response/industry-emergency-response-plans
[59] www.scc.ca/en/standardsdb/standards/18899
[60] www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/263_90.htm
[61] www.ec.gc.ca/lcpe-cepa/D6ADAD2D-2E02-4885-81AE-788168284720/guide-eng.pdf
[62] www.cda.ca

- potential impacts of mining and waste discharges on the source water quality, and relevant conditions from the regional health authority for well construction and the water system's operation;
- an assessment of upset conditions (e.g., extreme flow conditions, icing, etc.) on the performance of the Water Management Plan; and
- contingencies required to mitigate potential impacts of upset conditions and potential impacts related to failure of identified contingencies.

Include the delineation of the watershed or source area boundary upstream of the proposed water intake (if surface water, including a spring) or capture zone (if on a well). Methods for delineating the source area for a water supply spring or a well capture zone are presented in:

- "Defining the Source Area of Water Supply Springs"[63]
- Step 2 of the "Well Protection Toolkit"[64]

If the source is a water supply well, provide the details of the well's location and construction, yield and water quality testing and the source of the groundwater in relation to the geological units.

Identify and discuss any potential impacts of the proposed mining and waste discharge activities on the mine water source and use. Identify any relevant conditions in the permits from the regional health authority for the wells construction and the water system's operation.

7.8 Waste (Refuse and Emissions) Management Plan

Joint MA/EMA applications should briefly describe waste management strategies to be followed during construction, operation and closure, and a detailed Waste Management Plan should be included in the appended Environmental Management Plan. The Waste Management Plan should clearly outline all discharges through the various construction and operation phases of the project, including the following:

- Air Contaminants
    - List potential sources, including open burning; incineration; spills; dust; fugitive emissions from all processes (including cooling); emissions from ponds and yards; and emissions from electrical generation. (Depending on the mining process, an air discharge permit may be required.)
- Effluents
    - List sources, including spills, exfiltration, spray irrigation, other losses from processes (including cooling), sewage and stormwater discharges.
- Refuse
    - List sources, including spills and other losses of materials such as leachate, materials from landfilling or land-farming, or recyclable materials.
- Site Contamination
    - Provide an inventory of known or suspected site contamination and the potential for further soil or groundwater contamination on or near the site.

[63] a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=17862
[64] www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/wellprotect.html

- Provide water use determination as per "Technical Guidance 6 on Contaminated Sites"[65] and the Contaminated Sites Regulation[66] (EMA).
- Provide detailed descriptions of any proposed pollution control and/or water management necessary during construction and operations to manage existing contamination.
- Identify remedial strategies to be used to mitigate and/or remediate contamination.
- Identify a monitoring proposal to aid in characterizing potential groundwater contamination.

- Also provide information on proposed site decommissioning or planned site remedial activities, including information required for the completion of a site profile as described in the Contaminated Sites Regulation[67] (EMA).

7.9 Safe Discharge Plans

Within the joint MA/EMA application, propose safe discharge plans for all discharges to surface water or groundwater:

- A safe discharge plan should propose discharge limits (volumes and concentrations) that ensure no acute toxicity to aquatic organisms at the point of discharge and no chronic toxicity beyond the edge of the IDZ. This is achieved by back-calculating discharge concentration and volume limits using contaminant-specific WQGs, WQOs or science-based environmental benchmarks as values in the mass balance model. (See additional information in Section 6.3.2 related to mass balance modelling.)
- For groundwater, ensure groundwater use downstream is not compromised and no chronic toxicity occurs in surface waters as surface water recharge occurs. Note: This information may form the basis for terms or conditions incorporated into the EMA effluent discharge permit.
- Describe emergency procedures for pollution control system malfunctions/upsets, and contingency plans (e.g., contingency storage for water requiring treatment). Contingency plans for chemical and fuel storage areas should also be included.

7.10 ML/ARD Characterization and Management Plan

Provide day-to-day operational management and materials-handling procedures based on the integration of ML/ARD geochemistry (see Section 2.3.4 above) and water-quality baseline studies (Section 2.6) with the scheduling and sequencing defined in the mine plan (Section 3.2).The ML/ARD Characterization and Management Plan should include the following:

- operational procedures for identification, geochemical classification, handling and disposal of mine wastes, and follow-up monitoring programs;
- specific measures/strategies to prevent or mitigate ML/ARD, with rationale for technical feasibility (refer to "Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia"[68]; and

[65] www.env.gov.bc.ca/epd/remediation/guidance/technical/pdf/tg06.pdf
[66] www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/375_96_00
[67] Ibid.
[68] www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/permitting/ml-ard_guidelines.pdf

- contingency measures, identifying triggers for implementation.

7.11 Traffic Control Plan

Joint MA/EMA applications should provide a general description of the Mine Site Traffic Control Plan, which in turn should include information on the following:

- radio frequencies;
- maximum allowable speeds for the vehicles in use;
- rules for passing;
- "stop" and "yield" locations;
- priority rules for various vehicles;
- rules for night operation;
- maximum operating grades;
- emergency run-off protection;
- shoulder barriers;
- access roads to the mine site, including
    - access restrictions,
    - load restrictions (if any),
    - radio frequencies to be used by local traffic, and
    - route maps showing key locations or turns for access roads to the mine site; and
- any other information required by the Senior Inspector of Mines, Health and Safety.

7.12 Chemicals and Materials Storage and Handling Plan

This section of the joint MA/EMA application should identify potential chemicals and substances classified as or are deemed to be potentially hazardous (including toxic chemicals/substances) that will be used during construction and/or operation. This section should also briefly describe storage and handling plans for the identified chemicals and substances.

7.13 Vegetation Management Plan

The objectives of the Vegetation Management Plan are to ensure that disturbance is limited to permitted boundaries and that effects of disturbance are mitigated in a timely manner. This plan should provide details on proposed activities for achieving the objectives, including:

- best management practices during construction and operation;
- training requirements;
- detailed monitoring and reporting plans;
- provisions for adaptive mitigation;
- ongoing consultation with stakeholders; and
- considerations for reclamation planning.

The Vegetation Management Plan should also include standard operating procedures for addressing, if applicable, riparian areas, old growth and mature forests, rare and at risk species and ecosystems, metal uptake, large/coarse woody debris, and invasive plant species. It may be prudent to develop a separate

invasive plant management plan to highlight the key considerations for early identification and effective management of invasive plants in order to facilitate successful site reclamation.

7.14 Wildlife Management Plan

The objective of the Wildlife Management Plan is to minimize impacts on wildlife in the project area, with particular reference to focal species of interest and species at risk. The plan should provide details on proposed activities for achieving the objective, including:

- best management practices during construction and operation;
- employee education requirements and programs as related to those practices;
- detailed monitoring and reporting plans;
- provision for adaptive mitigation;
- ongoing consultation with stakeholders; and
- preliminary recommendations for consideration during reclamation planning.

7.15 Archaeological Management and Impact Mitigation Plan

This plan should address the following:

- archaeological and cultural heritage resources awareness training;
- training for archaeological monitoring;
- detailed Chance-Find Procedures, including obtaining required permits;
- applicable legislation, regulations and guidelines;
- Heritage Inspection and Alteration Permits; and
- protection of existing sites.

8 Discharge and Environmental Monitoring Requirements for MA and EMA Permits

Joint applications for MA and EMA permits must include proposed monitoring and reporting programs which enable ongoing evaluation of waste management performance and receiving environment condition, and evaluation of impact predictions made during the permit application. Monitoring programs should initially be spatially comprehensive including sites at reference or control locations, end-of-pipe locations, and exposure sites such as edges of IDZs and far field locations. Increased sampling frequency and a weight-of-evidence approach to the monitoring program is necessary early in mine life to support adaptive management. Over the life of the mine, monitoring requirements may be adjusted to reflect the results of ongoing assessment work.

Where applicable, the requirements of the federal Environmental Effects Monitoring (EEM) program under the Metal Mining Effluent Regulations[69] should be integrated into the monitoring program design outlined in the joint MA/EMA application. However, proponents should be aware that the federal EEM program is generic and not normally sufficient to address provincial regulatory requirements. Proponents should discuss provincial monitoring program requirements with regional MOE staff early in the mine planning stage. At a minimum, EMA permits will require comprehensive monitoring programs for discharges, immediate receiving environments, and a broader Aquatic Effects Monitoring Program. In each case, the submission for the monitoring program should include the following:

- proposed study design;
- objectives;
- site locations (should be mapped, and coordinates should be provided);
- sampling frequency;
- parameters for assessment;
- sampling and analytical lab methodology;
- rationale for proposed sampling program;
- proposed assessment techniques;
- proposed data quality assurance and quality control (QA/QC) programs; and
- reporting schedule.

Note: Aquatic Effects Monitoring Programs should be linked closely to baseline monitoring programs, particularly if a BACI study design is proposed.

Basic requirements of necessary monitoring programs are described briefly below.

8.1 Discharge Monitoring

Monitoring programs specific to effluent, seepage and solid waste are required. These monitoring programs must use appropriate physical (e.g., volume), chemical (e.g., concentrations) or short-term and long-term toxicological measures. These limits will form the basis for terms and conditions incorporated into the EMA effluent discharge permit.

[69] laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/index.html

Raw data should be included in appendices, provided on CD, DVD or USB memory stick with the application, and if applicable, uploaded for storage in the Ministry of Environment's EMS (Environmental Monitoring System) database.

8.2 Receiving Environment Monitoring

Joint MA/EMA permit applications should propose routine receiving environment monitoring programs that use physical, chemical and biological measurement endpoints to track the impact of effluent discharges on the near field (edge of or within the IDZ) and far field receiving environment. Media sampled at reference and exposure sites often include:

- surface waters;
- sediments or groundwater (the latter if permitted activity may affect groundwater quality/quantity); and
- other media being incorporated into the Aquatic Effects Monitoring Program.

The description of the monitoring program should include the following:

- monitoring locations;
- for groundwater, the general range of monitoring depths and whether multiple depths will be monitored at a given location;
- the rationale for the distribution of monitoring locations and depths, particularly as each one relates to the potential environmental effects and the uncertainties identified in the predictive analysis; and
- sampling or measurement frequency, and the associated rationale.

In some cases, receiving environment monitoring will be incorporated into the Aquatic Effects Monitoring Program (see Section 8.3 below). Where groundwater–surface-water interactions are important, groundwater testing should complement surface-water monitoring efforts. For surface waters, the sampling should be concurrent with discharge monitoring and should address WQG or WQO requirements. This surface water and groundwater monitoring program is expected to include two general characteristics:

- consistent, long-term monitoring stations that will be active over the life of the project to facilitate long-term trend analysis; and
- as part of the adaptive management plan, a commitment to add monitoring stations during the life of the project that might be required as the understanding of site conditions evolves.

In some cases, a monitoring station may be discontinued with the approval of MOE if it can be demonstrated that the station is inappropriate in light of new information. The data and analysis from the monitoring stations will form the basis for assessment of terms or conditions incorporated into EMA effluent discharge permit.

This section of the joint MA/EMA application should also summarize the assessment of the potential environmental effects and risks, and mitigation/management plans to be followed during emergencies and unexpected shutdown events for the pollution control systems. The link between each of the predicted effects and the associated monitoring should be demonstrated.

8.3 Aquatic Effects Monitoring

The Aquatic Effects Monitoring Program is the program used to evaluate the effectiveness of the EMA permit. As such, proponents must develop and implement an Aquatic Effects Monitoring Program to determine the effects of effluent discharges, seepages, and mining-related disturbances, separately and cumulatively on the receiving environment. This program provides weight-of-evidence assessment information using a range of tools commensurate with the risk posed by the project.

The Aquatic Effects Monitoring Program will likely include measures related to water, sediment, benthic invertebrates and fish. Other valued ecosystem components or assessment endpoints (e.g., periphyton, fish tissues, etc.) may also be appropriate as identified in the baseline or impact prediction studies. The Aquatic Effects Monitoring Program should be planned in consultation with MOE staff. It is common practice for this program to be officially approved by a Director under EMA, and implementation is necessary to ensure compliance with the EMA permit. Planning, implementation and reporting of Aquatic Effects Monitoring Program studies often occurs on a multi-year cyclical basis.

8.4 Reclamation Monitoring and Surveillance

Joint MA/EMA applications must include a detailed description of the means by which environmental protection and quality control will be achieved during all stages of reclamation, particularly soils salvage, soil replacement and any requirements pertaining to ML/ARD. This description should include details of the authority and reporting sequence of any environmental staff and the procedure for providing reports and updates to government agency representatives, particularly those from MEM's Health, Safety and Permitting Branch and MOE.

8.5 Temporary Closure Care and Maintenance and Monitoring

Describe potential temporary or short-term closure care and maintenance and monitoring that may be required for surface water quality and quantity, groundwater quality and quantity, geotechnical, ML/ARD, revegetation, sedimentation or other requirements, depending on the site and closure scenario. Rationale will be required for any changes to the regular monitoring program, including any ramp-down period following temporary closure and any ramp-up period prior to reopening.

8.6 Long-term and Post-closure Monitoring

Describe potential long-term monitoring that may be required for surface water quality and quantity, groundwater quality and quantity, geotechnical, aquatic effects, ML/ARD, revegetation, sedimentation or other site-specific requirements. A thorough set of criteria and associated rationale will be required for any changes relative to operational monitoring as follows:

- monitoring locations;
- monitoring frequency; and
- measurement parameters.

The post-closure monitoring program should also include a re-assessment of effects predictions in light of the data collected post-closure. The proponent should use the results of the reassessment to

conclude whether or not the design of the post-closure monitoring program needs to be modified. The re-assessment should include the data, methods and analysis to support the conclusions.

8.7 Quality Assurance and Quality Control Requirements

Quality assurance protocols must be described and followed in the proposed monitoring programs. These protocols include the following:

- equipment checks and calibration;
- field procedures to minimize data-collection errors;
- sampling equipment de-contamination;
- blank sampling;
- duplicate sampling;
- assessment of duplicate samples;
- assessment of ion balance;
- assessment of the influence, if any, of suspended solids on dissolved concentrations in groundwater samples;
- comparison of aggregate parameters with analytical parameters (e.g.,, conductivity with total dissolved solids, total dissolved solids with the sum of analyzed concentrations); and
- outlier flagging of data points that do not represent actual conditions.

Guidance on quality assurance and quality control can be found in Part A of the "British Columbia Field Sampling Manual"[70].

8.8 General Guidance

At a minimum, monitoring programs should adhere to the following general guidelines:

- Monitoring programs must be developed by qualified professionals, and must describe in detail
    - The sampling methods,
    - sample preparation and hold times,
    - analytical methods,
    - quality assurance/quality control procedures,
    - and data analysis methods.
- Reference the guidance document that describes the analytical methods being used.
- Monitoring programs should be based on guidance provided in the "Water and Air Baseline Monitoring Guidance Document"[71]. As well, programs should conform to methods and QA/QC procedures specified in the "British Columbia Field Sampling Manual"[72] and the Environmental Data Quality Assurance Regulation[73] (EMA).
- Analyses must be performed using standard analytical methods, as specified in the most recent edition of the "British Columbia Environmental Laboratory Manual" and supplements to the manual[74].

[70] www.env.gov.bc.ca/epd/wamr/labsys/field-sampling-manual
[71] www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/water_air_baseline_monitoring.pdf
[72] www.env.gov.bc.ca/epd/wamr/labsys/field-sampling-manual
[73] www.bclaws.ca/Recon/document/ID/freeside/22_301_90
[74] www.env.gov.bc.ca/epd/wamr/labsys/lab-manual

Appendix A: Description of Water Quality Thresholds

Water Quality Guidelines

British Columbia's Water Quality Guidelines[75] (WQGs) are science-based levels of substances (physical or biological) that are protective of given water uses such as aquatic life, drinking water, recreation, agriculture and industry. WQGs provide a consistent basis for assessing water quality conditions throughout the province of British Columbia. WQGs are intended to protect designated water uses (e.g., drinking water, aquatic life, recreation and agriculture) and apply provincewide. There are a large number of substances that have not been fully assessed and formally endorsed by MOE. The Province has adopted working water quality guidelines[76] for some of these substances to indicate safe levels in the environment.

Additional Science-based Water Quality Thresholds

In some cases, WQGs may not be appropriate thresholds for the assessment of environmental effects as they may be under or over-protective at sites with unique conditions. In a given watershed, or at a specific site, background water chemistry concentrations may exceed WQGs, or the toxicity of contaminants may differ from conditions under which WQGs were created due to factors such as pH, water hardness, presence of complexing agents, and the cumulative effects of other constituents in the water. Under such circumstances, it may be appropriate to modify generic WQGs by developing alternative thresholds to account for site-specific conditions. These measures should include water quality objectives (WQOs) and science-based environmental benchmarks.

Water Quality Objectives

Water quality objectives (WQOs) are science-based tools that provide an effective basis for managing aquatic ecosystems and describe conditions that should be met to protect designated uses of freshwater, estuarine, and marine ecosystems. WQOs are established following the principle of avoiding the degradation of existing water quality, upgrading existing water quality, or protecting water quality for the most sensitive designated use (e.g., drinking water, aquatic life, wildlife, agriculture, recreation, industrial supplies). WQOs are an extension of the WQGs and are prepared on a site-specific or watershed basis, with due regard for the water quality, water uses (including aquatic life), water movement, and waste discharges at a given location. WQOs are generally developed for watersheds in which multiple land uses pose risks to water quality. Once developed, WQOs become the water quality thresholds for current and future development within a watershed. For more information, see "Guidance for the Derivation and Application of Water Quality Objectives in British Columbia"[77].

Where WQOs exist for a watershed, they are to be used in the place of WQGs in an effects assessment.

In instances where proponents believe that development of WQOs is technically justified, they must meet with MOE staff to discuss their appropriateness and to determine next steps. If any work is to be

[75] www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines
[76] Ibid.
[77] www.env.gov.bc.ca/wat/wq/pdf/wqo_2013.pdf

conducted by project proponents (e.g., toxicity tests may be required to support the development of WQOs), the workplan should be reviewed by MOE staff.

Science-based Environmental Benchmarks

To support timely site-specific effluent permitting (or other management) decisions in cases where WQGs may not be appropriate and WQOs do not exist or cannot be developed according to the proper justification and principles, science-based environmental benchmarks (SBEBs) may be proposed. An SBEB is a quantifiable receiving-environment parameter or attribute developed by qualified professionals through a rigourous scientific process with the intent to guide management decisions and mitigative actions for a regulated activity at a specific location.

Like WQOs, SBEBs are science based and should be developed to protect water quality for the most sensitive designated use. SBEBs may be attributes of water, sediment and/or biota that are applied at specific locations to protect valued resources in the receiving environment and can be:

- derived using the methods recommended for the development of WQOs (e.g., re-calculation procedure, background concentration procedure, etc.), but without developing the full WQO report for approval; or
- based on alternative methods, not explicitly described in the WQO guidance document, which incorporate accepted and sound science in a weight-of-evidence approach.

A primary difference between SBEBs and WQOs is that SBEBs are not subject to the same formal reporting and approval process as WQOs. The science and rationale must be documented and provided in a comprehensive impact assessment.

SBEBs should not exceed WQGs (or WQOs) for human health in areas where water uses include domestic consumption, recreation or irrigation. SBEBs are also not appropriate for parameters where small increases in concentrations at or even below guideline levels can contribute to unpredictable changes to aquatic ecosystems (e.g., nutrients, PCBs). For these parameters, WQGs or WQOs are more appropriate thresholds. Establishment of an SBEB should not result in a situation that causes pollution or (if it is an already degraded site) increases pollution.

SBEBs should be supported by a comprehensive assessment of risk, environmental effects monitoring program and confirmatory studies as needed. New scientific information and monitoring program results should inform ongoing adaptive management efforts and continuous improvement.

Regardless of the tools and the methods used, the approach must be technically and scientifically defensible and consider the full range of conditions (e.g., contaminant mixtures) expected at the site in question.

Before SBEBs are developed, proponents should contact MOE Environmental Protection Division staff to discuss whether SBEBs and the planned development approach are appropriate. An SBEBs framework to guide SBEB use and development is expected to be finalized by MOE in 2016.

Appendix B: Risk Assessment

The proponent must *a priori* establish and describe likelihood and consequence criteria to assess risk. Potential criteria to determine consequence include those identified in the Environmental Assessment Office's "Guideline for the Selection of Valued Components and Assessment of Potential Effects"[78].

- **Context:** The ability of the environment to accept change. The effects of a project may have a greater impact if they occur in areas that are ecologically sensitive or significant and/or have little resilience to imposed stresses. Will the effect threaten the existence of a rare species or an isolated population of a particularly valued species?
- **Magnitude:** The expected size or severity of the effect. A comparison to water quality guidelines or existing water quality objectives is an initial tool to help determine magnitude. Risk increases with the number of parameters that are predicted to approach or exceed guidelines and the frequency and the size of the exceedances.
- **Extent:** The spatial scale over which the effect is expected.
- **Duration:** The length of time the effect is expected to persist. This could be related to the length of time organisms are exposed to a toxicant or stressor combined with reversibility.
- **Frequency:** How often the residual effect occurs. Episodic or infrequent effects or exposure may have a lower impact than continuous long-term and/or frequent effects.
- **Reversibility:** Whether an effect can be reversed once the physical work or activity causing the disturbance ceases.

In addition, it is important to consider cumulative and synergistic effects.

The proponent should also determine how risk factors change by implementing contingency and other mitigation measures.

The use of human health and ecological risk assessment exposure models are examples of a structured process for conducting a detailed impact analysis. Further guidance is available in the following:

- "Recommended Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia"[79] (MOE, 1999—specifically Chapter 8)
- "Quantitative Human Health Assessment: Phase 1 – Review of Methods and Framework Recommendation"[80] (MOE, 1993)
- "Concentration Limits for the Protection of Aquatic Receiving Environments"[81] (MOE Technical Guidance 15 on Contaminated Sites)
- Risk Assessment Guidance for Superfund (RAGS): Part A[82] (United States Environmental Protection Agency)

[78] www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf
[79] www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/protocols/protocol-1.pdf
[80] www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/external-guidance/humanhealth_section1.pdf
[81] www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/technical-guidance/tg15_2013.pdf
[82] www.epa.gov/oswer/riskassessment/ragsa/index.htm