BRITISH COLUMBIA | Ministry of Environment

Technical Guidance 1

Environmental Management Act Applications

TERMS OF REFERENCE

Environmental Impact Assessment
And
Technical Assessment Report

Version 1.0

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Environmental Protection Division
Regional Operations Branch

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Acronyms

AEMP	Aquatic Effects Monitoring Program
BACI	Before-After-Control-Impact
BAT	Best Achievable Technology
CABIN	Canadian Aquatic Biomonitoring Network
EIA	Environmental Impact Assessment
EMA	*BC Environmental Management Act*
ENV	Ministry of Environment
FLNRO	Ministry of Forests, Lands, and Natural Resource Operations
IDZ	Initial Dilution Zone
ML/ARD	Metal Leaching/Acid Rock Drainage
QA/QC	Quality Assurance/Quality Control
SBEB	Science-Based Environmental Benchmark
WQG	Water Quality Guidelines
WQO	Water Quality Objective
TAR	Technical Assessment Report
TOR	Terms of Reference

Preface

These Terms of Reference (TOR) are intended for proponents of major mine projects applying for an effluent discharge permit under the *Environmental Management Act* (EMA). If your project will have air discharges, dust, etc. contact the Regional Operations Branch, Environmental Protection Division (EPD) to discuss permitting requirements. This document outlines the information requirements of the Technical Assessment Report (TAR), with particular emphasis on the environmental impact assessment (EIA) normally required as part of the application.

This document builds on generic guidance related to TAR preparation[1]. A future version of these TOR will describe the information necessary to support a joint application for a *Mines Act* (MA) permit and an *Environmental Management Act* effluent discharge permit. The combined requirements are intended to reduce overlap in application requirements and enable bundled applications to be submitted together under British Columbia's coordinated authorizations process[2].

In cases where construction significantly precedes operation, a proponent may submit an application for an EMA permit[3] associated with construction effluent discharges prior to an application for operational effluent discharge permits. These TOR should be modified specifically for each project (single- or two-phase application) after discussion with and advice from the project's mine development review committee(MDRC), specifically the Ministry of Environment (ENV) staff.

Provision of the information specified in this TOR 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*[4]. This document 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 mining sector, the baseline guidance document also informs EMA applications for other industrial sectors.

Each qualified professional signing-off on components of the TAR or EIA is to provide a signed statement, specifying the sections they are responsible for and confirming that all of that respective information required has been provided and that it is true and complete based on their professional knowledge and judgment. Signed statements should be included as an Appendix in the application and should contain professional association affiliation and membership number.

In addition to providing technical information to address these TOR, the proponent must submit an application form for authorization to discharge effluent[5] under EMA and ensure application fees are included.

To expedite review of EMA effluent discharge permit applications for new or significantly expanded mines, proponents must submit a completed checklist per Technical Guidance 2 – Table of Concordance

[1] http://www2.gov.bc.ca/gov/topic.page?id=1653E566D9E84CCE81FB33F2819D350E
[2] www.for.gov.bc.ca/ftp/major_projects/external/!publish/web/mining/Proponent_Guide_Major_Mine_Projects.pdf
[3] An overview of the two-phase application process and roles of agency staff are available online: http://www2.gov.bc.ca/gov/DownloadAsset?assetId=2F43387DE13240BE9DB1B18D5CEE96B3&filename=effluent_permitting_guidance_doc_mining_proponents_apr2013.pdf
[4] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[5] http://www2.gov.bc.ca/assets/gov/topic/7FBA17F731B12ED37709B3A9BD473516/formstemps/approvalapplication.pdf

as part of the application package to the EPD. Completion of the checklist will indicate that the project proponent and its 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. Preference is given to applications with each component prepared and signed/sealed by a suitably qualified licensed professional.

Applicants also submitting a *Mines Act* application should contact Ministry of Environment Staff for guidance on incorporating information included in the EPD permit application and the larger Joint Terms of Reference for a *Mines Act* and *Environmental Management Act* application.

This TOR addresses effluent related discharges only. For other project activity related waste discharges, such as air emissions, solid waste, or hazardous waste disposal, separate applications may be required. Environmental Protection Division's Industrial Camp Waste Authorizations Fact Sheet [6] 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 effluent discharge applications for *Environmental Management Act* permits. This document is to be used in conjunction with the Technical Guidance 2 – Table of Concordance which will assist in ensuring submitted applications are complete. Preference is given to applications with each component prepared and signed/sealed by a suitably qualified licensed professional.

[6] http://www2.gov.bc.ca/assets/gov/topic/7BE6D1629C96685698920E29284EBCF4/mwr/workcampsfs.pdf

1 Project Description and Overview

Section 1 is an introduction to the application (new or amended), and provides background information on the mining project, the proponent, and an overview of the mine and development plans.

1.1 Introduction

- Background information and summary of the application
- Summary of the regulatory environmental assessment review and other regulatory requirements
- Overview of the company including legal name and address
    - head office contact information
    - site office contact information
- Corporate environmental policy
- Property description, location and access
- Facilities overview and layout
- Identification of current land use, surrounding land uses and downstream users

1.2 Project Description

- Project history leading up to the application, including a list of relevant related reports
- Overview of products and markets
- Phases of the project including:
    - site preparation and construction (sediment and erosion control, waste rock handling, soil salvaging, interim domestic effluent and solid waste requirements, etc.)
    - site operations (describe operation sediment control, seepage collection and management, water diversion and recycling, ore processing and milling, waste rock, tailings, and soils handling, current and planned discharges for both point and non-point)
    - site closure – for amendment applications, include information regarding changes to the closure plan

2 Baseline Information

Characterization and presentation of baseline environmental conditions is a critical element in applying for permits under the *Environmental Management Act*. 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, and periphyton and benthic invertebrate communities.

The proponent is advised to follow the detailed guidance provided by *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators*[7] and by the *B.C. Field Sampling Manual*[8].

The 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 Mine Review Committee (MRC) and the Mine Development Review Committee (MDRC) 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 following information:

2.1 Summary

The baseline section will include an overview of the existing baseline environmental conditions highlighting 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 the Ministry of Environment'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* document[9]. Applications for an EMA permit should:

- describe relevant meteorological and climate information sources for parameters such as wind speed and direction, precipitation, temperature, evaporation and evapotranspiration;
- predict normal and extreme ranges of climatic parameters such as rainfall and snow melt relevant to mine facility design and operations (i.e., focusing on factors affecting hydrological parameters); and
- identify information gaps and describe site-specific meteorological data collection methods proposed to augment existing regional data.

[7] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[8] www.env.gov.bc.ca/wsd/data_searches/field_sampling_manual/field_man_03.html
[9] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf

2.3 Geology

2.3.1 Regional Geology

Applications for an EMA permit should:

- describe the regional geological setting;
- provide an overview of the geology of the area, with emphasis on the regional framework. This will include a description of the tectonic belt(s), terrain(s), physiography, and regional metamorphism and structure; and
- describe geologic units or lithology in key areas of the project property such as tailings dam(s) and mill site. Include the distance to bedrock, overburden type, etc.

2.3.2 Deposit (Ore) Geology

Applications for an EMA permit should:

- summarize the mine site geology, including descriptions of major rock units, stratigraphy, structure, metamorphism, geochemistry, paleontology and details about the ore deposit;
- 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); and
- summarize geochemistry (See Section 2.3.3: Metal Leaching/Acid Rock Drainage).

2.3.3 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:

- *Policy for Metal Leaching and Acid Rock Drainage at British Columbia Mine Sites*[10] (1998);
- *Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia*[11] (1998); and
- *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*[12], 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

[10] www.empr.gov.bc.ca/Mining/Permitting-Reclamation/ML-ARD/Pages/Policy.aspx
[11] www.empr.gov.bc.ca/Mining/Permitting-Reclamation/ML-ARD/Pages/Guidelines.aspx
[12] www.abandoned-mines.org/pdfs/MENDPredictionManual-Jan05.pdf

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

Applications for an EMA permit should:
- describe pre-mine topography and surface drainage features;
- provide maps at a suitable scale to:
    - depict drainage divides, areas of groundwater discharge, wetlands and notable topographic features;
    - show the range of pre-mine slope configurations and typical slope cross-sections (include accompanying descriptions); and
    - cover the region show the entire drainage basin(s) in which the mine will be located; and
- provide information regarding any natural hazards relevant to the mine, such as snow avalanches, landslides and earthquakes.

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 *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators*[13]. The application 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, 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;
- 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;

[13] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf

- develop a conceptual hydrologic or water balance model for the site illustrating worst case scenarios for low and high flows which might affect mine operation or effluent discharge or mine impact on the environment and flows; and
- identify spatial or temporal gaps in the database.

2.5.2 Groundwater - Hydrogeology

Summarize results of the groundwater study of the mine property. A minimum of one year of quarterly data is recommended. Detailed guidance is provided in *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators*[14]. The TAR 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;
- provide plan-view maps showing well locations and inferred directions of groundwater flow, and x-sectional maps showing groundwater elevations;
- 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 *Guidelines for Groundwater Modelling to Assess Impacts of Proposed Natural Resource Development Activities*[15] if a numerical groundwater model is developed;
- describe the geological units in which groundwater occurs and the units' characteristics. (e.g., Does groundwater occur in fractured bedrock? If so, what evidence exists that groundwater can be assessed using a porous medium approach versus a discrete fractured approach in the conceptual or numerical model. What is the implication of a fractured porous medium on anisotropy in characteristics of the geological units?);
- identify and estimate relevant fluxes between surface water, and identify surface water and groundwater dependent features; and
- identify spatial or temporal gaps in the database.

2.6 Water Quality

EMA applications require a detailed summary of water quality. The water-quality baseline study characterizes conditions before project development. For groundwater, a minimum of four quarterly samples over one year is recommended before permit application. For surface water a minimum of monthly sampling for a period of one year is necessary, and more is preferred to assess trends and seasonal variation. To determine water quality guideline or objective attainment, 5 samples in 30 days during critical flows (high and/or low) or biologically relevant periods, are necessary. To assess interannual variation, or to prepare water quality objectives (WQOs) or science-based environmental benchmarks (SBEBs)[16], multiple years of water quality data is required. More detailed guidance is provided in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and*

[14] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[15] http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/groundwater_modelling_guidelines_final-2012.pdf
[16] See Appendix A

Operators[17] and in *Guidance for the Derivation and Application of Water Quality Objectives in British Columbia*[18].

2.6.1 Groundwater Quality

Applications for an EMA permit must:

- 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, statistical considerations and QA/QC protocols. Report turbidity with groundwater chemistry data;
- 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 former development (e.g. exploration activities, historical mining activities);
- provide a detailed map of groundwater quality sampling locations and proposed or existing discharge points, areas with seepage potential and areas of disturbance;
- describe groundwater chemistry and summarize data in tables organized by parameter, site and date. Include detection limits and any QA/QC concerns related to the data. Tabulate chemical data and flag values greater than provincial water quality guidelines (WQGs)[19]. Samples with turbidity values greater than 200 NTU should be removed from the data set prior to analysis;
- illustrate spatial and temporal variation in key parameters and among sites using graphs that illustrate data variability;
- identify critical parameters, locations and time windows or seasonality when baseline groundwater quality may exceed water quality guidelines; and
- identify spatial or temporal gaps in the database.

2.6.2 Surface Water Quality

Applications for an EMA permit should:

- identify downstream water uses (e.g., aquatic life, drinking, irrigation, livestock watering, industrial, etc.) and water licenses;
- 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, sampling frequency and period, site locations, statistical considerations and QA/QC protocols;
- 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 former development (e.g. exploration activities, historical mining activities);

[17] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[18] www.env.gov.bc.ca/wat/wq/pdf/wqo_2013.pdf
[19] www.env.gov.bc.ca/wat/wq/

- provide 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 in key parameters among sites using graphs that show variability in data (e.g., box plots);
- compare existing water quality conditions to provincial water quality guidelines[20] and/or existing water quality objectives:
    - tabulate and flag water quality values that exceed WQGs or WQOs
    - clearly document the frequency and magnitude of exceedances
- identify critical parameters, locations and time windows or seasonality when baseline surface water quality may exceed water quality guidelines;
- 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 ENV staff.); and
- identify spatial or temporal gaps in the database.

2.7 Sediment Quality

EMA applications will require 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 for Mine Proponents and Operators*[21]. Consider, and discuss with the ENV contact, the need to conduct simultaneously 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.

Applications for an EMA permit should:

- document and describe the rationale for baseline study design including parameters analyzed, (for a recommended list refer to the Water and Baseline Monitoring document), field instrumentation, sampling frequency and period, site locations, statistical considerations, 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);
- 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 former development (e.g. exploration activities, historical mining activities);
- provide 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;

[20] www.env.gov.bc.ca/wat/wq/
[21] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf

- compare, tabulate and map existing sediment quality conditions relative to provincial sediment quality guidelines[22], or Canadian Council of Environment Ministers interim sediment quality guidelines[23] (threshold or probable effect levels); and
- identify spatial or temporal gaps in the database.

2.8 Aquatic Resources

Aquatic life baseline studies determine ecosystem health and contribute to a weight of evidence approach for assessing impact during mine development, operation and closure. Components of study may include, but are not limited to, plankton, periphyton, benthic macroinvertebrates, shellfish, fish and fish habitat, macrophytes and biological tissues. The aquatic organisms identified for study will depend on the complexity and types of aquatic and marine habitats and the nature of the mine operation. Appropriate biological monitoring tools must be identified, and sufficient data must be collected and presented to demonstrate that the program will be able to detect a predetermined change 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 interannual variability and provide a suitable characterization of biological communities prior to development. Detailed guidance is provided in *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators*[24]. Applications for an EMA discharge permit to streams should contain the following information 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, ENV recommends using the Reference Condition Approach sampling design using Canadian Aquatic Biomonitoring Network (CABIN)[25] protocols, outlined in the CABIN field manual[26]. 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.

The Technical Assessment Report 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;

[22] www.env.gov.bc.ca/wat/wq/
[23] ceqg-rcqe.ccme.ca/
[24] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[25] www.ec.gc.ca/rcba-cabin/
[26] http://www.for.gov.bc.ca/hts/risc/pubs/aquatic/cabin/CABIN_field_manual.pdf

- identify which data reflect un-impacted baseline versus conditions affected by former development (e.g. exploration activities, historical mining activities); and
- identify spatial or temporal gaps in the database.

2.8.2 Fish and Fish Habitat

Resident fish populations and habitat are under the 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, the TAR 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;
- provide maps of sampling and stream reach survey locations;
- 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 former development (e.g. exploration activities, historical mining activities); and
- identify spatial 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. Within the TAR:

- 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 former 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 B.C. Water Quality Guidelines[27] or Canadian Tissue Residue Guidelines[28];
- illustrate graphically the spatial and temporal variance in key parameters among sites; and
- identify spatial or temporal gaps in the database.

3 Discharges and Treatment

Detailed waste treatment and discharge information must be included in the application for permits under EMA. This information should establish the location and quality and quantity of each of the

[27] www.env.gov.bc.ca/wat/wq
[28] www.ccme.ca/publications/ceqg_rcqe.html

proposed contact and process water storage facilities and each waste discharge anticipated over the life of the mine. It must also describe the design and intended use of any proposed pollution control works. ENV expects applicants 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 cost, design capacity, effectiveness, reliability and weaknesses (dealing with issues such as fires, power outages, floods, etc.), waste products, maintenance and personnel training. Information specified in these TOR largely fulfills requirements of Sections 4 and 5 of the Technical Assessment Report (TAR) described in *Guidance on Applications for Permits Under the Environmental Management Act – Technical Assessment*[29]. Nonetheless, the proponent should review TAR Sections 4 and 5 to ensure all relevant information is included in the application.

3.1 Summary

Provide an overview description 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 storm water control structures;
- waste rock, low grade ore and soil and overburden stockpiles;
- ancillary components stormwater management – plant site, explosives site camp, etc.; and
- an overview of the project and construction schedule.

Summarize information by media and location using tables. Illustrate location and zones of concern using maps or other graphics. 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.

3.2 Specific Information Requirements for Storage and Effluent Discharges

- 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*[30].
- 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 metal leaching and acid rock drainage potential, bench scale tests, pilot plant results, manufacturer's design specifications and performance guarantees, etc.).

[29] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=7AD12B8CF1B94CF29619BD9871FB5740&filename=assessment.pdf
[30] http://www2.gov.bc.ca/assets/gov/topic/C0188F632AEC266B044F8A2B756F055F/industrial_waste/settling_ponds.pdf

- Describe the timing (i.e., 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 best achievable technology have been applied.
- Include detailed designs of all proposed discharge works (e.g., outfalls, spillways, channels).
- Compare proposed discharge quality to known discharge criteria, guidelines or industry practices. This should include an evaluation of end of pipe water quality based effluent limits based on meeting 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. Rationale for the proposed IDZ should be included in the application, 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. ENV's Best Achievable Technology (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. Initial dilution zones are normally relatively small (e.g., for municipal effluents they are typically up to 100 m from the point of effluent discharge, but not exceeding 25 to 50% of the width of the waterbody). Generic guidance in setting an IDZ is provided by the Canadian Council of Environment Ministers[31] as follows:
  - The dimensions of an IDZ 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: ENV policy allows some chronic toxicity within an IDZ.
  - Conditions within an IDZ should not result in bioconcentration 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.

3.3 Information Requirements for Wastewater Treatment Plants

- Describe treatment methods, treatment capacity, retention times, materials and reagents used, reagent sourcing and transport, etc.

[31] ceqg-rcqe.ccme.ca/download/en/221

- 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 (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 and 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.
- Provide detailed engineering designs for any proposed treatment plants including electrical drawings and mechanical information, and document expected treatment effectiveness (based on pilot testing, industry examples, etc.) under variable conditions including flow, temperature, and hydraulic retention times, etc.
- Assess performance risks for collection and treatment of wastewater (i.e., extreme weather [icing, snow loading, flows, etc.], power outages, wearing of parts, scaling, reagent supply interruption, plugging, by-passing/short circuiting, etc.).
- Provide time schedule for construction and commissioning, capital and anticipated operating and maintenance costs.
- Describe operating requirements such as power, pumping, number of people to operate, volumes of materials and reagents, etc.
- Assess potential public health and safety risks and management plans.
- Describe maintenance and replacement plans for collection and treatment systems.

3.4 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.
- Provide water use determination as per Technical Guidance 6[32], *Contaminated Sites Regulation*[33].
- 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 monitoring proposal to aid in characterizing potential groundwater 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*[34].

3.5 Requirements for Sewage Disposal

Although this TOR primarily addresses 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 is desirable. For more information on registering under the MRW, see the regulations on the Ministry of Environment website[35].

[32] http://www.env.gov.bc.ca/epd/remediation/guidance/technical/pdf/tg06.pdf
[33] http://www.env.gov.bc.ca/epd/remediation/leg_regs/csr.htm
[34] http://www.env.gov.bc.ca/epd/remediation/leg_regs/csr.htm
[35] http://www2.gov.bc.ca/gov/topic.page?id=60755778FAE2413EABB0859BD9C9BAD6

- Alternatively, the sewage discharges may be included with the overall effluent permit for the site. Additional direction on inclusion in the application package should be sought from the Ministry of Environment, Environmental Protection Division staff.

4 Environmental Effects Prediction for EMA

The applicant 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 for EMA 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*[36] (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 B.C. Water Quality Guidelines[37] or existing water quality objectives to estimate the potential severity of impact. In some cases, it may be necessary to develop water quality objectives (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 to aquatic resources compared to baseline and evaluate risk reduction options. See Appendix B for further information;

[36] www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf
[37] http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html

- 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
- develop a safe discharge plan.

4.1 Summary

Provide an overview description of 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 this application. Summarize potential impacts by media and location using tables, and illustrate graphically the pathways from contaminant sources to receptors. Summarize risk 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 the Ministry of Environment's EMS (Environmental Monitoring System) database.

4.2 Groundwater Quantity and Quality

- Describe study boundaries and assessment endpoints (e.g., drinking water quality; stream recharge, etc.).
- Develop and display a conceptual model or framework to describe the contaminant transport through groundwater from source to receptors and establish a risk assessment process.
- For significant groundwater extraction, or waste discharge and seepage losses to ground, use modelling to estimate how groundwater quantity and quality may be affected within, and downstream of, the property.
- Explicitly consider the potential for changes to the groundwater flow regime around major mine infrastructure such as pits 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 and past experience to estimate the risk to groundwater use downstream of the property, in-stream flows, or dilution of effluent or seepage.
- 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.
- Identify data gaps, and uncertainty in models, and how they would be addressed in the monitoring efforts.

4.3 Surface Water Quantity and Quality

4.3.1 Water Quantity

- Assess how the mine operation will affect stream flow as a result of withdrawal, diversion, and discharge of effluents.
- 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.

- 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 could potentially affect permit conditions (dilution, water management scenarios, etc.).
- Consider climate, land use, and water allocation and withdrawal.

4.3.2 Water and Sediment Quality

- Describe study area boundaries and assessment endpoints (e.g., aquatic life, drinking water quality, etc.).
- Identify key discharges, seepages, or disturbance regimes and associated contaminants.
- Develop a conceptual model or framework to describe the transport of key contaminants from source 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.
- 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*[38].
- 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 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.
- Identify data gaps, and uncertainties in conceptual models, and describe how they would be addressed in adaptive management and environmental monitoring programs.

4.4 Aquatic Resources and other Receptors

- 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.

[38] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf

- Describe and discuss the potential for bioaccumulation or bioconcentration of contaminants, and the associated risk to assessment endpoints (i.e., 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.
- 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.
- Assess potential human health risks.

4.5 Safe Discharge Plans

- Propose safe discharge plans for all discharges to surface water or groundwater. A safe discharge plan should propose discharge limits (volume 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 water quality guidelines, water quality objectives or science-based environmental benchmarks as values in the mass balance model. See additional information in Section 3.3.2 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. *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 (for example, contingency storage for water requiring treatment). Contingency plans for chemical and fuel storage areas should also be included.

5 Discharge and Environmental Monitoring Requirements For EMA Permits

Applications for EMA permits must include proposed monitoring and reporting programs which enable on- going evaluation of waste management performance, 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, and exposure sites such as edge of IDZ, 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 proponent should strive to integrate the requirements of the Federal Environmental Effects Monitoring (EEM) program under the *Metal Mine Regulation*[39] within the EMA permit application monitoring program design. However, proponents should be aware that the Federal EEM program is generic and is not normally sufficient to address provincial regulatory requirements. The proponent should discuss provincial monitoring program requirements with regional staff early in the mine planning stage. At a minimum, EMA permits will require comprehensive monitoring programs for

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

the discharge, the immediate receiving environment, 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 (coordinates and mapped);
- 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 Before-After-Control-Impact (BACI) study design is proposed.

Basic requirements of necessary monitoring programs are described briefly here:

5.1 Discharge Monitoring

Monitoring programs specific to effluent, seepage and solid waste are required using 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 *Environmental Management Act* effluent discharge permit.

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.

5.2 Receiving Environment Monitoring

Within the applications, propose routine receiving environment monitoring programs using 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 are often surface waters, sediments or groundwater (latter, if permitted activity may affect groundwater quality/quantity); other media being incorporated into the Aquatic Effects Monitoring Program (AEMP). In some cases, Receiving Environment Monitoring will be incorporated into the AEMP. Where groundwater-surface water interactions are important, groundwater testing should augment surface water monitoring efforts. For surface waters, the sampling should be concurrent with Discharge Monitoring and should address water quality guideline or water quality objective requirements. This monitoring program is expected to remain relatively unchanged from year to year. These values will form the basis for terms or conditions incorporated into the *Environmental Management Act* effluent discharge permit.

This section should also include an assessment of the potential environmental effects and risks, and mitigation/management plans during emergencies and unexpected shutdown events for the pollution control systems.

5.3 Aquatic Effects Monitoring

The AEMP is the program used to evaluate the effectiveness of the EMA permit. As such, the proponent must develop and implement an Aquatic Effects Monitoring Program (AEMP) 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 AEMP 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 AEMP should be planned in consultation with ENV 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 AEMP studies often occurs on a multiyear cyclical basis.

5.4 Quality Assurance Requirements

Quality assurance protocols must be followed and described in the proposed monitoring programs. At a minimum:

- The monitoring programs must be developed by qualified professions and describe in detail the sampling methods, sample preparation and hold times, analytical methods, quality assurance/quality control procedures, and data analysis methods.
- Monitoring programs should be based on guidance in *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators*[40]. As well, programs should conform to methods and QA/QC procedures specified in the *British Columbia Field Sampling Manual: 2003 (or a later edition)* and the *Environmental Data Quality Assurance Regulation*[41].
- 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[42].

[40] http://www2.gov.bc.ca/gov/DownloadAsset?assetId=E49A49E800814C8FB2D6868B7F119AD6&filename=water_air_baseline_monitoring.pdf
[41] www.env.gov.bc.ca/epd/wamr/labsys/lab_meth_manual.html
[42] http://www.env.gov.bc.ca/epd/wamr/labsys/lab_meth_manual.html

Appendix A: Description of Water Quality Thresholds.

1.0 Water Quality Guidelines

B.C. Water Quality Guidelines[43] (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 province wide. There are a large number of substances that have not been fully assessed and formally endorsed by ENV. The Province has adopted working water quality guidelines[44] for some of these substances to indicate safe levels in the environment.

2.0 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 water quality guidelines 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 these circumstances, it may be appropriate to modify generic WQGs by developing alternative thresholds to account for site-specific conditions. These measures include water quality objectives and science-based environmental benchmarks.

2.1 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 (drinking water, aquatic life, wildlife, agriculture, recreation, industrial supplies). They 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. Water quality objectives 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. See *Guidance for the Derivation and Application of Water Quality Objectives in British Columbia*[45].

Where water quality objectives exist for a watershed, they are to be used in the place of water quality guidelines in an effects assessment.

In instances where proponents believe that development of WQOs is technically justified, they must meet with ENV staff to discuss their appropriateness and to determine next steps. If any work is to be conducted by project proponents (e.g., toxicity tests may be required to support the development of WQOs), the workplan should be reviewed by ENV staff.

[43] www2.gov.bc.ca/gov/topic.page?id=044DD64C7E24415D83D07430964113C9
[44] www.env.gov.bc.ca/wat/wq/BCguidelines/working.html#table1
[45] www.env.gov.bc.ca/wat/wq/pdf/wqo_2013.pdf BC ENV 2013

2.2 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 rigorous 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. They may be attributes of water, sediment and/or biota that are applied at specific locations to protect valued resources in the receiving environment. SBEBs can be:

- derived using the methods recommended for the development of WQOs (e.g., recalculation 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.

Examples of new science tools not covered in the current procedures for developing WQO include:

- measures of ecosystem health such as abundance and diversity of fish, invertebrates, and algae (e.g., Reference Condition Approach);
- molecular techniques (e.g., toxicogenomics);
- food web modelling for bioaccumulative substances; and
- alternative endpoints (e.g., chemosensory, biotic ligand models).

Such approaches may in the future contribute to the development of approved WQOs but in the meantime can contribute to the development of SBEBs.

A primary difference between SBEBs and WQOs is that SBEBs are not subject to the same formal reporting and approval process as WQOs. In many cases proponents conduct much of the assessment work required to develop SBEBs; however, the ENV Environmental Impact Assessment (EIA) biologist is responsible for setting SBEBs and should provide oversight and direction as necessary. The science and rationale must be documented in a comprehensive impact assessment that is peer-reviewed and signed off by the EIA Biologist as a qualified professional. The final approval process for SBEBs is within Regional Operations Branch (ROB) of the Environmental Protection Division.

Another attribute of SBEBs, which differentiates them from WQO, is that SBEBs do not need to be developed for an entire watershed and can be applied at specific sites. However, the ENV EIA Biologist must consider the geographic context for cumulative effects. SBEBs should not be used in watersheds that are, or may be, subject to a range of land use activities and development pressures; a more appropriate approach in these circumstances would be to set WQOs.

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 because of the degree of rigour associated with their development and the explicit consideration of uncertainties. Establishment of a SBEB should not result in a situation that

causes pollution or increases pollution (if it is an already degraded site). Furthermore, a SBEB should not be considered if a threshold value is equivalent to or in excess of the levels set in Protocol 11 for Contaminated Sites which defines a high risk contaminated site[46]; or if there are *Species at Risk Act*-listed or B.C.-listed red or blue species within the zone of impact and the SBEB is not based on levels naturally exceeding the WQG.

In instances where legacy impacts have led to the degradation of water quality and the goal is to improve conditions, ENV EIA biologists may set a combination of short-term and long-term WQOs (if sufficient data exists) or SBEBs. SBEBs of this nature should be supported by an approved (by ENV) environmental management plan or area based plan, which lays out timelines and commitments for continuous improvement. A corresponding security bond might also be appropriate.

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 chosen, the ENV EIA biologist must be confident that the approach is technically and scientifically defensible, and considers the full range of conditions (e.g., contaminant mixtures) expected at the site in question.

[46] Protocol 11 for Contaminated Sites – Upper Cap Concentrations for Substances Listed in the Contaminated Sites Regulation. June 2010.

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 from Guideline for the Selection of Valued Components and Assessment of Potential Effects[47].

- **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 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 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[48]
- Qualitative Human Health Assessment – Phase 1 Review of Methods and Framework Recommendations[49]
- Concentration Limits for the Protection of Aquatic Receiving Environments. BC Ministry of Environment Technical Guidance on Contaminated Sites[50]
- Risk Assessment Guidance for Superfund (RAGS) Part A[51]

[47] www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf (B.C. Environmental Assessment Office 2013)
[48] www.env.gov.bc.ca/epd/remediation/policy_procedure_protocol/protocols/tier1/chapter8.htm#83
[49] www.env.gov.bc.ca/epd/epdpa/contam_sites/guidance/external/humanhealthreport.html
[50] http://www.env.gov.bc.ca/epd/remediation/guidance/external/index.htm
[51] www.epa.gov/oswer/riskassessment/ragsa/index.htm