Appendix 58

Meadowbank Complex Aquatic Effects Management Program (AEMP) Version 5

Aquatic Effects Management Program (AEMP)

Meadowbank Complex

Version 5

Prepared for:

Agnico Eagle Mines Limited
Meadowbank Complex
Baker Lake, Nunavut X0C 0A0

Final

April 11, 2022

AZIMUTH

Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, B.C., V6K 2G8

DOCUMENT CONTROL

Version	Date (Y-M)	Section	Page	Revision
0	2005-10	All	All	Cumberland Resources- Meadowbank Gold Project Aquatic Effects Management Program (AEMP)
1	2010-05	All	All	Aquatic Effects Management Program (AEMP) Meadowbank Gold Project
2	2012-12	All	All	Aquatic Effects Management Program (AEMP) Meadowbank Mine
3	2015-11	4	51, 52, 53	Updated Tables 4-1, 4-2, 4-3 and language in text related to those tables to match current CREMP
4	2020-03	2	20	Added Pore Water Quality Monitoring Program and integrated the Whale Tail Project Note – the next revision will fulling integrate the Whale Tail Project into the AEMP
5	2022-04	All	All	Major revision to reflect changes in various monitoring programs. Program descriptions in Section 2 were updated and out-of-date summaries for monitoring programs completed during the initial construction phase at Meadowbank were removed. Section 2 provides a brief introduction to the various monitoring programs that are connected to the AEMP for the Meadowbank Complex.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACROYNMS

AEMP	Aquatic Effects Management Program
AMS	Adaptive Management Strategy
AN	Ammonium nitrate
AWAR	All-weather access road (Baker Lake to Meadowbank)
BACI	Before-after-control-impact statistical comparison
CCME	Canadian Council of Ministers of the Environment
CI	Control-impact statistical comparison
CIRNAC	Crown Indigenous Relations and Northern Affairs Canada (formerly INAC)
CPUE	Catch-per-unit-effort
CREMP	Core Receiving Environment Monitoring Program
CSM	Conceptual site model
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EAS	Effects Assessment Studies
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
FF	Far-field area
HADD	Harmful alteration, disruption or destruction
HCF	Habitat compensation feature
HCMP	Habitat Compensation Monitoring Program
ISQG	Interim sediment quality guideline (from CCME)
MDMER	Metal and Diamond Mining Effluent Regulations
MF	Mid-field area
MMP	Mercury Monitoring Program
MRP	Management response plan
NIRB	Nunavut Impact Review Board
NF	Near-field area
NWB	Nunavut Water Board

QA/QC	Quality assurance and quality control
ROC	Receptor of concern
SAP	Sampling and analysis plans
SOPC	Stressors of potential concern
SPL	Second Portage Lake
TDS	Total dissolved solids
TPL	Third Portage Lake
TSS	Total suspended solids
VEC	Valued ecosystem component
WL	Water Licence
WOE	Weight-of-evidence
WTHR	Whale Tail Haul Road (Meadowbank to Amaruq)

1 INTRODUCTION

The Aquatic Effects Management Program (AEMP) for Agnico-Eagle Mines' (Agnico Eagle) Meadowbank Gold Mine was included as part of the Environmental Assessment (EA) for the project in 2005 (Azimuth, 2005a), and has been formally implemented since 2006. The initial Type A Water Licence (2AM-MEA0815) issued in 2008 for the project by the Nunavut Water Board (NWB) required a revised AEMP, and specified some of the requirements for that revision. Most importantly, while the 2005 AEMP was focused on core receiving environment studies at the level of basins and lakes, the revised AEMP needed to be broader in scope to comply with the following licence requirements (stipulated in Part I-1):

- *Comprehensive receiving environment monitoring to identify changes to the aquatic receiving environment associated with mine activities[1];*
- *Linkage between monitoring results and adaptive management response [2];*
- *Monitoring of lake productivity [3];*
- *Sampling and analysis plans [4]; and*
- *Monitoring under Fisheries Authorizations, NWB Licence Compliance Monitoring, Metal and Diamond Mining Effluent Regulations (MDMER) Environmental Effects Monitoring (EEM), and Groundwater Monitoring*

The last requirement diverges from traditional AEMPs (INAC, 2009a,b) and required Agnico Eagle to propose a new approach, which was presented in draft to the NWB (March 2-3, 2010 in Yellowknife) and necessitated the restructuring of the AEMP. As a result, the AEMP was restructured to serve as an overarching 'umbrella' that conceptually provides an opportunity to integrate results of individual, but related, monitoring programs in accordance with the Type A water license requirements. The scope of the 2005 AEMP, which was essentially the core receiving environment monitoring, is now one of the monitoring programs that is integrated under the restructured AEMP and has been renamed the Core Receiving Environment Monitoring Program (CREMP) to minimize confusion.

The restructured AEMP is organized into the follow five sections:

---

[1] This component is included in quarterly environmental effects monitoring (EEM) receiving environment monitoring under the Metal and Diamond Mines Effluent Regulation (MDMER).

[2] This applies to most monitoring programs. Some programs, such as the Effects Assessment Studies (EAS) are conducted only when needed.

[3] This is conducted as part of the Core Receiving Environment Monitoring Program (CREMP).

[4] This is part of the CREMP and other programs.

- **Section 2** reviews each of the underlying monitoring programs, including the CREMP, the cornerstone aquatic monitoring program.
- **Section 3** reviews the inter-linkages among the component programs.
- **Section 4** develops the Management Response Plan for the AEMP that is to be implemented following the integration of results for each component program.
- **Section 5** outlines the expected structure and content for the annual AEMP report.

For the Meadowbank Project, the first water licence was issued in 2008 (2AM-MEA0815), covering the construction, operation, maintenance, reclamation, closure and monitoring of an open pit gold mine and milling facility at the Meadowbank mine site. The original licence was subsequently renewed by the Board in August 2015 and was amended in July 2018 to reflect changes to the Project associated with additional tailings deposition and ore processing at the Meadowbank mine site from the Whale Tail Pit Project. On March 2019, the Water License was amended for the third time to allow for tailings disposal in the mined-out Goose and Portage pits. On May 2020, the fourth amendment was granted to allow the activities for the Whale Tail Expansion Project, i.e., the term of the Water License was extended by 4 years, now expiring in March 2030. The Project is governed by current Water Licence No: 2AM-MEA1530.

In 2018, Agnico Eagle proposed to increase gold production from the original Whale Tail Pit Project by expanding mining activities at the Whale Tail Pit site as proposed in the Expansion Proposal. The Expansion Proposal proposes further developing the Whale Tail Pit open mine in addition to the development of the IVR open pit and Underground pit. The NWB Water License amendment process was completed on May 12th, 2020 and the Water License Amendment No. 2AM-WTP1830 was issued.

2 AEMP-RELATED MONITORING PROGRAMS

This section summarizes the major monitoring programs related to the AEMP. Key regulatory agencies and regulatory drivers for each program are listed in **Table 2-1**. For further details of each of the monitoring programs summarized below, consult the respective management plans which are updated regularly and appended to the Agnico Eagle Meadowbank Complex Annual Reports.

2.1 Core Receiving Environment Monitoring Program

The 2005 AEMP (Azimuth, 2005a) was developed to address issues identified during the environmental assessment (EA) process that could potentially impact the aquatic receiving environments surrounding the development. Building from earlier baseline monitoring (Azimuth, 2005b), the 2005 AEMP described the strategy designed to detect impacts to the aquatic environment, which included two types of monitoring:

- Core Monitoring – now known as the Core Receiving Environment Monitoring Program (CREMP), this is the central component of routine receiving environment monitoring and is considered as "the foundation against which potential mine-related changes in chemical, physical or biological characteristics…can be detected and acted upon, if necessary." It is intended to monitor large-scale basin-wide changes in physical and biological variables to evaluate potential impacts from all mine related stressors to the receiving environment. It was developed to assess these potential effects over a broad spatial area, including near-field, mid-field, far-field, and reference areas, over the life of the mine from baseline, through construction and operations, to closure and post-closure. An overview of the program is provided below.
- Targeted Monitoring – these studies were envisioned as having more focused temporal or spatial bounds than the core monitoring and/or to address specific questions related to particular components of mine development. Note that this is not a specific monitoring program, but rather a number of focuses studies that are complementary to the CREMP. They may be reported separately or included within the annual CREMP reports. Examples of such studies are provided below.

Core Monitoring

The CREMP monitors water quality, sediment quality as well as phytoplankton and benthic invertebrate communities at the Meadowbank, Whale Tail, and Baker Lake study areas. The CREMP is designed to be complementary to the requirements of the *Metals and Diamond Mine Effluent Regulations*; in addition to effluent-related monitoring, fish and fish habitat are included within the Environmental Effects

Monitoring component of the regulations (see **Section 2.7** for more information). A key aspect of the CREMP strategy is the inclusion of an early warning framework developed to identify changes *before* the reach levels that cause or have the potential to cause adverse effects to aquatic life. To this end, the CREMP includes two types of decision criteria (Azimuth, 2012a; see **Section 4.2.4** for more details):

- *Thresholds* – these are license limits, regulatory guidelines (e.g., CCME water quality guidelines for the protection of aquatic life) or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which unacceptable adverse effects may occur. If thresholds do not exist or are not used for a particular variable, then early warning triggers will be developed without thresholds (see next bullet).
- *Triggers* – these are site-specific early warning criteria that lead to action. In cases where thresholds are established, the triggers are set at values that are more conservative than the thresholds. Triggers ensure that action is taken before a threshold has been reached. For variables where no thresholds exist, the triggers are set using statistical methods based on existing data.

Potential mine-related changes in these components are assessed by comparing current results to baseline data and conditions at reference locations. CREMP data are explicitly assessed: (1) within a context of the decision criteria define above (i.e., to identify changes of potential environmental relevance) and (2) relative to baseline/reference conditions (i.e., to determine if changes are mine-related or due to natural variability). Thus, the initial step is to identify monitoring parameters where the mean annual concentrations (chemical parameters) or response metrics (biological parameters) exceed their respective trigger. The second step relies on the application of a Before-After-Control-Impact (BACI) statistical model to test whether the changes observed at a particular exposure area are significant relative to baseline/reference conditions.

The program was designed to take an integrated, ecosystem-based approach that links mitigation to monitoring of physical/chemical effects on key ecological receptors in the receiving environment. Monitoring results are intended to inform the *adaptive managemen*t process (see **Section 4** for more details), supporting the early identification of potential problems and development of mitigation options to address them. Note that a specific adaptive management strategy was developed to guide water management decisions related to phosphorus and arsenic in Mammoth Lake and Whale Tail Lake – South Basin; this is also discussed in more detail in **Section 4**.

Targeted Monitoring

"Targeted Monitoring" is a catch-all for any study conducted to improve the overall understanding of mine-related changes in the receiving environment as a complement to the CREMP. Examples of studies conducted to date include:

- Receiving Environment Effects Assessment Studies – *effects assessment studies* (EAS) were first initiated in 2008 to address concerns related to the potential impacts of elevated total suspended solids (TSS) from dike construction on the local receiving environment. Multi-year EAS studies were conducted to specifically target the East Dike and the Bay-Goose Dike (Azimuth, 2012b). More recently, a multi-year EAS study was conducted to address sediment chromium bioavailability concerns in Third Portage Lake after chromium increased in the east basin following dike construction; these results were integrated directly into the CREMP.
- Activity-Specific Monitoring – main examples include dike construction and dewatering monitoring. Due to the nature of the activities these studies are targeting, they are designed to collect, interpret and act on data are finer temporal and spatial scales relative to the CREMP. To that end, they generally include their own decision framework to support environmental management of these activities.

2.2 Mercury Monitoring Plan

This program addresses concerns regarding the potential for the impoundment of the Whale Tail Lake (South Basin) to result in elevated methylmercury concentrations in the receiving environment, particularly in large, long-lived, predatory fish species like Lake Trout. The Mercury Monitoring Plan (MMP) addresses these concerns within and downstream of Whale Tail Lake.

Construction of the Whale Tail Dike in 2018-2019 split the north and south basins of Whale Tail Lake. The north basin was dewatered to create access for the Whale Tail Pit. The south basin was isolated in the upper portion of the watershed, requiring the creation of a new, higher elevation outlet channel to Mammoth Lake, which was completed in 2020. The altered surface water flow patterns resulted in higher water levels (+3.5 m) that ultimately flooded approximately 150 ha of terrestrial habitat and caused the full joining of the south basin to Lakes A20, A63 and A65.

From a mercury perspective, it is the flooding of the terrestrial habitat that are of concern. Rapid decomposition of terrestrial organic matter by bacteria following flooding can result to a substantial increase in the methylation of inorganic mercury present in the soil. As methylmercury is more bioavailable than inorganic mercury, increased methylation leads to higher concentrations in water, sediment pore water and throughout the food chain, with the highest concentrations by far in predatory fish such as Lake Trout. This ‘reservoir effect’ is temporary, however, and methylation rates are reduced after the accessible terrestrial organic carbon stores in the soil have been depleted, resulting in the gradual reduction of mercury concentrations throughout the ecosystem.

The MMP monitors this potential methylmercury influx to surface water, sediment, and fish tissue in Whale Tail Lake (South Basin), associated downstream lakes (Mammoth Lake and Lake DS1) and at key reference locations. Water and sediment sampling conducted under the CREMP is also utilized in the

MMP with additional ultra-trace methylmercury sampling occurring annually. Small-bodied fish (Threespine Stickleback and Slimy Sculpin) have been sampled annually as part of an associated research project being led by Dr. Heidi Swanson of the University of Waterloo. Lake Trout are sampled on a three-year cycle during EEM sampling to streamline monitoring and to minimize the effects of sampling on the local population.

Data evaluation for the MMP focuses on comparing current mercury concentrations to baseline conditions, to reference location concentrations, and to modeled predictions of expected mercury concentrations in surface water and Lake Trout tissue. Monitoring results feed into the adaptive management response plan as outlined in **Section 4**.

2.3 Fisheries Authorizations

2.3.1 Fish-Out Programs

Agnico Eagle is required to implement and report on fish-out programs at impounded lake basins prior to dewatering under the NIRB Project Certificate No. 004 Condition 49 and Fisheries and Oceans Canada (DFO) Authorizations 16HCAA-00370 and 20HCAA-00275. Key objectives of fish-out programs are to engage the local community, recover a large proportion of the fish occurring in the impounded lake basins, and to gather ecological information to contribute to the scientific understanding of Arctic lakes. Fish-out plans are reviewed and approved by DFO and the work is completed as per DFO guidelines.

At the Meadowbank Site, fish-out programs occurred following the impoundment of Second Portage, Third Portage, Vault, and Phaser Lakes from 2008 to 2016. More recently, fish-out programs have been focused at the Whale Tail Site, the largest of these being the removal of fish from the north basin of Whale Tail Lake which occurred in August/September 2018. In 2020, fish-out programs were conducted at ten waterbodies to prepare for the expansion of the IVR Pit and the Whale Tail Waste Rock Storage Facility (WRSF).

2.3.2 Habitat Compensation/Offsetting Monitoring

Under Fisheries and Oceans Canada (DFO) Fisheries Act Authorization NU-03-190 (AWAR), NU-03-0191.3 / NU-03-191.4 (Meadowbank Study Area), NU-14-1046 (Phaser Lake), and 16-HCAA-00370 and 20-HCAA-00275 (Whale Tail), Agnico Eagle is required to present a habitat compensation (offsetting) strategy and No-Net-Loss Plan for the mine site to comply with DFO's habitat policy. Habitat compensation features (HCFs) have been designed and approved by DFO to serve as productive fish habitat for the purpose of compensating for harmful alteration, disruption or destruction (HADD) related habitat loss.

2.4 Groundwater Monitoring

Agnico Eagle is responsible for completing annual groundwater monitoring as a condition of the Nunavut Impact Review Board (NIRB) Project Certificate No. 004 Condition 8, for Meadowbank; and No. 008 Condition 15, for Whale Tail. Groundwater monitoring also falls under the NWB Water Licence regulations. Under this regulatory framework, groundwater must be monitored to characterize hydrology (hydraulic gradient and conductivity) along with the following water quality parameters: hardness, pH, conductivity, alkalinity, anions, TDS, TSS, turbidity, ammonia, Total and Dissolved Organic Carbon (TOC and DOC), nutrients, and a suite of metals (total and dissolved).

Monitoring at Meadowbank focuses on characterizing hydrology and groundwater quality for effects related to historic deposition of tailings in the tailings storage facility and current in-pit tailings deposition. In contrast, Whale Tail monitoring targets potential changes in groundwater quality and flow (conductivity and gradient) related to active ore extraction.

2.5 Dike Construction and Dewatering

The AEMP includes complementary targeted studies during dike construction and dewatering that may require more intensive monitoring. Dike construction monitoring serves to ensure that the requirements of the current NWB Water Licence are met. Dike construction occurred at Meadowbank and Vault from 2008 to 2013 and at Whale Tail from 2018 to 2020 to dewater the north basin of Whale Tail Lake and lakes in the vicinity of the IVR Pit and associated infrastructure (WRSF and attenuation pond).

2.6 Site Water Quality and Flow Monitoring

The Water Quality and Flow Monitoring Plans for the site were prepared in accordance with the requirements of the Nunavut Water Board Type A Water Licence 2AM-MEA1530 and 2AM-WTP1830. The purpose of the Water Quality and Flow Monitoring Plan is to guide monitoring and evaluate the performance of the waste and water management systems. The Water Quality and Flow Monitoring Plan summarizes the monitoring locations, sampling frequency, monitoring parameters, compliance discharge criteria and an adaptive management plan for water quality.

2.7 Effluent-Related Monitoring

In January 2010, Agnico Eagle's Meadowbank Gold Project and in July 2018, the Whale Tail Project became subject to the Metal Mines Effluent Regulations (MMER; changed to Metal and Diamond Mining Effluent Regulations [MDMER] in 2018). MDMER monitoring requirements include, monitoring effluent (weekly/quarterly chemistry analysis, discharge estimates, toxicity testing), receiving environment water quality (quarterly monitoring at discharge and reference areas), and biological monitoring studies (fish and benthic invertebrate monitoring on a three-year cycle).

2.8 Access Road and Haul Road Monitoring

Agnico Eagle is responsible to manage erosion, water quality, and the introduction of sediment along the 110-km All Weather Access Road (AWAR) that connects the Hamlet of Baker Lake to the Meadowbank mine site and the 64 km Whale Tail Haul Road (WTHR) that connect the Meadowbank mine site to the Whale Tail Project. As part of the water quality management, all crossings are visually inspected for erosion and turbidity on a regular basis, with increased inspections during and immediately after freshet. If visual turbidity is observed at a specific location during routine inspections or event inspections (i.e., following freshet or after a rain event), the characteristics of the plume are monitored (field measurements and water sample collection for laboratory analysis). Unless turbidity issues are observed, surface water quality sampling is not deemed necessary. Further details are provided in the Water Management Plan under the Freshet Action Plan.

2.9 Other Related Monitoring Activities

2.9.1 Blasting

In accordance with NIRB Project Certificate No.004 Condition 85 and Project Certificate No. 008 Condition 22, Agnico Eagle Meadowbank Complex developed a blasting monitoring program which complies with *The Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky, 1998) as modified by DFO for use in the North and in adherence with guidance provided in *Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002* (Cott and Hanna, 2005). As a result, Agnico Eagle conducts monitoring to evaluate blast related peak particle velocity and overpressure to protect nearby fish bearing waters.

2.9.2 Air Quality Monitoring

The Air Quality Monitoring Plan at Meadowbank and Whale Tail has been established to satisfy the requirements of Project Certificate 004 Condition 71 and Project Certificate 008 Condition 1 of the NIRB. The plan addresses the concentration of suspended particulate matter and the deposition rate of particles due to mine operation activities. The main components of the air quality monitoring plan include the monitoring of suspended particulate matter (i.e., dust due to wind erosion, vehicles, airstrip activity and incineration), dust fall monitoring, passive and continuous NOx monitoring, QA/QC and reporting.

2.9.3 Pore Water Quality Monitoring

The Type A Water Licence 2AM-MEA1526 was amended on March 2019 to authorize water use and tailings deposition in the Goose and Portage mined pits at the Meadowbank Site. The current Licence (2AM-MEA1530) incorporates these authorizations. One of the requirements of the authorization

(Section IV, Part B: General Conditions) was the development of a Tailings Pore Water Quality Monitoring Program for Board review and approval. The purpose of the tailings Pore Water Quality Monitoring Program is to characterize and monitor the chemical composition of the pore water that exists in the tailings during operation and confirm predictions for mine closure. The elements of this program include characterizing the chemical composition of the tailings pore water for comparison to Portage Effluent Limits and to verify parameter concentrations are adhering to model predictions.

Table 2-1. AEMP-related monitoring plans.

Monitoring Program	Regulator	Authorization / Regulation
Core Receiving Environment Monitoring Program (CREMP)	NWB DFO ECCC CIRNAC	Water Licence 2AM-MEA1530 & 2AM-WTP1830 Part I: Item 1 (AEMP) ; Item 2 (CREMP)
Mercury Monitoring Program (MMP)	NWB DFO ECCC CIRNAC	Project Certificate No. 008 Condition 63 Water Licence 2AM-WTP1830 Part B Item 13.
Metal and Diamond Effluent Regulations (MDMER) & Environmental Effects Monitoring (EEM)	ECCC	*Fisheries Act* (Section 36)
Meadowbank Habitat Compensation Monitoring Plan (HCMP)	DFO	NU-03-0190 (All weather access road) NU-03-0191.3 (Second and Third Portage Lakes) NU-03-0191.4 (Vault Lake) NU-14-1046 (Phaser Lake)
Whale Tail Fish Habitat Offsets Monitoring Plan	DFO	16-HCAA-00370 (Whale Tail Pit Project) 20-HCAA-00275 (Whale Tail Pit Expansion Project)
Water Quality and Flow Monitoring Plans	NWB	2AM-MEA1530 Part I, Item 3 2AM-WTP1830 Part I, Item 3
Groundwater Monitoring Plan	NWB	2AM-MEA1530 Part I, Item 6 2AM-WTP1830 Part I, Item 1
Water Quality Monitoring Plan for Dike Construction and Dewatering	NWB	2AM-MEA1530 Part D, Item 6 2AM-MEA1530 Part D, Item 6
QAQC Plan	NWB NIRB	2AM-MEA1530 Part I, Item 16 2AM-WTP1830 Part I, Item 17 Project Certificate 004 Conditions 6 & 23
Fish-Out Program	DFO	NU-08-0052 NU-03-0191.3 (Second and Third Portage Lakes) NU-03-0191.4 (Vault Lake) NU-14-1046 (Phaser Lake) 16-HCAA-00370 (Whale Tail Project) 20-HCAA-00275 (Whale Tail Pit Expansion Project)
Operational ARD-ML Testing Plan	NWB	2AM- MEA1530 Part B, Item 13 2AM- WTP1830 Part B, Item 14
Blast Monitoring Program	NIRB DFO NWB GN	Project Certificate 004 Condition 85 Project Certificate 008 Condition 22 2AM-MEA1530 Schedule B, Item 16 2AM-WTP1830 Schedule B, Item 19
Adaptive Management Plan Whale Tail Expansion Project	NWB	2AM-WTP1830 Part B, Item 18
Air Quality Monitoring Plan	NIRB	Project Certificate 004 Condition 71 Project Certificate 008 Condition 1
Pore Water Quality Monitoring Program	NWB	2AM-MEA1530Part B, Item 13
Freshet Action Plan	NWB	2AM-MEA1530 Part B, Item 13
Ammonia Management Plan	NWB	2AM-MEA1530 Part B, Item 13 2AM- WTP1830 Part B, Item 14

3 CROSS-LINKAGES AMONG AEMP-RELATED PROGRAMS

As described in **Section 2**, Agnico Eagle is responsible for implementing numerous monitoring programs related to local aquatic receiving environments. This section presents a framework that highlights cross-linkages among monitoring programs and conceptually shows how it can be used to make more informed environmental management decisions (note that the latter element is presented in detail in **Section 4**).

3.1 Introduction

The framework is founded on the conceptual site model, which is used in ecological risk assessment to help understand potential relationships between site activities and the environment (e.g., water quality or certain ecological receptors). Conceptual site models (CSM) typically consist of the following elements:

- **Stressor Sources** – These are the sources of chemical (e.g., metals) or physical (e.g., total suspended solids) stressors that can potentially impact the environment.
- **Stressors** – These are the actual agents that have the potential to cause adverse effects to the receiving environment.
- **Transport Pathways** – These are the ways in which a stressor is released from the source to the receiving environment.
- **Exposure Media** – These are the media where a stressor occurs in the receiving environment. A single stressor might actually end up in multiple exposure media, with different ones being most important at different times. For example, if an effluent contained mercury, it would initially be found to the water column, then most would settle to sediments where it would then enter the food chain (i.e., biota tissue).
- **Receptors of Concern** – These are ecological entities selected for a variety of reasons, usually including sensitivity to relevant stressors and perceived ecological importance. These entities are often called valued ecosystem components in environmental impact assessments (see Section 4.2.1.2 for more details).

These components are depicted in a variety of ways in ecological risk assessment. An example of a simple pathway-style CSM focusing on a single stressor (total suspended solids [TSS] from dike construction) is presented in **Figure 3-1**. Sediment enters the water column by direct discharge (i.e., fine particulates associated with dike construction material) or by resuspension (i.e., disturbance of fine bottom sediments by deposition of construction material). Once in the water column, TSS can affect pelagic receptors through a variety of mechanisms (e.g., reduced light penetration for phytoplankton). TSS can also settle out of the water column to the lake bottom, where it can affect benthic organisms through (for example) smothering of the benthic community.

3.2 Cross-Linkages Among Monitoring Programs

Strategic monitoring of various nodes of the CSM helps to build our overall understanding of the situation to make informed management decisions. Independently, the information provided by monitoring a single node of the CSM is just one piece of the puzzle. Integrated into the CSM framework they provide a much better sense of the "big picture." Ultimately, our ability to mitigate stressors that could potentially affect the receiving environment (e.g., unacceptably high nutrient concentrations) requires identification of the stressor (e.g., nitrate) and its site-related source (e.g., blasting residue). Conceptually and practically, this places an emphasis on the CREMP program results which seek to evaluate potential effects from inputs from all mine related sources (including blasting, effluent, dust, etc.).

The generic principles of the CSM can be applied to any situation, provided that sufficient effort has been expended to adequately characterize each of the key elements. For this project, Agnico relied on the wealth of information generated as part of the environmental impact assessment process for the Meadowbank Gold Project.

- **Sources** – Potential effects on the aquatic environment from the Meadowbank Project were assessed in the Aquatic Ecosystem/Fish Habitat Impact Assessment (Azimuth, 2005c). Effects to the aquatic environment from the Whale Tail Pit Project were assessed in Volume 6 of the 2016 FEIS (Golder, 2016). The AEIA used "linkage matrices" to describe how each mine-related activity could affect water quantity, water quality, fish, or fish habitat for each major development phase (i.e., construction, operations and closure/post-closure). Collectively, these matrices identify all major activities and their potential effects to the receiving environment; compiled lists of key activities for each development phase are provided in **Table 3-1** to **Table 3-3**.
- **Transport Pathways** – These are listed in **Figure 3-2**. Effluent has been included as its own transport pathway to distinguish it from other pathways (i.e., increases resolution among pathways).
- **Exposure Media** – These are listed in **Figure 3-2**. Tissue is included to cover potential exposure to contaminants via the food chain.
- **Receptors of Concern** – The receptor groups are listed in **Figure 3-2** and include metrics for primary productivity and secondary productivity for both the benthic and pelagic zones of the

receiving environment. "Fish habitat" represents critical biological or physical aspects of high-value fish habitat.

Each of the monitoring programs undertaken for the Meadowbank and Whale Tail Project (**Section 2**) provides data for one or more of the transport pathways, exposure media, and/or receptors of concern. Collectively, as shown in **Figure 3-2**, they represent a comprehensive monitoring network that addresses the nodes of the CSM. Their inter-linkages are highlighted for any given stressor through the development of a stressor-specific CSM. In the example shown in **Figure 3-3**, zinc has been identified as an effluent-related stressor (through effluent monitoring). Several other monitoring programs (e.g., CREMP water) may provide insights relevant to assessing the significance of the elevated effluent zinc concentrations in the receiving environment.

Table 3-1. Conceptual summary of key mine-related activities and potential effects for the construction phase.

Activity	Potential Effects		
	Water Quality	Water Quantity	Fish/Fish Habitat
General Construction	Sedimentation	Creating impoundments	Barge noise
Dike construction	Emissions (hydrocarbons, incinerated waste)	Dewatering	Reduced fish passage
Dewatering	Dust (blasting, overburden, stripping, excavation)	Water level rise - shoreline erosion	Sedimentation
Pit development	Blasting residues (nitrogen spp.)	Closure of connecting channel - alternate channel erosion	Construction footprint
Rock storage facilities	Spills (fuel/diesel/explosives/loads on ice)	Lake isolation (Vault Lake) - no natural outflow	
Main site roads & traffic	Sediment resuspension / increased TSS	Culvert placement (seasonal increased water levels)	
Airstrip & air traffic	Release of soluble dike material	Decreased storage capacity in ponds and wetlands	
Mine plant and facilities	Dewatering Effluent (entrained TSS and pore water metals)	Change in lakes circulation patterns	
Freshwater intake and pipeline	Waste rock seepage (metals, acid, TSS)	Surface drainage pattern disruption	
Discharge facilities and pipeline	Release of sediment, metals, and contaminants from surface water runoff		
Non-contact diversion facilities	Sediment losses via permafrost degradation (mainly in bogs)		
Road crossings over water courses	Leaching incineration ashes		
Plant site storage	Sewage/waste water discharged to tailings pond		
AN/Explosives storage and emulsion plant	Fires or explosions at the explosives magazine		
Sewage and waste disposal			
Access road and traffic			
Barge landing facility			
Barge traffic			
Explosive magazine			
Tank farm			

Notes
Adapted from the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (Azimuth, 2005c)
AN - ammonium nitrate
TSS - total suspended solids

Table 3-2. Conceptual summary of key mine-related activities and potential effects for the operations phase.

Activity	Potential Effects		
	Water Quality	Water Quantity	Fish/Fish Habitat
General Construction	Release of soluble dike material	Potentially high seepage rates (from lakes into pits)	Fish larvae entrainment into water intake pipe
Dikes	Dust (terrain, tailings desiccate)	Lost natural storage capacity in small ponds and wetlands	Sedimentation
Dewatering	Blasting residues	Water circulation changes	Blasting (physical effect)
Pits	Increased TSS	Lost natural surface drainage	Attenuation pond effluent discharge
Rock storage facilities	Emissions (hydrocarbons, incinerated waste)	Decreased water volume	Reduced fish passage
Main site roads & traffic	Runoff from pit walls and tailings (TSS, metals, acid, nitrogen spp., reagent spills)	Increased water volume	Noise (Barge)
Airstrip & air traffic	Concentrated pore water release during tailings freeze back	Culvert (seasonal increase in lake water level)	
Mine plant and facilities	Attenuation pond effluent (TSS, metals, acidity, explosives residues; tailings supernatant, cyanide spp.)		
Freshwater intake and pipeline	Sediment losses via permafrost degradation (mainly through bogs)		
Discharge facilities and pipeline	Leaching incineration ashes		
Effluent discharge	Waste water/ sewage discharge to tailings pond/attenuation pond		
Non-contact diversion facilities	Sediment loading during drawdown		
Dewatering and draining facility	Release of water from waste rock piles (to attenuation pond)		
Road crossings over water courses	Spills (fuel, diesel, transferred metals, explosives, tailings, reagents)		
Plant site storage			
AN/Explosives storage and emulsion plant			
Sewage and waste disposal			
Access roads and traffic			
Barge landing facility			
Barge traffic			
Explosive magazine			
Tank farm			

Notes
Adapted from the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (Azimuth, 2005c)
AN - ammonium nitrate
TSS - total suspended solids

Table 3-3. Conceptual summary of key mine-related activities and potential effects for the closure/post-closure phase.

Activity	Potential Effects		
	Water Quality	**Water Quantity**	**Fish/Fish Habitat**
Dikes	Release of soluble metals from pit walls (controlled flooding)	Controlled flooding of pits	Leaching/runoff of metals, acid (from waste rock pile, pit walls, dikes)
Pits/ attenuation pond	Release of metals and acid (waste rock pile, dike material)	Drawdown for pit flooding	
Dewatering and draining facility	Pit Lake water into groundwater	Lake area and volume decrease (permanent)	
Rock storage facility	Pit Lake part of receiving environment (ultimately)	Recontouring to restore drainage patterns	
	Release of nitrogen and metals (tailings dust)	Alteration of lake circulation patterns	
	Increased TSS (during flooding)	Continued disruption of surface drainage patterns	
	Release of concentrated pore water (during tailings freeze back)	Deep pits become deposition area for sediment	
		Loss of storage capacity in ponds and wetlands	

Notes
Adapted from the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (Azimuth, 2005c)
TSS - total suspended solids

Figure 3-1. Simple pathway-style conceptual site model showing transport, fate and potential effects relationships for construction-related sedimentation.

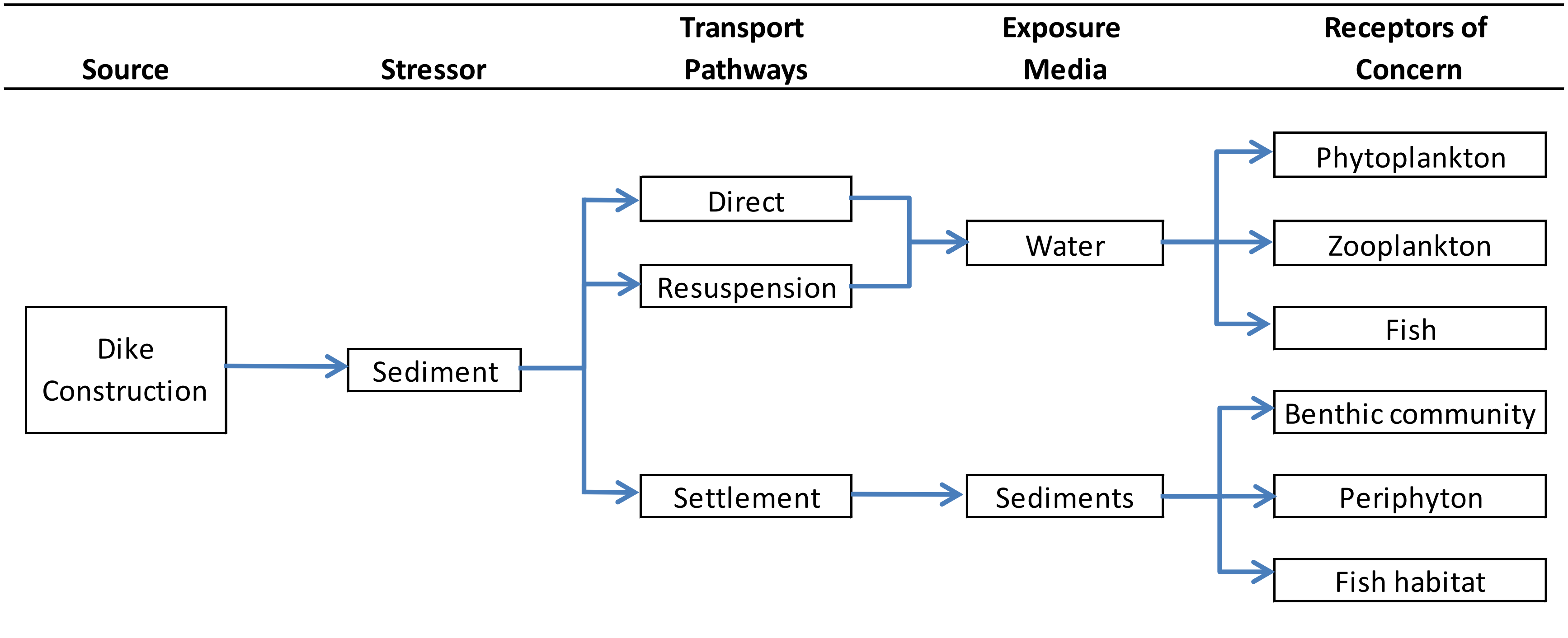
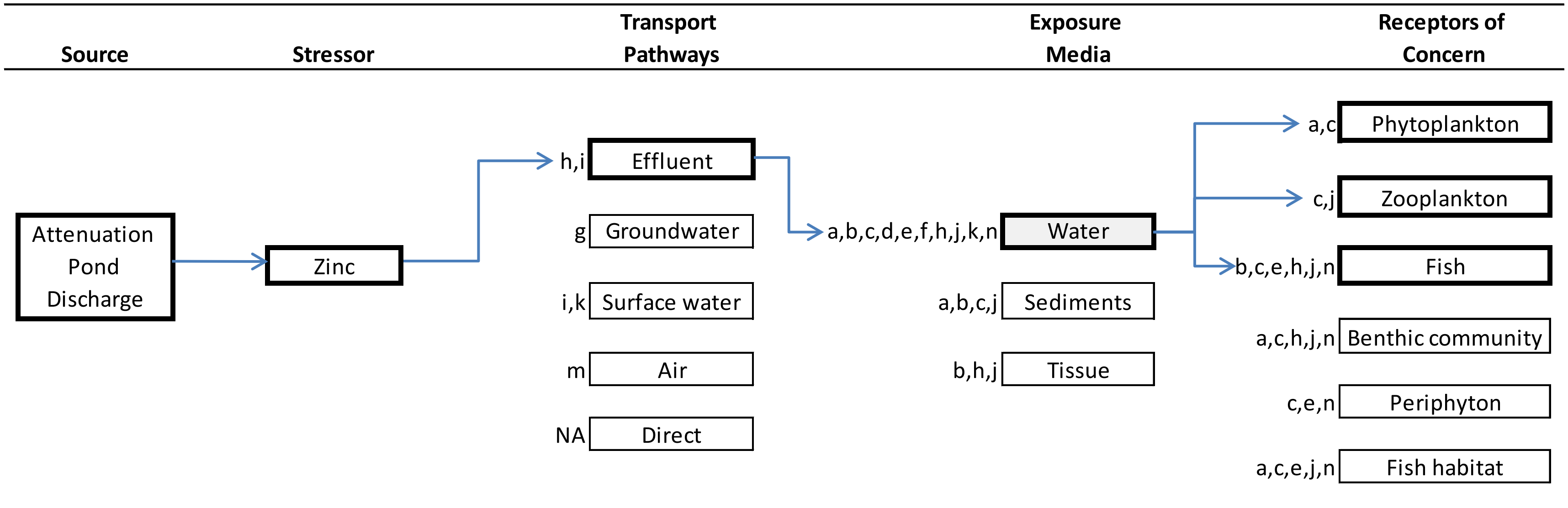


Figure 3-2. Primary transport pathways, exposure media, and receptors of concern for the Aquatic Effects Management Program.

Transport Pathways	Exposure Media	Receptors of Concern
h,i Effluent	a,b,c,d,e,f,h,j,k,n Water	a,c Phytoplankton
g Groundwater	a,b,c,j Sediments	c,j Zooplankton
i,k Surface water	b,h,j Tissue	b,c,e,h,j,n Fish
m Air		a,c,h,j,n Benthic community
NA Direct		c,e,n Periphyton
		a,c,e,j,n Fish habitat

Notes
a Core Receiving Environment Monitoring Program
b Mercury Monitoring Program
c Targeted Studies
d Dike Construction Monitoring
e Habitat Compensation Monitoring Program
f Dewatering Monitoring
g Groundwater Monitoring
h MDMER Monitoring
i Water Quality and Flow Monitoring
j Fish-Out Studies
k AWAR/WTHR and Quarry Water Quality Monitoring
l Blasting
m Air Quality Monitoring
n Pore Water Quality Monitoring
NA Direct, so measured in exposure medium

Figure 3-3. Example of stressor-specific (zinc in effluent) conceptual site model showing cross-linkages among AEMP-related monitoring programs.



Notes

a	Core Receiving Environment Monitoring Program
b	Mercury Monitoring Program
c	Targeted Studies
d	Dike Construction Monitoring
e	Habitat Compensation Monitoring Program
f	Dewatering Monitoring
g	Groundwater Monitoring
h	MDMER Monitoring
i	Water Quality and Flow Monitoring
j	Fish-Out Studies
k	AWAR/WTHR and Quarry Water Quality Monitoring
l	Blasting
m	Air quality monitoring
n	Pore Water Quality Monitoring
NA	Direct, so measured in exposure medium

4 MANAGEMENT RESPONSE PLAN

4.1 Introduction and Objective

The Management Response Plan (MRP) aims to fulfill the water licence requirement for 'annual reporting for more immediate adaptive management' (see text box below for discussion of terminology). In simple terms, the MRP describes the process of identifying potential risks to the aquatic environment and developing appropriate management responses.

The generic management response process in the context of the Meadowbank mine AEMP is shown in **Figure 4-1**.

Terminology:

The management response plan (MRP) describes the actions that will be taken if potential effects of various magnitudes are predicted or observed (INAC, 2009a). The INAC guidance has replaced the term 'adaptive management plan' with MRP because adaptive management refers strictly to the use of deliberate experimental management to improve understanding and reduce uncertainties (Walters, 1986; Greig et al., 2008). Reviewers of adaptive management plans for other northern mines (e.g., Murray and Nelitz, 2008) have correctly pointed out that the scope of those plans was much broader than adaptive management. The potential role of true adaptive management (i.e., experimental management) is likely to be quite limited, because the impacts of such 'experiments' may not be acceptable or reversible (Greig et al., 2008). Monitoring for impacts from a mine and reacting to results of monitoring is not adaptive management (Murray and Nelitz, 2008). The Type A-licence for the Meadowbank Mine requires that the AEMP include 'annual reporting for more immediate adaptive management' (H-1(b)). It is assumed that the intent or meaning of that requirement is broad rather than strictly experimental management. Consequently, the term adaptive management is not used in the AEMP.

The general management response plan for the AEMP is shown in **Figure 4-2**. The development of the MRP is tailored to each program, but response actions are based on the cumulative results of all programs. **Section 4.2** of this document describes the methodology for development and application of the MRP at the program-specific level, while **Section 4.3** describes the methodology and application of the MRP at the AEMP level.

In addition to the generic MRP described herein, a specific adaptive management strategy (AMS) was developed by Agnico Eagle to guide water management decisions for phosphorus and arsenic in Mammoth Lake and Whale Tail Lake (South Basin) (Agnico Eagle, 2021). Similar to the generic MRP, the AMS is designed to keep water quality below concentration-based thresholds (see **Section 4.2.4**) for both phosphorus (CCME water quality guideline [WQG] of 0.01 mg/L) and arsenic (site-specific water quality objective (SSWQO) of 0.025 mg/L). The AMS has 'Levels' ranging from 0 (normal operating conditions) to 4 (emergency situation), with concentration-based breakpoints based on FEIS predictions (Golder, 2019) or the aforementioned thresholds, and each level is associated with a prescriptive management action (**Table 2-4**). Water quality data for phosphorus and arsenic collected as part of the CREMP are used in the assessment. The remainder of the CREMP results follow the generic MRP detailed herein.

Table 4-1. Adaptive Management Strategy for contaminants of potential concern (COPCs) in water from Whale Tail Lake (South Basin) and Mammoth Lake*.

Adaptive Management Level	Threshold (Total Phosphorus and Arsenic)	Management Strategy[1]
Level 0 (Normal operating condition)	Within 20% of FEIS predicted concentrations.	No changes - continue with CREMP monitoring plan.
Level 1 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND less than 80% of the WQG or SSWQO.	Continue with Level 0 management strategy. Analyze site wide water quantity and quality data to identify and assess cause(s) of the difference(s) and reported to the NWB. Report results of data review in annual reporting to the NWB including implications on the Water Management Plan and evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 10%).
Level 2 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 80% and 100% of the WQG or SSWQO.	Continue with Level 1 management strategy. Report results of data review to the NWB in the Annual Report, including implications on the Water Management Plan and the evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 20%). Move discharge location to MAM or WTS. Assess potential discharge in lakes D1 or D5 in case level 3 is reached, with approval from the NWB as per NIRB Project Certificate Conditions.
Level 3 (High risk situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 100% and 120% of the WQG or SSWQO.	Continue Level 2 management strategy. Report results of data review in the Annual Report to the NWB including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., review overall water management strategy to stay within assimilative capacity of the receivers). Continue monitoring in the original receiving area to evaluate if they recover and define threshold to restart using them.
Level 4 (Emergency situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND greater than 120% of the WQG or SSWQO.	Continue Level 3 management strategy. Report results of detailed data review in the Annual Report to the NWB, including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., move discharge location to an approved location). Continue monitoring in the original receiving area to evaluate if they recover and define thresholds to restart using them. Evaluate potential new discharge location to resume operation.

Notes:

* Agnico Eagle will consult with the NWB on the required approval process, execution, and implementation prior to initiating the adaptive management strategy items for Adaptive Management Levels 3 and 4.

[1] See Table 3 in the Adaptive Management Plan for more details on management strategies for each Adaptive Management Level (Agnico Eagle, 2021).

Acronyms

FEIS = Final environmental impact statement. SSWQO = Site-specific water quality objective. WQG = Water quality guideline.

Figure 4-1. Generic management response process for the AEMP.

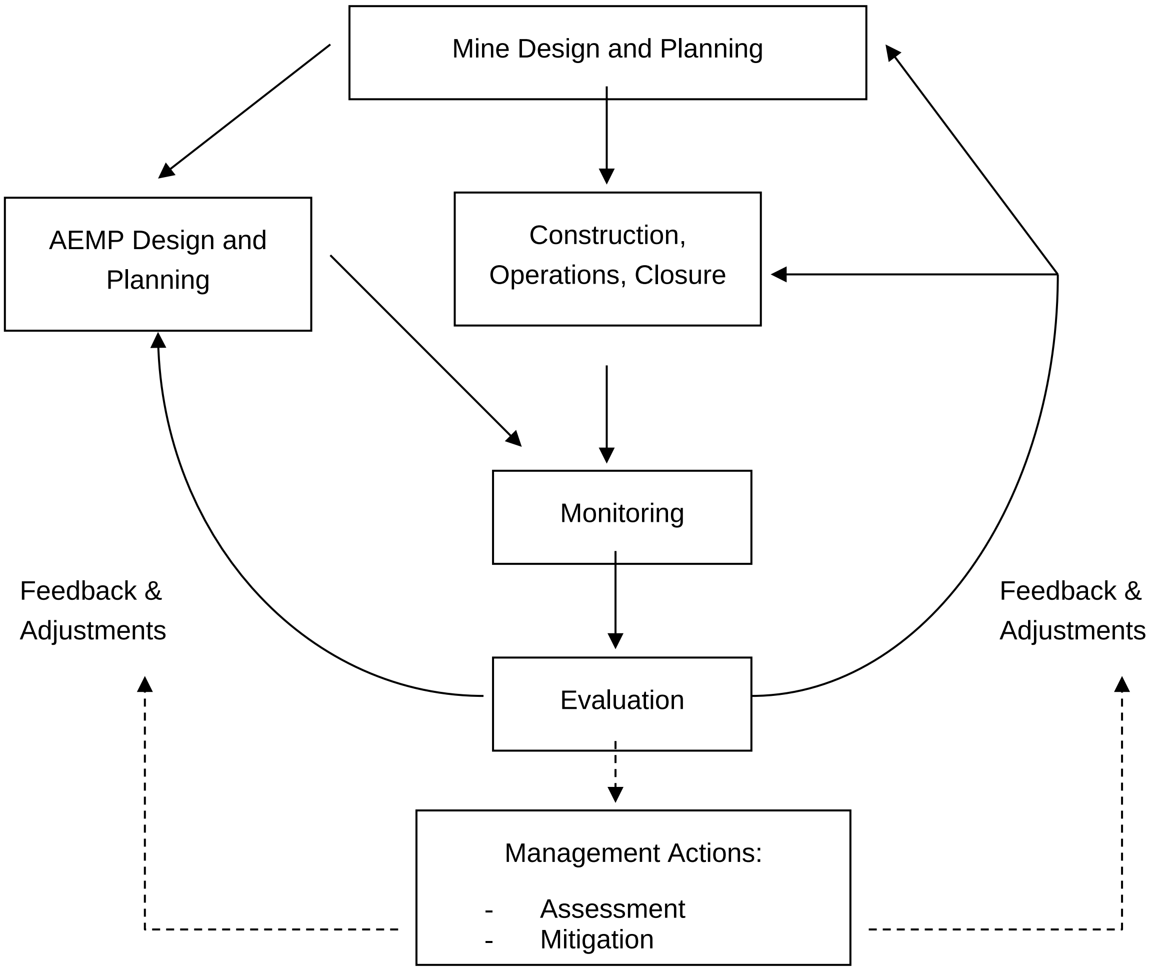
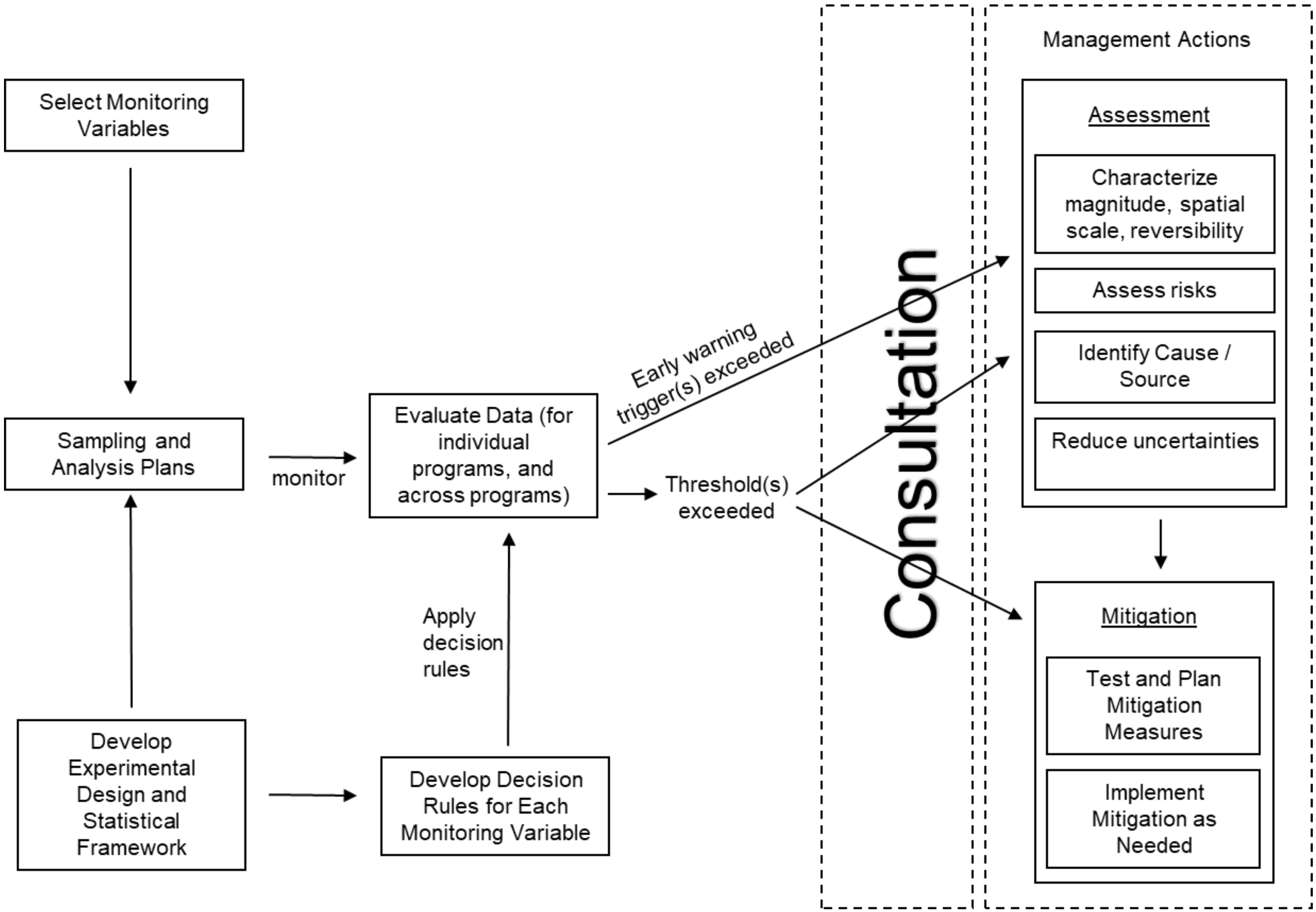


Figure 4-2. Management response plan for the AEMP programs.



4.2 The MRP at the Program-Specific Level

This section describes the methodology for development and application of the portions of the MRP that occur at program-specific levels. The CREMP is the program where the most rigor is needed in determining thresholds and early warning triggers for each variable, since the CREMP is the primary program used to detect impacts in the receiving environment, and unlike monitoring under EEM does not have pre-determined decision rules.

The end goal of applying these principles to the existing monitoring programs is to have clear decision criteria with which to evaluate the status of the results of each program. While a fair amount of detail has been provided herein to support the CREMP, the process for other AEMP-related monitoring programs may follow the same principles, but could be implemented in a simpler manner.

The components of the MRP are covered in this section as follows:

- Risk -based approach for determining which variables under each program may be used for establishing decision rules that will lead to management responses (**Section 4.2.1**);
- General experimental design and statistical framework to be applied to monitoring under each program (**Section 4.2.2**);
- Principles for sampling and analysis plans (SAPs) to be applied to each program (**Section 4.2.3**);
- Methodology for determining decision rules (thresholds and early warning triggers) for monitoring variables under each program (**Section 4.2.4**); and
- Process for summarizing data on a program-specific basis (**Section 4.2.5**).

4.2.1 Risk-Based Selection of Key Monitoring Variables

Depending on the program, the variables that are monitored include three types:

- Direct measures of potential effects (e.g., measurement of benthic community abundance and diversity);
- Contaminants or other variables that can cause effects, but that are measures of exposure rather than effects directly; and
- Ancillary variables that modify potential exposure or effects (e.g., water hardness; sediment particle size) or measure general characteristics of a particular environmental medium.

The list of variables that are monitored under each program may be defined in part by legal requirements (e.g., the water licence). However, where applicable, scientific rationale must be used to determine which subset of variables should be the focus for development of effects-based benchmarks (i.e., thresholds – explained further in **Section 4.2.4**). This is particularly relevant for the CREMP where some variables, particularly ancillary variables, may not be expected to be affected by the mine. Those variables will still be tracked over time, but their evaluation could be based on statistical triggers rather than effects-based thresholds. This section outlines the process that should be used for selecting variables for which effects-based thresholds should be established – consistent with recommendations in recent guidance for AEMP development (INAC, 2009b), implementation of AEMPs for other northern mines (e.g., Diavik, 2007a; b), and current risk assessment guidance at federal level (Azimuth, 2010a), a risk-based process is outlined with the following components:

- Identify stressors of potential concern (e.g., contaminants) that may impact the aquatic environment, and their characteristics related to (a) transport and fate, and (b) potential effects on aquatic receptors. Of particular importance is the availability of published effects benchmarks representing concentrations above which unacceptable effects might be expected.
- Identify receptors of concern (i.e., species, populations, communities or habitats that need to be protected – equivalent to 'valued ecosystem components')
- Characterize the potential exposure pathways by which sources of stressors may impact the receptors, and depict those linkages using a conceptual site model.
- Select assessment endpoints (specific attributes for receptors that are to be protected) and measurement endpoints (the monitoring variables that are to be used to measure exposure or effects). Measurement endpoints are categorized as primary (those which measure effects, or for which effects-based thresholds are established) and secondary (those that are monitored and evaluated on a statistical basis only, since thresholds are either not warranted or can't be easily developed).

4.2.1.1 Potential Stressors and Their Characteristics

Identification of SOPCs – Metals, suspended solids and other chemical or physical variables that may adversely affect aquatic life are referred to as stressors of potential concern (SOPCs). The list of SOPCs will be program-specific to some degree (e.g., suspended solids are not relevant in groundwater), but there will be a high degree of overlap among the programs. The starting point for identifying SOPCs for each AEMP program will be the variables that are listed in the water licence, plus any additional variables that were identified in the Environmental Assessment for the mine as potentially impacting aquatic life. Any variable that can be affected by the mine and could impact aquatic life should be considered.

Potential Effects of SOPCs – The effects of each SOPC will be characterized as part of the CREMP re-design, and most of the information will apply directly to other programs. The emphasis will be partly on summarizing primary literature but more on summarizing and evaluating the derivation of CCME guidelines and other effects benchmarks (such benchmarks will later be used for derivation of decision rules).

The review of effects characteristics of a SOPC emphasizes the types of organisms that may be affected by the contaminant of potential concern (COPC) and the relevant mechanisms of action. The concentrations associated with particular effects in particular organisms may be specified, helping to identify the types of effects and receptors that are expected to be most sensitive.

Transport and Fate Characteristics of SOPCs – The transport and fate characteristics of a SOPC determine how the contaminant will move from source(s) and partition into various environmental media such as water, sediment and biota. The transport and fate characteristics help determine which receptors and exposure pathways are relevant for each SOPC. For example, sediment benthic organisms may be the most relevant receptor group for stressors that partition primarily into sediment rather than water. Higher trophic level organisms such as fish may be most relevant for stressors that bioaccumulate or biomagnify up the food chain.

4.2.1.2 Receptors of Concern

For AEMP programs that target the receiving environment, in particular the CREMP, it is important to identify what Receptors of Concern (ROCs)[5] could be affected by stressors. A Receptor of Concern (ROC) is any non-human individual, species, population, community, habitat or ecosystem that is potentially exposed to a SOPC. The level of biological organization at which an ROC is defined varies. In the case of lower levels of biological organization, the community is often identified as the ROC (e.g., zooplankton community, benthic community). In the case of higher trophic levels, the ROC is usually defined at the species level (e.g., mink, eagle). In the latter case, the selection of an individual species may be for direct assessment of the identified organism and/or may be selected as a representative (or surrogate) for similar organisms.

The Environmental Assessment for the mine, specifically the identified Valued Ecosystem Components (VECs), will be the starting point for identification of ROCs in the receiving environment. If it is necessary to identify specific surrogate ROCs to represent particular functional groups, or if gaps are identified based on knowledge gained since completion of the EA, the following criteria (from Azimuth, 2010a) will be used to identify appropriate ROCs:

1. **Ecological relevance** – An ecologically 'relevant' ROC is an organism that is an appropriate indicator of actual or potential exposures given the environmental conditions germane to the

[5] The term Valued Ecosystem Component (VEC) has the same or similar meaning, but ROC is used here for consistency with risk assessment terminology, and to allow for variations from VECs identified during the environmental assessment as appropriate.

assessment. An ecologically relevant organism should be expected to be found at a site under reasonably foreseeable conditions (e.g., an arctic fox at a site in the arctic). It is usual practice to select ROCs that represent key functional groups that are expected to be exposed to the SOPCs on site. In addition, keystone species that are important to ecosystem stability may be preferentially selected as ROCs.

2. **Degree/mechanism of exposure to the SOPCs on site** – A number of factors have the potential to affect the degree to which ROCs are exposed to the SOPCs on the site, including:
   - The status of the ROC (life stage, migratory versus resident);
   - How the ROC uses the site (feeding guild, feeding behaviour);
   - How much/often the ROC uses the site (home range size, habitat suitability, off-site habitat characteristics); and
   - Number and type of exposure pathways (environmental media, indirect/direct contact/consumption, bioaccumulation and biomagnification processes).
3. **Relative sensitivity to the SOPCs** – It is customary to include species or other receptor types that are relatively sensitive to the SOPCs. The principle for selection of a sensitive species is that demonstration of lack of harm for a sensitive organism conveys protection for the less sensitive taxa in the same functional group.
4. **Relative importance from a conservation perspective** – If rare, endangered or threatened species (i.e., listed species) and/or habitats are confirmed to be present, these species must be considered as potential ROCs. They should also be included if they are likely to be present in the future (based on information regarding geographic distribution, habitat preferences and site-specific habitat availability).
5. **Relative social, economic and/or cultural importance** – Any particular species or group that is of special importance (e.g., species of significance to First Nations, species of commercial or recreational importance) would typically be included as an ROC and may be subjected to more emphasis and more scrutiny than other ROCs.
6. **Availability of ecotoxicological and life history data** – Where effects data will be literature-based, ROCs for which ecotoxicological data are readily available are preferentially selected; otherwise, the ability to assess effects on the ROC may be reduced. The benefit of selecting highly-specific ROCs is offset where data related to toxicity thresholds are limited.

4.2.1.3 Exposure Pathways

Exposure pathways are the routes of exposure from environmental media (e.g., soil, water, air, sediment) to the receptors of concern. Examples of exposure pathways include water and food consumption (for wildlife) and direct contact (for invertebrates). The identification of pathways links sources of SOPCs to ROCs based on the characteristics of each. For AEMP programs that specifically target sources (e.g., groundwater, effluent discharges) the evaluation of exposure pathways is not relevant; rather, exposure pathways are most relevant for programs that target the receiving environment (e.g., the CREMP).

The starting point for evaluation of exposure pathways will be the Environmental Assessment findings (e.g., linkage matrices) for the project.

4.2.1.4 Assessment and Measurement Endpoints

An assessment endpoint is an explicit expression of the attribute of a ROC that is to be protected. For example, if the ROC is the benthic invertebrate community, an assessment endpoint might be benthic invertebrate abundance and diversity. The assessment endpoint sets the stage for exactly what effects variables will be measured as measurement endpoints.

Measurement endpoints are the specific exposure and effects variables selected to be measured and then used to evaluate risks. For purposes of the MRP for the AEMP, the measurement endpoints are categorized as primary (those which measure effects, or for which effects-based thresholds are established) and secondary (those that are monitored and evaluated on a statistical basis only, since thresholds are either not warranted or can't be easily developed). Criteria for the selection of measurement endpoints and categorization as primary/secondary are:

- Legal requirement for monitoring (e.g., inclusion in the water licence);
- Availability of CCME guidelines or other published benchmarks (for exposure variables);
- Availability of toxicological information on effects (for exposure variables);
- Likelihood that mine-related activities would cause changes in the variable (for exposure variables);
- Likelihood that changes in the variable would cause effects on the receptors at the site, given understanding of sources, fate and transport pathways, and sensitivities of receptors (for exposure variables);
- Ability of the specific variable to represent effects on receptors (for effects variables);
- Ability of a variable to simultaneously represent several individual variables. For example, principal components could be used to represent groups of chemistry variables; and
- Duplication with other variables (a program design that targets every parameter has more change of false positives, i.e., type-I errors).

Since the Meadowbank AEMP has been operating for some time, rationale should be provided not only for the inclusion of specific variables as measurement endpoints, but also for the exclusion of variables.

4.2.2 Experimental Design and Statistical Framework

The monitoring programs outlined in Section 2 vary considerably in terms of focus and content. Some are data rich (e.g., CREMP), allowing for quantitative statistical analyses, and others are constrained by data limitations (e.g., groundwater monitoring) and are assessed without statistical procedures. Some involve explicit comparisons to spatial and temporal reference conditions (e.g., the before-after-control-impact [BACI] design, where data from the 'before' period and for 'control' stations are used to help make inferences from the data about potential impacts of the mine), whereas others rely on tracking trends at individual monitoring stations over time (e.g., the before-after [BA] design, where temporal changes at individual stations are used to make inferences about mine-related changes). Consequently, no single experimental design and analysis framework will apply to all cases. In general, one or more of the following tools will be used for evaluating potential effects in each of the component programs:

- **Visual trend analysis** – although graphical presentation of data and time trends would be an integral part of all analyses, we specify interpretation of graphical data separately because it may include data that are not used in the formal statistical tools below.
- **Time series analysis** – This approach refers to any methods of evaluating the data where time is treated as a continuous variable. The methods may range from simple linear models (e.g., linear regression) to more complex and formal time series methods (e.g., autoregressive integrated moving average modeling), if warranted and supported by the data. We distinguish time series regression from BACI-style analyses below only for communication purposes – the general modeling framework is the same, with the only distinction being the treatment of time as a continuous variable. Treatment of time as a continuous variable will become more relevant as the temporal length of the data sets increase.
- **BACI-style (including CI) linear and multi-level modeling** – This refers to a general modeling framework that evaluates measured variables as functions of time, space and other measured variables. It covers statistical tools such as analysis of variance, analysis of covariance, linear regression, and multiple regression. Depending on what type of data are available and how those data are structured, linear and multi-level models encompass traditional control-impact, before-after, and BACI-style designs (Hewitt et al., 2001) and related formulations such as impact level by time, impact trend by time, and exposure gradient analyses (as described by Wiens and Parker, 1995). The reference to 'multi-level' modeling (Gelman and Hill, 2006; Pinheiro and Bates, 2000) refers to model formulations that account for the structured nature of the data (i.e., in cases where data are not independent but rather are grouped by year, month/season, station, or other variables). In this generalized, flexible modeling framework, data may be balanced or

unbalanced (e.g., different numbers of replicates per station, missing data for some area / time combinations, etc.), and predictor variables can be treated as continuous or categorical. The levels inherent in any data groupings as well as their interactions are considered. To the extent that the available data support the analyses, model formulations that are relevant from a monitoring viewpoint will be explored. For additional details, the 2021 CREMP report (Azimuth, 2022) is the best example to date of implementation of the statistical modeling framework.

In general, for programs where statistical approaches are appropriate for data analysis, implementation will aim to:

- Use more than one method or model where appropriate.
- Use models that take into account the sources of variability that could affect any measured variable. Key sources of variability likely to be common to all programs are spatial variability, temporal variability (annual or seasonal), subsample variability and measurement error.
- Carefully consider subsampling / replication and the potential impact of pseudoreplication.

4.2.3 Sampling and Analysis Plans

After the monitoring variables are selected, sampling and analysis plans (SAPs) for each program are used to specify how data will be collected and how laboratory analyses will be conducted. Since the programs within the AEMP have been underway for multiple years, the SAPs are already implemented for the various programs (e.g., CREMP). However, these should be updated as needed. SAP's should cover the following elements:

- Field sampling methods;
- Field QA/QC procedures including storage and transport;
- Data quality objectives;
- Lab methods including sample processing, analytical methods and detection limits; and
- Lab QA/QC procedures.

4.2.4 Thresholds and Triggers

4.2.4.1 Background

The need for and nature of management actions can be based on various criteria, but the most important among these are criteria that measure the *magnitude* of a problem, such as the concentration of suspended solids in the water column. The key principle is to establish an approach that allows actions to be triggered before unacceptable adverse effects occur (INAC, 2009a). In addition, there may be more than one type or level of trigger for a given measured variable.

4.2.4.2 CREMP Approach

Despite the varied nature of the monitoring programs contributing to the AEMP (**Section 2**), most benefit from having clear decision criteria to help inform the management response plan. That said, there may be some programs (e.g., fish-out programs) where the approach does not make sense or where it may need to be modified. As an example, the remainder of this section focuses on the decision criteria for the CREMP, where a two-tiered approach is being applied, consisting of:

- **Thresholds** are defined as legal requirements, regulatory guidelines, or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which unacceptable adverse effects may occur. If effects-based thresholds do not exist or are not warranted for a particular variable, then early warning triggers will be developed without thresholds. In such cases, if triggers are exceeded then the implications of such exceedances can only be understood through the integration of results from other AEMP monitoring programs, or, if important information gaps still exist, through focused studies (e.g., risk assessment).
- **Triggers** are early warning criteria that lead to action. The triggers may be based on absolute numbers (e.g., an increases half-way from baseline to an identified effect threshold) or statistical criteria (e.g., statistically significant trend that predicts exceedances of a threshold within 3 years).

The principles to be used for derivation of thresholds and triggers are as follows:

- For exposure variables, thresholds should be based on available benchmarks that relate the variable to potential effects. CCME guidelines are generally appropriate for use as thresholds because they have a toxicological basis and are relatively conservative, but the applicability of the underlying data to the receptors of concern at the site should be evaluated. Where CCME guidelines do not exist, there may be published guidelines or standards in other jurisdictions that could be considered applicable.
- For effects variables, thresholds should be derived by defining a critical effect size of ecological relevance. Effect sizes of relevance may vary depending on the variable but should be consistent with effect sizes that are (a) used in Canada for derivation of environmental quality guidelines, (b) used in Canada for site-specific risk assessments, (c) specified in the Environmental Assessment.
- More than one type of trigger may be appropriate for either exposure or effects variables. It is expected that triggers will be based on statistical analysis of time series data as well as comparison of data for any particular sampling event to baseline data. Time series triggers are expected to become more relevant as the length of the time series grows.

The types of thresholds and triggers that are developed will be different for exposure variables (e.g., chemical concentrations) and effects variables. The derivation process for thresholds and examples of potential triggers are shown in **Figure 4-3** (for exposure variables) and **Figure 4-4** (for effects variables, such as those in the CREMP). These figures are not detailed or specific to particular variables – the application to each variable (or groups of variables) may be developed as appropriate on a program-specific basis (e.g., for the CREMP [Azimuth, 2012a]). It should be noted that for many programs (e.g., EEM) thresholds and triggers are pre-defined and are not subject to revision and for others the methods described above may not be applicable (e.g., AWAR habitat compensation monitoring program).

The difference in the derivation processes for exposure variables and effects variables is most easily understood with examples from the CREMP:

- *Exposure* Variable Example:
  - Variable: Zinc concentration in bulk sediment.
  - Threshold: CCME sediment quality guideline.
  - Triggers: (a) Mean zinc concentration in an area increases halfway from baseline (in a BACI framework) to the CCME ISQG, with a given degree of confidence; (b) Time trend analysis shows zinc concentration likely to exceed the CCME ISQG within three years, with a given degree of confidence.
- *Effects* Variable Example:
  - Variable: Benthic invertebrate community richness measured as total number of taxa.
  - Threshold: x % decrease in the total number of taxa relative to baseline (where x represents an agreed acceptable effect size, and baseline is estimated in a BACI framework).
  - Triggers: (a) Mean estimate of total number of taxa in an area decreases by ½ (x %) relative to baseline, with a given degree of confidence; (b) Time trend analysis shows that the mean estimate of total number of taxa in an area is expected to decrease by ½ (x %) relative to baseline within three years, with a given degree of confidence.

A key concept for derivation of thresholds is effect size. Effect sizes are implicit in CCME environmental quality guidelines (or other published benchmarks) and are unlikely to be questioned in those cases since they are already generally acceptable to regulatory agencies. However, for effects variables, a threshold can only be developed through explicit agreement on a critical effect size (an effect size below which effects would be considered acceptable). If a threshold cannot be developed or agreed, early warning triggers will be based purely on statistical criteria.

A key concept for application of triggers is statistical confidence. As part of the design for the CREMP (and other AEMP programs as appropriate), sample sizes required to ensure that exceedances of triggers can reasonably be detected in a BACI-style framework or time series analysis framework will be determined using *a priori* statistical power analysis for typical modeling scenarios and various time frames. Sample sizes may relate to the number of sampling areas and/or the number of samples in a given area depending on what question is being addressed by a statistical model. The desired power and the trade-offs among type 1 and type 2 errors will be determined for the CREMP (and other programs as appropriate) based on review of available guidance and discussion with regulators.

Once details regarding application of triggers are agreed, the subsequent evaluation of data should be based on the level of confidence in results (e.g., probability that the actual effect size is greater than the critical effect size of interest) (Newman, 2008).

4.2.5 Data Summary Framework

If a trigger or threshold is exceeded, a risk-based, integrated evaluation of key results across AEMP programs will be conducted that evaluates monitoring variables according to criteria commonly used in risk assessment (Hull and Swanson, 2006; Azimuth, 2010a):

- **Magnitude** – the degree to which a variable exceeds early warning triggers or thresholds (as described above in **Section 4.2.2**)
- **Spatial Scale** – the scale at which exceedances of triggers or thresholds occurs.
- **Causation** – the strength of evidence for a mine-related cause.
- **Permanence** – the likelihood and rate of reversal of the effect over time.
- **Uncertainty** – a reflection of confidence (or lack thereof) in the findings regarding magnitude, spatial scale and causation.

Within the annual report for each AEMP-related program, these criteria will be applied to each monitoring variable in each medium, and the results will be summarized using a categorical rating system for magnitude, spatial scale, causation, permanence and uncertainty, as shown in the example in **Figure 4-1**.

4.3 The MRP at AEMP Level

The role of the annual AEMP report is more than a summary of the findings of each program. While each program may identify particular issues, evaluation of the findings across all programs is needed to understand the linkages between sources of stressors and potential effects, and to best design management actions. For example, if zinc is found to be elevated in sediment in the receiving environment, it will be important to evaluate the zinc data for groundwater, effluents and other discharges in order to determine the mine-related source, if any.

Once data are summarized for each program, the key findings for each program need to be evaluated together at the AEMP level so that any issues can be identified and understood, and management response actions can be developed. This section describes the process of integrated data evaluation (**Section 4.3.1**), and the process of selecting management actions (**Section 4.3.2**).

4.3.1 Integrated Data Evaluation

The integrated evaluation of data across all programs begins with a summary of the data. Since magnitude is the most important criterion for determining the need for management actions, a simple table such as that shown in **Table 4-3** should be used to summarize under which programs there were exceedances of triggers and thresholds. **Table 4-3** is the highest level of summary table. For those variables or groups of variables where there are exceedances of triggers or thresholds, a more thorough summary of the data is warranted including the other criteria related to spatial scale, causation, permanence and uncertainty. An example template for such a summary is provided in **Table 4-4** for a stressor variable.

Once the data summary is complete, the patterns among the programs need to be characterized in mechanistic detail. This should be done using an issue-specific conceptual site model. For each issue identified, available information across AEMP-related programs for source, stressor, transport pathways, exposure media, and effects measures will be evaluated. Each stressor/transport-pathway, stressor/medium and medium/effect measure combination related to the issue would be assessed across programs based on the overall evidence for magnitude, spatial scale, causation permanence and uncertainty. In addition, the strength of available information relating stressors to specific sources and effect measures to specific stressors will be assessed. As shown in **Figure 4-2**, understanding both these linkages (i.e., effect to stressor to source) are critical to the identification of effective management actions. An example of an issue-specific conceptual site model for the 2008 sedimentation event during East Dike construction is shown in **Figure 4-5**. This summary is based on a range of data collected in 2008 and 2009 across several programs (CREMP, Dike Construction Monitoring, Effects Assessment Studies, Habitat Compensation Monitoring; Azimuth, 2010b,c,d,e), but all related to East Dike construction.

4.3.2 Management Actions

Management actions will be taken in cases where integrated evaluation of results across AEMP programs identifies a potential impact to the receiving environment; the scope of management actions will depend on the nature of the problem, the spatial scale, evidence for causality, permanence and uncertainty. The process that will be used to identify management actions was shown in **Figure 4-2**. Management actions can be divided into those aimed at further assessment and those aimed at mitigation. A toolbox of assessment options is provided in **Table 4-5** and a toolbox of mitigation options is provided in **Table 4-6**.

The specific management action that would be appropriate in a given case depends on the underlying cause. For example, if a metal becomes elevated in receiving water, the identification of options for further assessment and/or mitigation options would be different if the source of the metal is groundwater versus effluent versus dust.

The timing of management actions is also case-specific. In cases where further monitoring and assessment is warranted, that assessment should begin as soon as practically possible. In cases where mitigation is considered, mitigation should begin as soon as the weight of evidence indicates that mitigation is warranted, and the benefits of commencing mitigation immediately outweigh the disadvantages of waiting for further information. Consultation with regulators and stakeholders is important for determining management actions.

Consultation and Communication – Stakeholder involvement is key to the success of the AEMP. Mechanisms for stakeholder involvement are in place. Annual reporting processes generally have a time lag (e.g., results from one year are not distributed until early the following year). To the extent that data analyses can be completed in advance of finalization of annual reports, any issues that arise should be communicated as soon as they are detected. For some cases (e.g., elevated TSS during dike construction), problems can be detected within a day or two and can be communicated to regulatory agencies immediately.

Table 4-2. Example template for summarizing results of monitoring under each program.

Variable Type & Variable group	Magnitude[1]	Spatial Scale[2]	Causation[3]	Permanence[4]	Uncertainty[5]	Comments	Management Action[6]
Sediment Chemistry – total metals	0	n/a	n/a	Moderate	??		0
Benthic Invertebrates – total abundance	1	Small	Moderate	Moderate	?		1
…							

Notes

[1] Magnitude Ratings:
- 0 – no exceedances of early warning triggers or thresholds (or no apparent changes from baseline of concern)
- 1 – early warning trigger exceeded (or change from baseline warranting concern)
- 2 – threshold exceeded (or change from baseline exceeding magnitude of concern)

[2] Spatial Scale Ratings:
- n/a – no magnitude of effect, therefore not evaluated
- Small – localized scale
- Moderate – sub-basin to basin scale
- Large – basin to whole lake scale

[3] Causation Ratings:
- n/a – no magnitude of effect, therefore not evaluated
- Low – no evidence for a mine-related source
- Moderate – some likelihood of a mine-related source
- High – the source of the problem is very likely to be mine-related

[4] Permanence Ratings:
- n/a – no magnitude of effect, therefore not evaluated
- Low – rapidly reversible (e.g., months to years)
- Moderate – slowly reversible (e.g., years to decades)
- High – largely irreversible (e.g., decades +)

[5] Uncertainty Ratings:
- ? – low uncertainty
- ?? – moderate uncertainty
- ??? – high uncertainty

[6] Management Actions:
- 0 – no action
- 1 – continued trend monitoring in following year
- 2 – active follow-up with more detailed quantitative assessment in following year

Table 4-3. Example / template summary of exceedances of triggers and thresholds for key AEMP monitoring variables.

	AEMP Program[1,2]													
	Core Receiving Environment Monitoring Program	Mercury Monitoring Program	Targeted Effects Assessment Studies	Dike Construction Monitoring	Habitat Compensation Monitoring Program	Dewatering Monitoring	Groundwater Monitoring	MMER Monitoring	Water Quality and Flow Monitoring	Fish-Out Studies	AWAR/WTHR and Quarry Water Quality Montoring	Blasting	Air quality monitoring	Pore Water Quality Monitoring
Stressor Variables														
suspended solids	●	NA	●	●	NA	●	NA	○	○	○	◐	NA	NA	NA
sediment deposition														
water-borne toxicants														
sediment toxicants														
nutrients														
other physical stressors														
Effects Variables														
Phytoplankton														
Zooplankton														
Fish														
Benthic invertebrate community														
Periphyton														
Fish habitat														

Notes:

[1] Maximum values from each program are used.

[2] Codes for exceedances of triggers and thresholds:

○ No observed effects

◐ Trigger or guideline exceedance - early warning, explained in report

● Observed effects, explained in report

Table 4-4. Example template for integrated evaluation of monitoring results across all programs for a monitoring variable or group of variables[1].

Program	Magnitude[2]	Spatial Scale[2]	Causation[2]	Permanence[2]	Uncertainty[2]	Comments
EAS and CREMP	2	Large	High	Low	?	
Dike Construction						
INTEGRATED SUMMARY:						

Notes
[1] The table would be tailored to the relevant media and programs for each variable.
[2] See **Table 4-2** for all ratings.

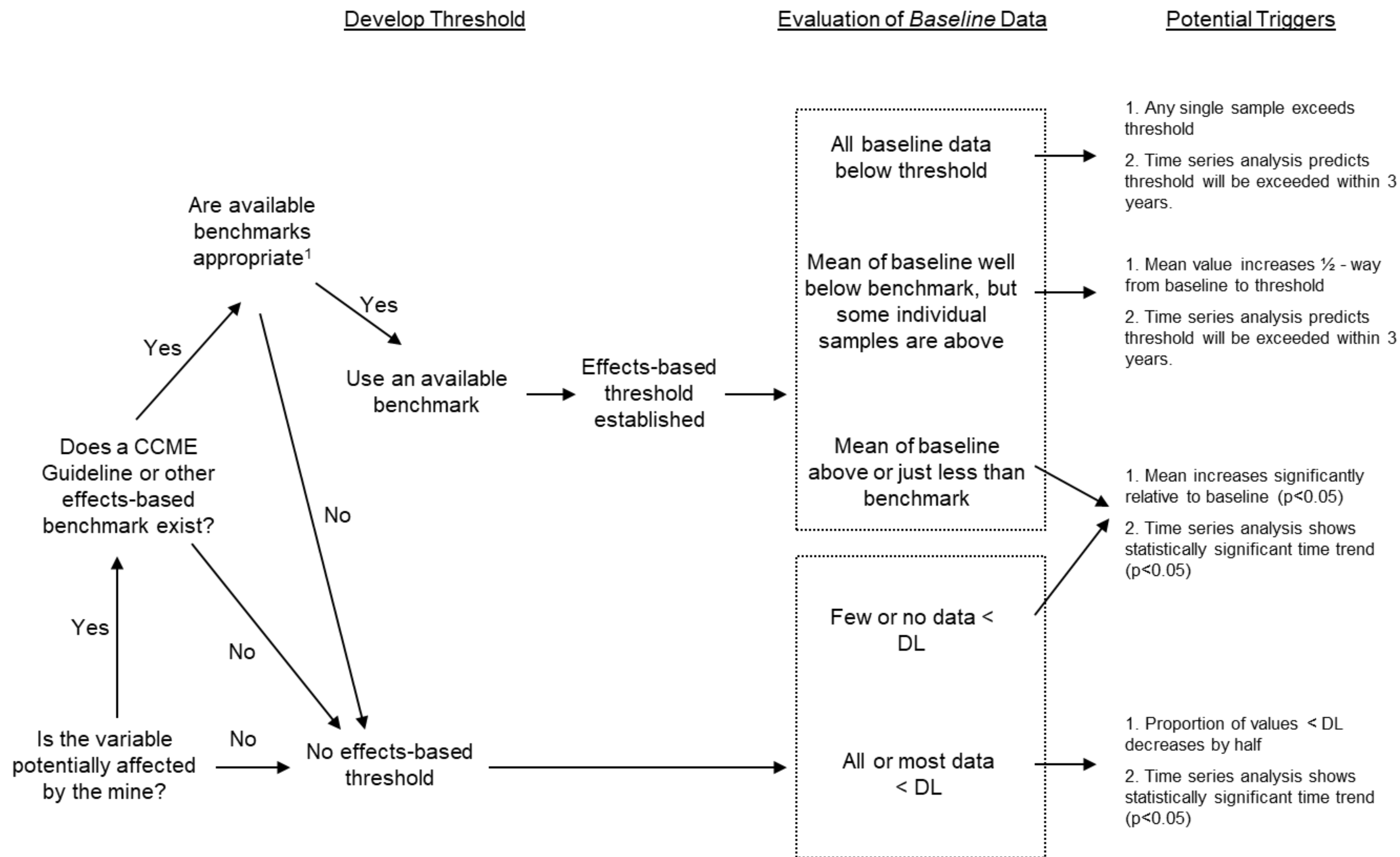
Table 4-5. Toolbox of some potential receiving environment assessment methods.

Type of Variable Triggered	Potential Assessment Options
Sediment – Contamination	• Bioavailability studies (e.g., AVS-SEM for selected metals or sequential extraction methods) • Bulk sediment toxicity tests for invertebrates • Porewater toxicity tests (e.g., if transport is via groundwater) • Benthic invertebrate abundance / diversity • Development of site-specific sediment quality objectives (if not already done)
Sediment – Deposition of Particulate Matter	• Sediment traps to measure exposure • Literature review and analysis to evaluate likely effect of deposition • Bulk sediment toxicity tests for invertebrates • Benthic invertebrate abundance / diversity • In situ or ex situ experimental testing of effects of different deposition rates of particulate matter
Water – Contamination	• Bioavailability studies (e.g., Biotic Ligand Model for some metals) • Water column toxicity tests for fish and invertebrates • Benthic invertebrate abundance / diversity • In situ or ex situ experimental testing of effects of different contaminant concentrations on receptors • Development of site-specific water quality objectives (if not already done)
Water – Suspended Solids	• Water column toxicity tests for fish and invertebrates • In situ or ex situ experimental testing of effects of different concentrations of suspended solids on receptors
Water – Decrease in measures of productivity	• Literature review and modeling to evaluate likely effect on fish populations
Effects variables (direct measures of zooplankton, benthos, fish, etc.)	• More intensive study to characterize the magnitude of effects, spatial extent, and likely causes (e.g., through evaluation of spatial gradients).

Table 4-6. Toolbox of some potential mitigation options.

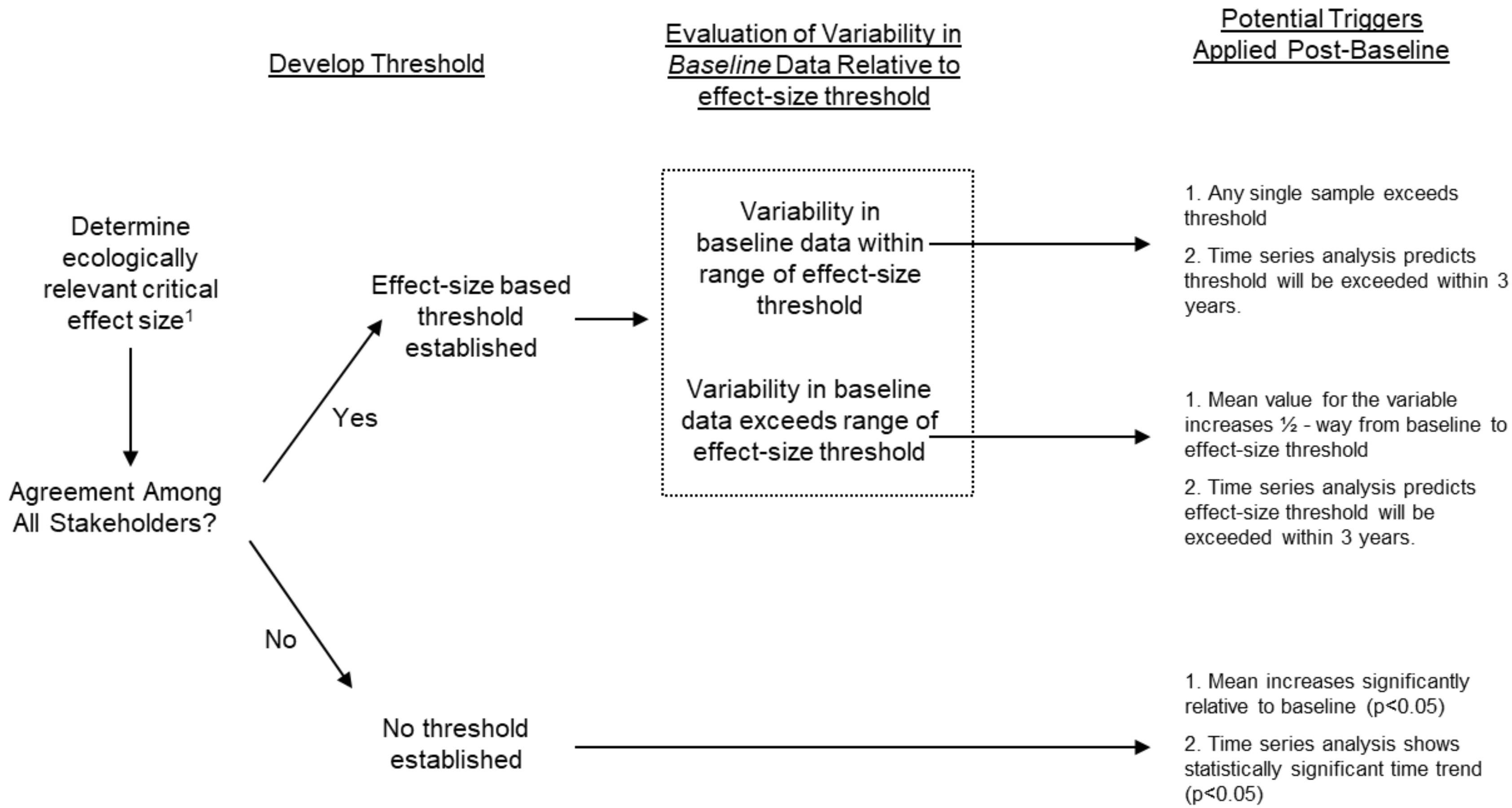
Cause of Potential or Known Effect	Potential Mitigation Options
Dike Construction	• Modification of use of turbidity barriers (e.g., use more than one barrier, lower barrier to bottom) • Change material used to construct dike • Modify methods of placing dike construction materials • Slow placement rate • Construct causeway prior to open water season
Dike Materials (e.g., leaching of metals)	• Cover with other material types
Groundwater	• Identify and cut-off pathway from source to groundwater • Cut off pathway from groundwater to receiving environment • Treat groundwater
Effluent and Discharges	• Increase settling times prior to discharge • Treat effluent prior to discharge • Adjust effluent treatment methods
Dust	• Increase intensity of dust suppression measures (e.g., water trucks) • Change materials used as top layer for exposed surfaces • Use wind breaks in key places

Figure 4-3. Derivation of thresholds and potential triggers for exposure variables.



[1] Considering acceptable effect sizes and site-specific information on receptors and exposure pathways.

Figure 4-4. Derivation of thresholds and potential triggers for effects variables.



[1] Based on risk assessment policy, protection levels inherent in Canadian (e.g., CCME) environmental quality guidelines, and/or information in the Environmental Assessment.

Figure 4-5. Example of an issue-specific conceptual site model for the 2008 sedimentation event during East Dike construction.

Source	Stressor	Transport Pathways	Exposure Media	Effects Measures
Dike Construction	Sediment	Direct Deposition of Dike Construction; Resuspension of Bottom Sediments; Settlement of TSS		

Exposure Media

Medium /Stressor	Narrative	Magnitude	Spatial	Link to Source
Water				
TSS	TSS increased to 10 to 15 mg/L across most of SP basin and 5 to 10 mg/L in TE basin.	T-TT	B+	Strong
Metals	While total metals exceeded CCME guidelines, dissolved metals generally did not.	T-	B	Strong
Nutrients	As above.	T-	B	Strong
Sediments				
Deposition	Higher closer to the dike, but some across most of the SP basin.	1-2mm	B to B-	Strong
Metals	Higher at SP (and to a lessor degree TE) in 2009 relative to 2008 and two reference areas.	to +35%	B	Strong

Effects Measures

Medium-Zone	Narrative	Magnitude	Spatial	Link to Stressor
Water - Pelagic				
Primary Production •Chlorophyll-α •Phyto biomass •Phyto taxonomy	Biomass reduced in exposure areas in 2008, but to a much lower degree two weeks later.	SD	B to B-	Strong to TSS
SecondaryProduction •Zoop biomass •Zoop taxonomy •Zoop Lethal Tox •Zoop Sublethal Tox	No effects in field measurements or lab tests.	None	None	NA
Fish •Lethal Juv. tox •Sublethal larval tox. •Sublethal embryo tox. (with renewal)	No effects.	None	None	NA
Sediment - Benthic				
Primary Production •Periphyton biomass •Sediment in mats	Biomass reduced in shallow exposure areas close to the East Dike; mat sediment inversely related to biomass.	SD	B-	Strong to TSS
Secondary Production •Benthic community abundance/richness	No effects in field measurements or lab tests.	None	None	None
Fish/Fish Habitat				
Fish Habitat •Underwater video	Higher sediment loads seen in areas close to the East Dike.	Qual	B-	Strong to TSS
Fish •Sublethal embryo tox. (no renewal of overlying water)	Minor impairment of embro development possible through settlement.	SD	B-	Strong to TSS

Notes:

Magnitudes
- T- Exceeds relevant threshold due to particulate form.
- T- Exceeds relevant threshold.
- TT Grossly exceeds relevant threshold.
- SD Statistically significant difference
- Qual Qualitative assessment

Spatial Extent
- B- scale less than lake basin
- B basin-wide
- B+ extending beyond a basin

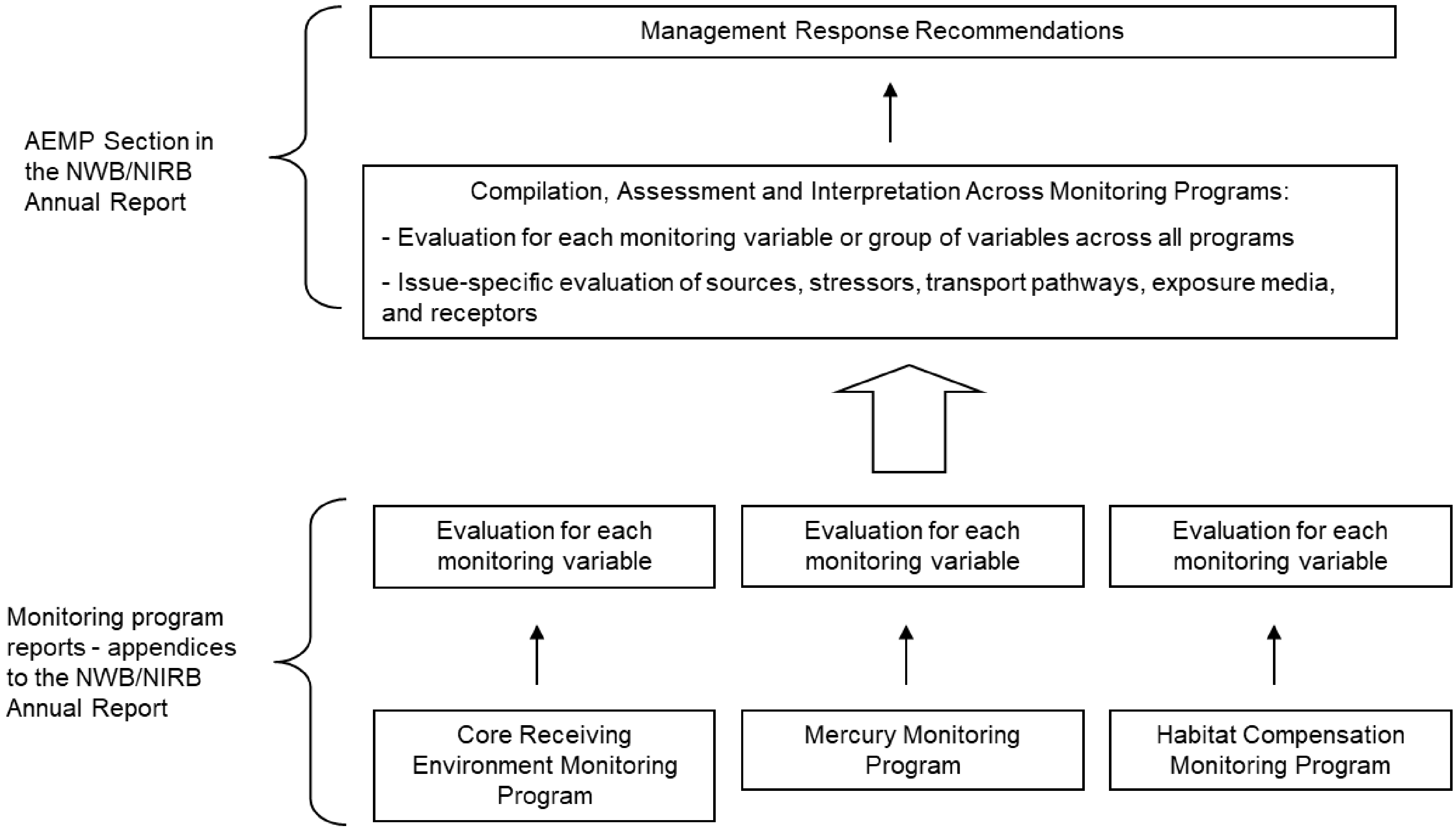
5 STRUCTURE AND CONTENT OF THE ANNUAL AEMP REPORTS

Following the process outlined in **Section 4.3.1**, the annual AEMP report would integrate the key findings from all of the component programs, conduct a meta-analysis of findings across the programs (i.e., through development of issue-specific conceptual site models), and develop corresponding recommendations for management response actions for each key issue. The specific monitoring program annual reports would still be published as stand-alone documents. Under this framework, the structure of the annual AEMP report would be as follows:

1. Introduction
2. Summary of AEMP-related programs with a focus on key findings.
3. Compilation and integration of results across all programs.
4. Discussion and assessment of key issues.
5. Recommendations, including (a) suggested revisions to the design of each monitoring program and (b) management response actions for each key issue.

This reporting process is depicted in **Figure 5-1**.

Figure 5-1. AEMP Reporting Process.



6 REFERENCES

Agnico Eagle. 2021. Whale Tail Pit Expansion Project – Adaptive Management Plan. Report prepared by Agnico Eagle Mines Limited – Meadowbank Division. July, 2021.

Azimuth. 2022. Core Receiving Environment Monitoring Program (CREMP) 2021, Meadowbank Complex. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2012a. Core Receiving Environment Monitoring Program (CREMP): Design Document 2012. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico Eagle Mines Ltd., Baker Lake, NU.

Azimuth 2012b. Aquatic Effects Management Program (AEMP) – Targeted Study: Dike Construction TSS Effects Assessment Study 2011, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2010a. Federal Contaminated Sites Action Plan (FCSAP) – Ecological Risk Assessment Guidance. Draft report prepared for Environment Canada, March 2010.

Azimuth. 2010b. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction TSS Effects Assessment Study 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010c. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction Monitoring 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010d. Aquatic Effects Monitoring Program – Core Receiving Environment Monitoring Program 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010e. Aquatic Effects Monitoring Program – Habitat Compensation Monitoring 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2005a. Aquatic Effects Management Program (AEMP). Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Cumberland Resources Ltd., Vancouver BC. January 2005.

Azimuth. 2005b. Baseline Aquatic Ecosystem Report (BAER). A report prepared by Azimuth Consulting Group, Vancouver for Cumberland Resources Ltd. October, 2005.

Azimuth. 2005c. Aquatic Ecosystem/Fish Habitat Impact Assessment (AEIA). Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Cumberland Resources Ltd. (now AEM). October 2005.

Cott PA, Hanna BW. 2005. Monitoring explosive-based winter seismic exploration in waterbodies, NWT 2000-2002. In Environmental Effects Monitoring – Approaches and Technologies, edited by SL Arnsworthy, PJ Cranford, and K Lee. Battele Press, Columbus, Ohio

Diavik Diamond Mines Inc. (Diavik). 2007a. Adaptive management plan for aquatic effects. August 2007.

Diavik. 2007b. AEMP design document. December 2007.

Gelman, A., and J. Hill. 2006. Data Analysis Using Regression and Multilevel/Hierarchal Models. Cambridge University Press.

Golder Associates Ltd. 2019. Whale Tail Pit Expansion Project. Mine Site and Downstream Receiving Water Quality Predictions. Report Submitted to Agnico Eagle Mines Ltd, Meadowbank Division, May 2019.

Greig, L., D. Marmorek and C. Murray. 2008. Guidelines for preparation of adaptive management plans. Prepared by ESSA Technologies Ltd, Richmond Hill, Ontario, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife.

Hewitt, J.E., S.E. Thrush and V.J. Cummings. 2001. Assessing environmental impacts: effects of spatial and temporal variability at likely impact scales. Ecological Applications 11(5): 1502-1516.

Hull, R.N., and S. Swanson. 2006. Sequential analysis of lines of evidence – an advanced weight of evidence approach for ecological risk assessment. Integrated Environmental Assessment and Management 2(4): 302-311.

INAC (Indian and Northern Affairs Canada). 2009a. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the northwest territories: Volume 3 – Recommended procedures for developing data quality objectives and a conceptual study design. Report prepared by D.D. Macdonald, B. Zajdlik and INAC Water Resources, June 2009.

INAC (Indian and Northern Affairs Canada). 2009b. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the northwest territories: overview report. Report prepared by D.D. Macdonald, B. Zajdlik and INAC Water Resources, June 2009.

Murray, C., and M. Nelitz. 2008. Review of Diavik and EKATI adaptive management plans. Prepared by ESSA Technologies Ltd., Vancouver, BC, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife.

Newman, M.C. 2008. "What exactly are you inferring?" A closer look at hypothesis testing. Environmental Toxicology and Chemistry 27(5): 1013-1019.

Pinheiro, J.C., and D.M. Bates. 2000. Mixed-Effects Models in S and S-PLUS. Springer, New York.

Walters, C. 1986. Adaptive Management of Renewable Resources. MacMillan Publishing, New York.

Weins, J.A. and K.R. Parker. 1995. Analyzing the effects of accidental environmental impacts: approaches and assumptions. Ecological Applications 5(4): 1069-1083.

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of Explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.