Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories:

Overview Report

Indian and Northern Affairs Canada
Yellowknife, Northwest Territories

June 2009 Version

Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories

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June 2009; Version 1.0

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Preface

Over the past 10 years, the need for guidance on the development of Aquatic Effects Management Programs (AEMPs) has been identified by numerous participants involved in the water licencing process. In response to this interest, Indian and Northern Affairs Canada (INAC) Northwest Territories Region initiated a three year process to facilitate the development of such AEMP Guidelines. This process included conducting a series of interviews, meetings and workshops to determine the interests and needs of Aboriginal governments/organizations, regulatory boards, federal and territorial governments, and other interested parties. Focussed reviews of Traditional Knowledge (TK)-based and western science-based literature were also undertaken.

This process culminated in the release of draft AEMP Guidelines in the summer of 2008. These draft guidelines described a detailed process for proponents to follow to develop AEMPs that would meet the needs of the interested parties in the NWT. The AEMP Guidelines contained herein (Overview Report) and in the associated Technical Guidance Documents reflect the revisions made to address the comments that were submitted by reviewers. Importantly, these AEMP Guidelines now provide a basis for incorporating TK in an efficient and effective manner, integrating AEMP development activities with those conducted in support of environmental assessments, and harmonizing the requirements for aquatic effects monitoring with those associated with the Environment Canada's Environmental Effects Monitoring (EEM) program. These key revisions are intended to streamline the AEMP development process and ensure that all interests and needs are effectively met.

The AEMP Guidelines describe an eight-step process for designing, documenting, implementing, and interpreting AEMPs that provide an effective basis for determining if sensitive northern aquatic ecosystems are being protected from the effects associated with the construction, operation, and/or closure and reclamation of development projects in the NWT. The framework outlines a flexible process for developing AEMPs that provide opportunities for input by interested parties, including both TK and western science. The framework differs from the EEM program in that it does not identify specific valued ecosystem components that must be addressed or monitoring program elements that must be included. Rather, it recognizes that the environmental assessment and water licencing processes in the NWT are intended to be inclusive and reflective of the interests and needs of the residents. Accordingly, INAC believes that this framework will provide a useful resource to guide AEMP development in the NWT. It is our intention to review these guidelines every two years to ensure that they reflect the most recent and relevant procedures for monitoring aquatic effects in northern ecosystems.

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List of Acronyms

AEMP	-	Aquatic Effects Monitoring Program
CCME	-	Canadian Council of Ministers of the Environment
BACI	-	before and after control impact
BACIP	-	before and after control-impact paired designs
CEAA	-	Canadian Environmental Assessment Act
CI	-	control impact
DQO	-	data quality objective
EEM	-	Environmental Effects Monitoring
EQG	-	environmental quality guideline
EQO	-	environmental quality objective
FSP	-	field sampling plan
GIS	-	geographic information system
GLWB	-	Gwich'in Land and Water Board
HSP	-	health and safety plan
INAC	-	Indian and Northern Affairs Canada
K_{oc}	-	organic carbon partition coefficient
K_{ow}	-	octanol water partition coefficient
LWB	-	the Land and Water Board
MMER	-	Metal Mining Effluent Regulations
MRP	-	Management Response Plan
MVEIRB	-	Mackenzie Valley Environmental Impact Review Board
MVLWB	-	Mackenzie Valley Land and Water Board
MVRMA	-	Mackenzie Valley Resource Management Act
NWTWA	-	Northwest Territories Water Act
NWTWB	-	Northwest Territories Water Board
NWTWR	-	Northwest Territories Water Regulations
NWT	-	Northwest Territories
PPER	-	Pulp and Paper Effluent Regulations
QAPP	-	quality assurance project plan
QA/QC	-	quality assurance/quality control
SLWB	-	Sahtu Land and Water Board
TK	-	Traditional Knowledge
USEPA	-	U.S. Environmental Protection Agency
VEC	-	valued ecosystem component
WLWB	-	We'eezhii Land and Water Board
WQG	-	water quality guideline
WQO	-	water quality objective

Acknowledgements

The Aquatic Effects Monitoring Program (AEMP) Guidelines were developed through the cooperative efforts of many individuals and organizations. More specifically, the first draft of the AEMP Guidelines document were prepared by Michele Culhane and Jeanne Arsenault (Water Resources Division, Indian and Northern Affairs Canada), and Kathy Racher (former manager of (Water Resources Division, Indian and Northern Affairs Canada), in association with Don MacDonald (MacDonald Environmental Sciences Ltd.) and Barry Zajdlik (Zajdlik and Associates Inc.). These authors would like to express their sincere appreciation to a number of individuals who have made significant contributions to the project. First, Terriplan Consultants organized and facilitated several workshops on this topic. Terriplan's Team included Ricki Hurst, Wayne Ingham, Vicki McCullough, David Milburn, and Nathan Towsley. We would also like to thank the following people who provided written comments or other input on the first draft of the AEMP Guidelines: Robin Staples and Juanetta Sanderson (Water Resources Division, Indian and Northern Affairs Canada), Bill Ross (Independent Environmental Monitoring Agency), Rick Walbourne (Sahtu Land and Water Board), Rachel Crapeau (Yellowknives Dene First Nation), Anne Wilson (Environment Canada), Lorraine Sawdon (Fisheries and Oceans Canada), Doug Crossley (Environmental Monitoring Advisory Board), Hilary Machtans (Golder Associates), Gord Macdonald (Diavik), Kathy Racher and Ryan Fequet (Wek'eezhii Land and Water Board), Sheryl Crieve (North Slave Metis Alliance), Laura Tyler (BHP Billiton Diamonds Inc.), and Jason Brennan (Indian and Northern Affairs Canada).

We would also like to thank John McCullum (Environmental Monitoring Advisory Board), Tim Byers and Jaida Ohokannoak (Independent Environmental Monitoring Agency), David White (Snap Lake Environmental Monitoring Agency), and Carole Mills (Water Resources Division, INAC) who, through their participation in an informal working group, have provided significant guidance on the development of the soon to be released Traditional Knowledge "Toolbox"/Guidance Document developed by Brenda Parlee (University of Alberta).

The draft AEMP Guidelines were revised and finalized by Michele Culhane, Nathan Richea, and Carole Mills (Water Resources Division, INAC), in association with Don MacDonald and Barry Zajdlik. Sincerest thanks also to David Livingstone for conceiving and supporting this initiative.

Chapter 1 Introduction and Scope

1.0 Introduction

In the Northwest Territories (NWT), project proponents are often required to develop and implement an Aquatic Effects Monitoring Program (AEMP) under the terms and conditions of Type A water licences. However, specific guidance to assist project proponents in the development of such monitoring programs has not been established. In addition, the role of Traditional Knowledge (TK) and community-based monitoring in the AEMP development and implementation process has not been defined. As a result, project proponents are unclear about the expectations of Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties regarding AEMPs. This problem has lead to the development of a number of AEMPs that do not meet the reviewers' expectations and require substantial efforts on behalf of all parties to resolve differences regarding the scope and design of the AEMPs.

In recognition of the need for consistent guidance on the development of AEMPs, Indian and Northern Affairs Canada (INAC), Northwest Territories Region, initiated an AEMP Guidelines project in 2006 to support the preparation of a guidance document that would provide project proponents with a better understanding of expectations regarding the development and implementation of AEMPs. This project culminated in the development of draft AEMP Guidelines. The draft AEMP Guidelines were distributed for review by Aboriginal governments/organizations, federal and territorial governments, regulatory boards, environmental monitoring agencies, industry, and other interested parties. Additionally, a workshop was convened in October, 2008 to provide reviewers with further opportunity to better understand the draft guidelines, to discuss the role of TK, and provide detailed technical comments. The resultant AEMP Guidelines reflect reviewers' input and are intended to provide the regulatory boards with a consistent basis for articulating expectations regarding the AEMPs that are developed by project proponents.

1.1 Intended Scope of the Aquatic Effects Monitoring Program Guidelines Document

The AEMP Guidelines are intended to provide project proponents clear guidance on the development and implementation of AEMPs in the NWT. More specifically, the AEMP Guidelines are intended to:

- Provide a framework that encompasses current best practices related to monitoring and assessment of aquatic effects of development activities for application in the NWT;
- Establish guiding principles for aquatic effects monitoring in the NWT;
- Establish a framework for designing and implementing effective aquatic effects monitoring programs in the NWT; and,
- Describe the roles of TK and western science in the design and implementation of AEMPs in the NWT.

Although the AEMP Guidelines are focussed on the NWT, the intent is that they could be adapted and applied in Nunavut or Yukon, if the regulatory bodies in these jurisdictions so choose.

1.2 Approach to Development of Aquatic Effects Monitoring Program Guidelines

The approach taken to develop AEMP Guidelines for the NWT consisted of several steps, including:

- Conducting a series of interviews to determine the interests and needs of industry and regulatory agencies relative to AEMPs;
- Convening a technical workshop in April, 2006 to identify best practices in aquatic monitoring (Terriplan Consultants 2006; 2009);

- Convening a series of meetings to determine the interests and needs of Aboriginal governments/organizations, environmental monitoring agencies, federal and territorial governments, and regulatory boards relative to AEMPs;
- Conducting focussed reviews of the scientific literature on aquatic effects monitoring;
- Compiling the information obtained during the course of the project into a draft AEMP Guidelines document;
- Convening a workshop in October, 2008 to review the draft AEMP Guidelines and discuss the process for effectively incorporating TK into the AEMP development process (Terriplan 2009);
- Conducting focussed reviews of the literature on TK and identifying relevant approaches for addressing the needs of Aboriginal governments/organizations and TK holders in the AEMP development process; and,
- Incorporating reviewer's comments and finalizing the AEMP Guidelines document.

This approach to AEMP Guidelines development was taken to reflect the unique environment management process that exists in the NWT. By design, the environmental management process is intended to be inclusive and reflect the interests and needs of the residents. As a result, AEMP Guidelines that prescribe the selection of specific monitoring program elements, or valued ecosystem components (VECs), may not directly respond to the concerns of interested parties. For this reason, the resultant AEMP Guidelines describe a consistent process for addressing the interests and needs of participants in the AEMP development process. This framework is consistent with various other approaches that are in broad application in the fields of environmental assessment, ecological risk assessment, and natural resource damage assessment.

1.3 The Need for Aquatic Effects Monitoring Programs

In the NWT, AEMPs are required to provide the data and information needed to:

- Determine if aquatic ecosystems and their uses are being adequately protected in areas affected by major development projects;
- Determine the short-term and long-term effects on aquatic ecosystems that occur in conjunction with the construction and/or operation of a project;
- Evaluate the accuracy of the predictions that are made in environmental assessments regarding the impacts of a project on aquatic ecosystems, if applicable;
- Assess the efficacy of impact mitigation measures that are used to minimize the effects of the project on aquatic ecosystems; and,
- Identify the need for additional impact mitigation measures to reduce or eliminate project-related effects on aquatic ecosystems (i.e., to be addressed within a management response framework; management response is a new term that will be used by some regulatory boards instead of the term adaptive management. The term Management Response Plan (MRP) is used consistently throughout the AEMP Guidelines to replace the term Adaptive Management Plan).

Typically, AEMPs are needed for all new developments that require a Type A Water Licence. For metal mines, it is important to ensure that AEMPs meet the requirements of Environmental Effects Monitoring (EEM) programs to avoid duplication of effort (see Section 2.5 for more information; Environment Canada 2002; 2004). In addition, AEMPs should provide the data and information needed to support evaluation of the cumulative effects on the aquatic environment that may occur due to the presence of multiple human activities within an area or region. In this context, the data collected in project-specific AEMPs can support regional cumulative effects assessments.

These AEMP Guidelines are intended to assist project proponents in developing AEMPs that are acceptable to Aboriginal governments/organizations, federal and

territorial governments, regulatory boards, and other interested parties. By doing so, these AEMP Guidelines should enable project proponents to develop AEMPs that can be reviewed and approved in a timely and efficient manner by the responsible regulatory board(s).

1.4 Organization of this Report

These AEMP Guidelines provide project proponents and others involved in the monitoring and assessment of northern ecosystems with general guidance on the steps that should be taken to support the development and implementation of AEMPs in the NWT. To provide ready access to this information, this document has been organized into an Overview Report and a series of Technical Guidance Documents, which are intended to provide more detailed information on each step in the AEMP development process. The overview report is organized as follows:

- Introduction and Scope (Chapter 1);
- Water Management in the NWT - The Regulatory Setting (Chapter 2);
- Guiding Principles for Developing and Implementing Aquatic Effects Monitoring Programs in the NWT (Chapter 3);
- Role of Traditional Knowledge in the Development and Implementation of Aquatic Effects Monitoring Programs (Chapter 4);
- Overview of the Recommended Framework for Designing and Implementing Aquatic Effects Monitoring Programs in the NWT (Chapter 5);
- Summary and Conclusions (Chapter 6); and,
- References Cited (Chapter 7).

In addition to the Overview Report, a series of Technical Guidance Documents have been prepared to provide more specific guidance and information on each element of the framework for implementation of AEMPs, as follow:

- Recommended Procedures for Identifying Issues and Concerns Associated with Development Projects: AEMP Technical Guidance Document - Volume 1.
- Recommended Procedures for Developing Problem Formulation to Support the Design of Aquatic Effects Monitoring Programs: AEMP Technical Guidance Document - Volume 2.
- Recommended Procedures for Developing Data Quality Objectives and a Conceptual Study Design: AEMP Technical Guidance Document - Volume 3.
- Recommended Procedures for Developing Detailed Designs for Aquatic Effects Monitoring Programs: AEMP Technical Guidance Document - Volume 4.
- Recommended Procedures for Documenting and Verifying Conceptual and Detailed Designs for Aquatic Effects Monitoring Programs: AEMP Technical Guidance Document - Volume 5.
- Recommended Procedures for Evaluating, Compiling, Analyzing, Interpreting, and Reporting Data and Information Collected Under Aquatic Effects Monitoring Programs: AEMP Technical Guidance Document - Volume 6.

A TK "Toolbox"/Guidance Document is currently being developed to accompany the AEMP Guidelines. It will provide guidance to proponents and interested parties on community consultation and engagement of Aboriginal governments/organizations in the AEMP development process. Specific protocols and reference documents, including a review of TK-based literature are also included. Adequate consultation and engagement is the first step towards integrating TK into project-specific AEMPs. This new "Toolbox"/Guidance Document will be released as a draft for review (summer 2009) since it has not yet been reviewed by Aboriginal governments/organizations and interested parties.

Chapter 2 Water Management in the Northwest Territories - The Regulatory Setting

2.0 Introduction

The responsibility for conserving the water resources of the Northwest Territories (NWT), while facilitating the development and utilization of renewable and non-renewable resources, is shared between Indian and Northern Affairs Canada (INAC) and a number of public regulatory boards. Effective integration of land use planning, environmental assessment, water licencing, and land use permitting is intended to provide a basis for effective co-management of lands and waters within the NWT. This chapter briefly describes the existing water management processes under the *Northwest Territories Waters Act* (NWTWA) and the *Mackenzie Valley Resource Management Act* (MVRMA), and discusses how they are linked to the AEMP Guidelines.

2.1 Water Management Under the *Northwest Territories Waters Act*

On June 23, 1992, the NWTWA was proclaimed by the Government of Canada to support water management in the NWT. This Act established a legal and administrative framework for water use and waste disposal. The NWTWA also established the Northwest Territories Water Board (NWTWB) to provide for the conservation, development, and utilization of territorial waters in a manner that would provide the optimum benefit for all Canadians and for the residents of the NWT.

Until the MVRMA was proclaimed in 1998, the NWTWB issued all water licences for the NWT. Since the MVRMA was enacted, the NWTWB only issues water licences in the Inuvialuit Settlement Region of the NWT. The NWTWB fulfills the requirements of the NWTWA and the *Northwest Territories Water Regulations* (NWTWR) through the issuance of water licences, which include terms and

conditions for use of water and/or deposition of waste into receiving waters. The terms and conditions are intended to ensure that the use of waters and/or the deposit of waste proposed by an applicant will not adversely affect the use of waters within or outside the water management area.

A Type A water licence is required for activities of broad scope, having significant potential for adversely affecting human health or the environment, and/or requiring substantial volumes of water. Type B water licences are required for activities of generally limited scope, which tend to have less potential for adversely affecting human health or the environment. All development projects that require water licences undergo preliminary screenings by the NWTWB. The screening includes a detailed review of the water licence application and determines whether a project must proceed to an environmental assessment (see Section 2.1.1) or go directly into the regulatory phase. All Type A water licences issued by the NWTWB must be approved by the Minister of INAC. Inspectors employed by INAC are responsible for enforcing the provisions of the NWTWA and NWTWR. For a detailed flow chart of the steps to be followed for under the regulatory phase please see http://www.nwtwb.ca and www.nwtboardforum.com.

2.1.1 Environmental Assessment in the Inuvialuit Settlement Region

All prospective development projects are evaluated through screening processes to assess their potential impacts on human health and the environment. In the Inuvialuit Settlement Region, the screening process is shared between the NWTWB [under the *Canadian Environmental Assessment Act* (CEAA)] and the Environmental Impact Screening Committee (under the Inuvialuit Final Agreement). Under the Inuvialuit Final Agreement, the Environmental Impact Review Board is responsible for the environmental impact assessment process. Under CEAA, the Canadian Environmental Assessment Agency is responsible for this process. If a water licence application is referred to environmental assessment, the project will typically undergo one assessment that meets the needs of both the Inuvialuit Final Agreement and CEAA processes. The Minister of INAC is responsible for approving the environmental assessment report. Following approval, the project then proceeds to

the regulatory phase, lead by the NWTWB. For more detailed information see www.jointsecretariat.ca/eisc.html or www.nwtboardforum.com).

2.2 Water Management Under the *Mackenzie Valley Resource Management Act*

On December 22, 1998, the MVRMA was proclaimed, creating an integrated co-management structure for public and private lands throughout the Mackenzie Valley, an area that includes the entire NWT with the exception of the Inuvialuit Settlement Region and Wood Buffalo National Park (INAC 2001). A number of public boards were established under the MVRMA, including:

- Mackenzie Valley Land and Water Board (MVLWB);
- Mackenzie Valley Environmental Impact Review Board (MVEIRB);
- Gwich'in Land and Water Board (GLWB);
- Gwich'in Land Use Planning Board;
- Sahtu Land and Water Board (SLWB);
- Sahtu Land Use Planning Board; and,
- Wek'eezhii Land and Water Board (WLWB).

These boards were established to prepare regional land use plans to guide developmental activities; to carry out environmental assessment and reviews of proposed projects in the Mackenzie Valley; and, to regulate the use of land and water (INAC 2001). The MVRMA also includes provisions for monitoring cumulative impacts on the environment and for conducting independent environmental audits.

The MVLWB, GLWB, SLWB, and WLWB are responsible for regulating the use of land and waters and the deposit of waste, so as to provide for the conservation, development, and utilization of land and water resources in a manner that will provide the optimum benefit to all Canadians and, in particular, to residents of the Mackenzie

Valley. The MVLWB fulfills this mandate by issuing land use permits and water licences on land in unsettled claim areas within the Mackenzie Valley. In contrast, the regional land and water boards, including the GLWB, SLWB, and the WLWB are responsible for issuing land use permits and water licences in their respective settled land claim areas on public and private land. The MVLWB processes land use and water licence applications for transboundary projects. The only completed land use plan in the NWT is for the Gwich'in Settlement Area. Any land use or water licence application that applies to this area has to conform with the existing land use plan prior to the preliminary screening and the public review process. The GLWB evaluates conformity with the land use plan.

Again, Type A water licences are required for activities of broad scope, having significant potential for adversely affecting human health or the environment, and/or requiring substantial volumes of water. Type B water licences are required for activities of generally limited scope, having less potential for adversely affecting human health or the environment. All development projects that require licences undergo preliminary screenings by the responsible regulatory board. The screening determines if the project must proceed to an environmental assessment (see Section 2.2.1) or go directly into the regulatory phase, which includes a detailed review of the water licence application.

The NWTWA and NWTWR form part of the legal and administrative framework that was established for managing land and water use under the MVRMA (see Section 2.1 for more detail). As with the NWTWB, the Minister of INAC is responsible for approving all Type A water licences. Inspectors employed by INAC are responsible for enforcing the provisions of the NWTWA, NWTWR, and MVRMA. For more details on the regulatory phase see www.nwtboardforum.com, www.mvlwb.ca, www.glwb.com, www.wlwb.ca, and/or www.slwb.com.

2.2.1 Environmental Assessment in the Mackenzie Valley

In the Mackenzie Valley, the Mackenzie Valley Environmental Impact Review Board (MVEIRB) is responsible for the environmental impact assessment process. If a

water licence application is referred to MVEIRB following the preliminary screening process, the project will undergo either an environmental assessment or an environmental impact review. The Minister of INAC is responsible for approving the environmental assessment report. Following approval, the project then proceeds to the regulatory phase, lead by the respective LWB. For more detailed information, see www.mveirb.nt.ca or www.nwtboardforum.com.

2.3 Interests and Needs Relative to the Water Management Process in the Northwest Territories - Public Consultation

Consultation is paramount under both the NWTWA and the MVRMA. Accordingly, extensive public consultation is undertaken in the NWT as evidenced by opportunities to:

- Request further information on water licence applications;
- Participate in technical sessions to identify issues and concerns regarding applications;
- Intervene at public hearings convened by the regulatory boards;
- Participate on technical committees struck to provide the regulatory boards with input on water licence terms and conditions; and,
- Comment on draft water licences.

Input provided during various consultative processes indicates that participants often have similar interests and needs. For example, testimony provided at the public hearings that were convened to support licencing of the three diamond mines in the NWT indicated that virtually all participants recognized that northern ecosystems represent unique aquatic resources that must be protected and conserved for future generations. This consistent input emphasizes the need for appropriate and thorough consultation with Aboriginal governments/organizations at the early stages of the regulatory process to provide communities with an understanding of a project and the proponent with an understanding of the interests and needs of the communities. Such

consultation must be based on the principal of mutual respect and consider the capacity of interested parties. This ultimately leads to relationship building in affected communities that will be mutually beneficial for all parties.

2.4 Need for Aquatic Effects Monitoring to Support the Water Management Process in the Northwest Territories

Data and information on the characteristics of aquatic ecosystems is required to support water resources management in the NWT. More specifically, information on the physical, chemical, and biological conditions of aquatic ecosystems is required to identify land uses that are compatible with the goal of protecting and conserving the unique characteristics of NWT's various watersheds. Aboriginal governments/organizations and other interested parties need to be engaged in this process to ensure that their interests and needs are understood and respected. In addition, baseline data on the physical, chemical, and biological conditions of a water body (including TK and western science) is needed to accurately predict the potential effects of a land or water use development in that watershed. Furthermore, monitoring data need to be collected during project construction, operation, and closure and reclamation to evaluate the actual effects of the project on the aquatic ecosystem and to evaluate the need for further mitigation.

Aquatic effects monitoring encompasses an array of activities designed to provide information on the physical, chemical, and biological characteristics of a receiving water system. These activities typically involve the design and implementation of ongoing monitoring programs to support water quality management. In addition, special one-time or limited-duration surveys (e.g., Special Effects Studies) may also be conducted to provide additional information for predicting and/or assessing project-related effects. Data and information (TK and western science based) provide a basis for evaluating effects development activities have on the natural physical, chemical, and/or biological characteristics of a waterbody and water management area. This information can ultimately be used to refine the management of the facility to mitigate effects and/or refine the tools that are being used to regulate the project

within a management response framework (see Section 1.3). In this way, aquatic effects monitoring provides the data and information needed to make informed decisions regarding the current and future uses of aquatic ecosystems (Ward *et al.*1986; Kilgour *et al.* 2006).

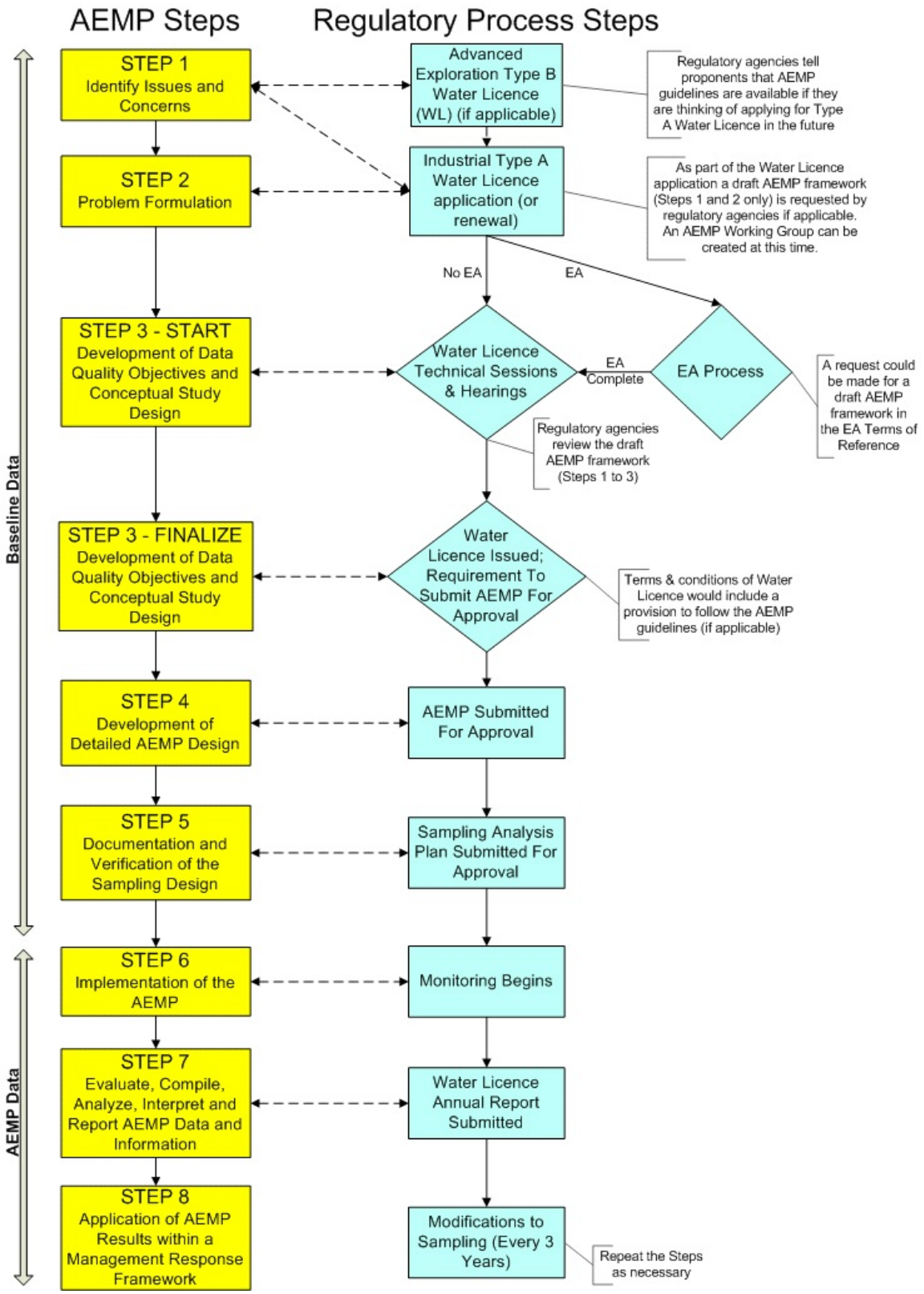
The AEMP Guidelines have been developed to ensure consistency with existing regulatory processes in the NWT. Importantly, a step-wise process has been recommended to align the AEMP Guidelines with the typical regulatory process for major developments in the NWT. Figure 1 demonstrates the linkages between the AEMP development process and the various phases of water licencing (i.e., application through to issuance, including environmental assessment). The AEMP Framework steps are defined in Chapter 5.

2.5 Harmonization of AEMPs and Environmental Effects Monitoring Programs

In Canada, effluent discharges from metal mines and pulp mills are regulated under the *Metal Mining Effluent Regulations* (MMER) and the *Pulp and Paper Effluent Regulations* (PPER), respectively. These regulations include discharge limits that provide national minimum standards that are intended to protect fish, fish habitat, and the use of fisheries resources. When these regulations were developed, there was uncertainty about the effectiveness of the discharge limits in terms of protecting receiving waters across the country. For this reason, EEM was included as a requirement for both the MMER and PPERs to evaluate the adequacy of the end-of-pipe regulations for effluent discharges.

The EEM Programs are intended to provide the information needed to evaluate the effects of effluent discharges from metal mines and pulp mills on fish, fish habitat, and the uses of fisheries resources. Such programs consist of effluent, water quality, and biological monitoring. Effluent quality is evaluated through sub-lethal toxicity testing. Effluent characterization and water quality monitoring studies are required for metal mines. Biological monitoring consists of evaluating responses of adult fish

Figure 1. AEMP steps in the context of the regulatory process in the NWT.



and benthic invertebrates exposed to effluent compared with those for unexposed adult fish and benthic invertebrates. The levels of bioaccumulative contaminants are measured in fish tissue and fish tainting studies are conducted to evaluate effects on the uses of fisheries resources. These data are collected at the same locations at various time intervals (monitoring intervals vary depending on results and the variable being monitored. See the MMR and PPER for specific requirements) to support evaluations of spatial and/or temporal trends in response to effluent discharges from regulated facilities.

As EEM is currently required for metal mines and pulp mills, harmonization of AEMPs and EEM programs will be necessary for some projects in the NWT. However, if EEM is extended to additional types of activities in the future (e.g., diamond mines), interest in developing monitoring programs that satisfy the needs of both programs will continue to increase. The following list highlights some of the factors that need to be considered during the design of AEMPs that will provide the data and information needed to satisfy the requirements of EEM:

- The requirements of EEM are established under the MMER and PPER. These monitoring program elements can, therefore, be considered to represent the minimum requirements for projects that require both EEM and AEMPs;
- The requirements of AEMPs are not prescribed in the AEMP Guidelines. Rather, the AEMP Guidelines describe a process that ought to be followed to facilitate development of a monitoring program that will meet the requirements of the applicable regulatory board and the expectations of interested parties. AEMPs and EEM programs can be effectively integrated when participants in the AEMP development process carefully consider EEM requirements while identifying measurement endpoints, monitoring locations, sampling timing and frequency, sampling methods, and other elements of the AEMP. In many cases, the data generated using a well-designed AEMP will satisfy the requirements of both programs; and,

- Critical effects sizes for EEM programs are specified in the MMER and PPER. In contrast, critical effects sizes are developed during the environmental assessment and/or data quality objectives process for the AEMP (see Section 5.1.3). While critical effect sizes may differ between the EEM programs and AEMP, such differences do not reduce the applicability of the underlying data in the two programs.

In summary, both EEM programs and AEMPs may be required for certain projects in the NWT. Harmonization between these two programs for individual projects can be achieved by adopting the EEM requirements as the core elements of the AEMP. Any additional monitoring required to meet the needs of the applicable regulatory board and the expectations of interested parties would be incorporated into the AEMP design and the resultant data used to meet the specific needs for aquatic effects monitoring. In this way, the requirements of both programs can be met on a cost-effective basis.

Chapter 3 Guiding Principles for Developing and Implementing Aquatic Effects Monitoring Programs in the Northwest Territories

3.0 Introduction

In April 2006, Indian and Northern Affairs Canada convened a workshop to support the formulation of guidelines for developing and implementing AEMPs in the NWT. As part of the pre-workshop preparations, a series of interviews were conducted with interested parties on the northern monitoring and assessment process (Terriplan Consultants 2006). The results of these interviews provide salient information for defining the role of AEMPs in water management and for establishing guiding principles for the development and implementation of AEMPs in the NWT (see Appendix 1 for more information).

3.1 Objectives of Aquatic Effects Monitoring Programs in the Northwest Territories

AEMPs are designed and implemented as a requirement of the water licencing process for projects that are anticipated to have adverse effects on aquatic ecosystems in the NWT. More specifically, AEMPs are required to provide the data and information needed to:

- Determine if aquatic ecosystems and their uses are being adequately protected in areas affected by developmental activities;
- Determine the short-term and long-term effects on aquatic ecosystems that occur in conjunction with the construction and/or operation of a project;
- Evaluate the accuracy of the predictions that are made in environmental assessments regarding the impacts of a project on aquatic ecosystems, as applicable;

- Assess the efficacy of impact mitigation measures that are used to minimize the effects of the project on aquatic ecosystems; and,
- Identify the need for additional impact mitigation measures to reduce or eliminate project-related effects on aquatic ecosystems (i.e., to be addressed within a management response framework).

In addition to these primary objectives, AEMPs should also provide the data and information needed to evaluate the cumulative effects on aquatic ecosystems that may occur due to the presence of multiple human activities within an area or region. In this context, project-specific data generated by AEMPs can support regional cumulative effects assessments.

3.2 Guiding Principles for Aquatic Effects Monitoring Programs in the Northwest Territories

To support determination of expectations and best practices related to baseline and aquatic effects monitoring, a series of interviews were conducted with representatives of selected Aboriginal governments/organizations, federal and territorial governments, regulators, monitoring agencies, consulting firms, and industry (Terriplan Consultants 2006). As part of this survey, respondents were asked to identify a series of principles that could be used to guide the development of AEMPs. This focussed input was reviewed and utilized to establish the following guiding principles for developing and implementing AEMPs in the NWT:

- AEMPs must be developed in a rigorous and scientifically-defensible manner, incorporating both TK and western science;
- AEMPs must have clearly-defined objectives that are used to guide the design of the monitoring program;
- AEMPs must be designed to determine the short- and long-term effects on human health and aquatic ecosystems associated with project-related activities;

- AEMPs must provide an effective basis for early detection of changes in aquatic environmental quality and project-related effects;
- AEMPs must be designed to provide a basis to distinguishing between random variability and project-related effects in aquatic ecosystems;
- AEMPs must be designed to provide the data and information needed to assess the effectiveness of impact mitigation measures and to identify the need for additional impact mitigation measures to reduce or eliminate adverse effects on human health or aquatic ecosystems;
- AEMPs must be designed to consider the potential effects of the project on the physical, chemical, and biological characteristics of aquatic ecosystems, including water quality, water quantity, sediment quality, biological health and integrity, and human health;
- The AEMP development process should be initiated prior to collecting baseline data to ensure comparability between baseline and AEMP-generated data (i.e., to facilitate before-after comparisons of the resultant data);
- The evaluation and selection of reference areas should be considered to be an integral component of the overall AEMP design process (i.e., to facilitate control-impact comparisons of the resultant data);
- AEMPs must be designed to provide data that contribute directly to a broader regional cumulative effects monitoring programs;
- AEMPs must be designed and implemented in a manner that facilitates the use of the associated results to support effective adaptive management of the project, such that the nature, magnitude, duration, and spatial extent of any effects that occur are minimized and do not exceed those identified in the environmental assessment. Any significant changes to the project should trigger a review of the AEMP;
- Consultation must occur throughout the AEMP development and implementation process to ensure that the interests and needs of Aboriginal governments/organizations, territorial and federal governments, regulatory boards, non-governmental organizations, and other interested parties are

understood and appropriately addressed. Such consultation must be based on the principal of mutual respect, consider the capacity of interested parties, and ensure that the resources needed for meaningful participation are provided;

- The implementation of AEMPs must be guided by detailed sampling and analysis plans which include detailed field sampling plans (FSPs), quality assurance project plans (QAPPs), and health and safety plans (HSPs; collectively referred to as sampling and analysis plans);
- The data and information that are generated under AEMPs must be evaluated, compiled, and managed in a manner that assures their quality and their accessibility by the proponent, Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties;
- The results of AEMPs must be disseminated in a timely manner, in formats that are readily understood by communities, regulators, and scientists; and
- Guidelines and requirements for researchers under the Scientists Act should be considered in the development and implementation of AEMPs.

These principles provide general guidance for the development and implementation of AEMPs in the NWT. More specifically, these guiding principles articulate the areas of agreement among interested parties on how AEMPs should be developed and implemented in the NWT. As such, AEMPs that are developed in accordance with these guiding principles are likely to be generally acceptable, thereby enhancing the prospects for timely review and approval of the AEMP by all of the parties involved in the process.

Chapter 4 Role of Traditional Knowledge in the Development and Implementation of Aquatic Effects Monitoring Programs in the Northwest Territories

4.0 Introduction

Traditional knowledge is generally defined as the knowledge acquired by indigenous or local peoples through generations of direct contact with the environment. According to the Mackenzie Valley Environmental Impact Review Board (MVEIRB 2005), there are three important elements of TK that contribute to our understanding of the environment. First, TK provides factual knowledge about the environment that is based on direct observation and experience, shared information within the community, and an oral history spanning multiple generations. Such factual knowledge includes specific observations, patterns of biophysical, social, and cultural phenomena, inferences relative to cause and effect, and predictions of the impacts of human activities. Second, TK provides essential information on the use and management of the environment. In this context, TK enhances our understanding of cultural practices and social activities, land use patterns, archeological sites, harvesting practices, and harvesting levels, both now and in the past. Furthermore, TK provides information on the values that people place on the environment (MVEIRB 2005).

Many project proponents have expressed an interest in better understanding how to integrate TK into the AEMP development process. It is essential to understand that Aboriginal governments/organizations, communities and TK holders will explicitly define the applications and uses of TK on a project-by-project basis. The extent to which TK is incorporated into an AEMP is likely to vary significantly depending on numerous factors, including: political will on the part of industry, government and communities; priorities and capacities of communities to participate; and, the availability of knowledge and expertise related to TK and its role in aquatic effects

management. To complement project-specific TK requirements, the framework for developing and implementing AEMPs in the NWT presented in Section 5.0 highlights how proponents can benefit from consultations with TK holders. The key is to engage Aboriginal governments/organizations and TK holders early and often to ensure that the best AEMP possible is developed through a participatory process that utilizes all available information.

This chapter briefly describes the benefits of incorporating TK into the AEMP development process. In addition, a separate document, the TK "Toolbox"/Guidance Document, is currently being developed by INAC Water Resources Division and a small working group to accompany the AEMP Guidelines and to provide guidance on the inclusion of TK in aquatic effects monitoring. The draft TK "Toolbox"/Guidance Document will be released in the summer of 2009 for general review.

4.1 Contributions of Traditional Knowledge to the Aquatic Effects Monitoring Programs in the Northwest Territories

Information on northern ecosystems and on the impacts of industrial developments on the plants and animals that utilize these habitats can be acquired through the application of both TK and western science. Because the information from both sources is unique, valuable, and complementary, it is strongly recommended that project proponents design AEMPs in a manner that utilizes both approaches for acquiring information. Some of the reasons for including TK in the AEMP development process include:

- TK provides an understanding of baseline conditions within the study area;
- TK provides an understanding of the structure and function of the aquatic ecosystem within the study area. This is particularly important in the NWT where little or no western scientific data have been collected for many areas;

- TK provides a historic perspective and understanding of the variability associated with aquatic ecosystems. Such information can support the design of baseline sampling programs and/or AEMPs that need to characterize that variability;
- TK enhances understanding of the linkages between environmental components, which can help to identify exposure pathways and key receptor groups. In this way, key indicators of aquatic ecosystem health can be identified and integrated into AEMPs;
- TK can be used to predict the effects of development activities on the ecological receptors that live within the study area. Impacts on human health and/or the traditional uses of the aquatic ecosystem can also be predicted using TK. This information contributes to the environmental assessment process and to problem formulation during AEMP design;
- TK provides a basis for monitoring environmental conditions within the study area, thereby representing a key element of well-designed AEMPs;
- TK provides information to help identify the need for mitigation measures to minimize or avoid the impacts of development projects on the aquatic ecosystem and/or its uses. TK can also be used to evaluate the efficacy of such mitigation measures; and,
- TK can lead to a better understanding of the AEMP and its conclusions by the local communities. As such, integration of TK into the AEMP is likely to enhance community support for the monitoring program.

4.2 Traditional Knowledge Requirements for AEMP Development and Implementation

An overview of the eight steps of the recommended framework for developing and implementing AEMPs in the NWT is provided in Chapter 5 of this document. While opportunities to engage Aboriginal governments/organizations and TK holders in the process are identified in the description of each step of the process, the following

table provides a detailed summary (Table 1). The information in this table will be expanded upon in the TK "Toolbox"/Guidance Document that is being developed to highlight steps for including TK in an AEMP.

Table 1. Contribution of Traditional Knowledge to each step of the AEMP Guidelines framework

AEMP Guidelines Framework Steps	Contribution of Traditional Knowledge to each step of the AEMP Guidelines Framework
Pre-Step 1	Prior to beginning Step 1 of the AEMP framework, it is recommended the following background research be conducted: • Identify your primary communities; • Determine whether TK protocols or research agreements exist and follow them; • Review transcripts from past hearings/meetings related to other development projects to identify possible TK and community concerns; and, • Consult with leaders, environment committees and/or elders to identify the appropriate TK experts in each community.
Step 1: Identify issues and concerns associated with a development project relative to potential effects on the aquatic ecosystem (aquatic ecosystem)	TK provides information on: • historical conditions, including variability in environmental conditions; • present conditions (e.g., encourage site visits by TK holders); • changing conditions (e.g., related to climate/permafrost); • traditional resource uses in the area surrounding the project site; • structure and function of the aquatic ecosystem; • valued components of the aquatic ecosystem (e.g., fish species, based on Aboriginal taxonomies); • community-based concerns on the potential effects of the project on the aquatic ecosystem and its uses, based on all of the above.
Step 2: Problem formulation for aquatic effects monitoring	TK can support: • identification of important stressors of potential concern; • understanding of linkages between the aquatic ecosystem and other parts of the environment; • identification of possible threats to plants and animals in the aquatic ecosystem, as well as possible effects on human health; • identification of pathways for transport of stressors of concern; and, • selection of assessment endpoints (e.g., survival of jackfish or change in taste of whitefish) and measurement endpoints (e.g., what will be measured/monitored to determine if the aquatic ecosystem is being adequately protected).

Step 3: Development of data quality objectives and conceptual study design	TK can support: • selection of approaches for evaluating the effects of a project on the aquatic ecosystem; • prediction of possible impacts on the aquatic ecosystem; and, • evaluation of the conceptual AEMP design.
Step 4: Developing detailed AEMP design	TK can help determine the: • location and timing of sampling (e.g. upstream and downstream locations known for healthy fish populations); • sensitivity of monitoring programs to reflect local desires to maintain relatively pristine aquatic ecosystems; and, • sensitivity of monitoring programs to ensure all key species, based on Aboriginal taxonomies, are being monitored.
Step 5: Documentation and verification of the sampling design	TK can support: • field sampling planning (expanding on Step 4 and detailing how specific sampling should be conducted to respect the aquatic ecosystem); and, • quality assurance project planning and health and safety planning.
Step 6: Implementation of the AEMP	Aboriginal governments/organizations and communities can: • collect samples and information that are both TK and western science based.
Step 7: Evaluation, compilation, analysis, interpretation and reporting of AEMP data and information	Aboriginal governments/organizations and TK holders can: • evaluate, compile, analyze, interpret and report data generated through TK collection; • determine if the program meets objectives; • determine appropriate ways to report results to communities; • ensure the results are relevant and understandable; and, identify data and information gaps.
Step 8: Application of AEMP results within a management response framework	Aboriginal governments/organizations and TK holders can: • help identify possible mitigation measures to address project-related effects and subsequently determine if the mitigation/measures are effective.
Long Term Monitoring	Aboriginal governments/organizations and communities can • provide long-term community understanding of the project through continued involvement in long-term monitoring beyond the life of the project

Project proponents are encouraged to discuss TK requirements with TK holders and Aboriginal governments/organizations at or near the beginning of the AEMP

development process to ensure that a plan to acquire the necessary information can be developed and implemented. In developing such a plan, it is important to understand that TK is an extremely valuable source of information that can require substantial time and resources to acquire and document. In addition, directed approaches are needed to facilitate its acquisition (e.g., workshops, site visits, interviews, interpretation, nomenclature development). Therefore, resource requirements and schedules should be developed in consultation with TK holders and Aboriginal governments/organizations to ensure that project requirements can be satisfied. Effective partnerships, built early in the process and in a manner that respect the significance of this information, will ensure that many of the ensuing steps in the AEMP development and implementation process run efficiently.

4.3 Approaches to Integrating TK into AEMP Development Process

A fully integrated approach to TK-based monitoring of aquatic effects would, at a minimum, necessitate the use of TK in the development of indicators and in the selection of methods for data gathering. The following steps to meaningful inclusion of TK in AEMPs will be discussed in the forthcoming TK "Toolbox"/Guidance Document:

- Assessment of background information related to TK;
- Defining terms for inclusion of TK (i.e., research agreements, codes of conduct);
- Identifying key indicators valued by TK holders (i.e., considering Aboriginal taxonomies);
- Developing methods/protocols for systematic documentation of TK (i.e., community consent, compensation);
- Verification, evaluation, compilation and interpretation of data and information;

- Reporting of aquatic effects data and information (i.e., plain language, use of Aboriginal language);
- Application of AEMP results within a management response framework; and,
- Post water licence monitoring.

Use of TK must be based on mutual trust and respect. Including Aboriginal peoples, communities, and TK holders in all aspects of the AEMP development and implementation process will increase trust, respect and understanding, as well as ensure protection of aquatic environments and their uses.

Chapter 5 Overview of the Recommended Framework for Designing and Implementing Aquatic Effects Monitoring Programs in the Northwest Territories

5.0 Introduction

In the NWT, AEMPs must be designed and implemented as a requirement of the water licencing process for major development projects that could have adverse effects on the aquatic ecosystem. Such AEMPs must be designed and implemented in a manner that will provide the data and information needed to determine if aquatic ecosystems and their uses are being adequately protected; to evaluate short-term and long-term effects in the aquatic ecosystem resulting from the project; to evaluate the accuracy of impact predictions; to assess the effectiveness of impact mitigation measures; and to identify the need for additional impact mitigation measures to reduce or eliminate environmental effects. The guiding principles for developing and implementing AEMPs in the NWT were presented in Chapter 3. This chapter presents a framework for designing AEMPs that are consistent with these guiding principles and are intended to meet the expectations of Aboriginal governments/organizations, federal and territorial governments, regulatory boards, industry, and other interested parties.

5.1 Recommended Framework for the Development of Aquatic Effects Monitoring Programs in the Northwest Territories

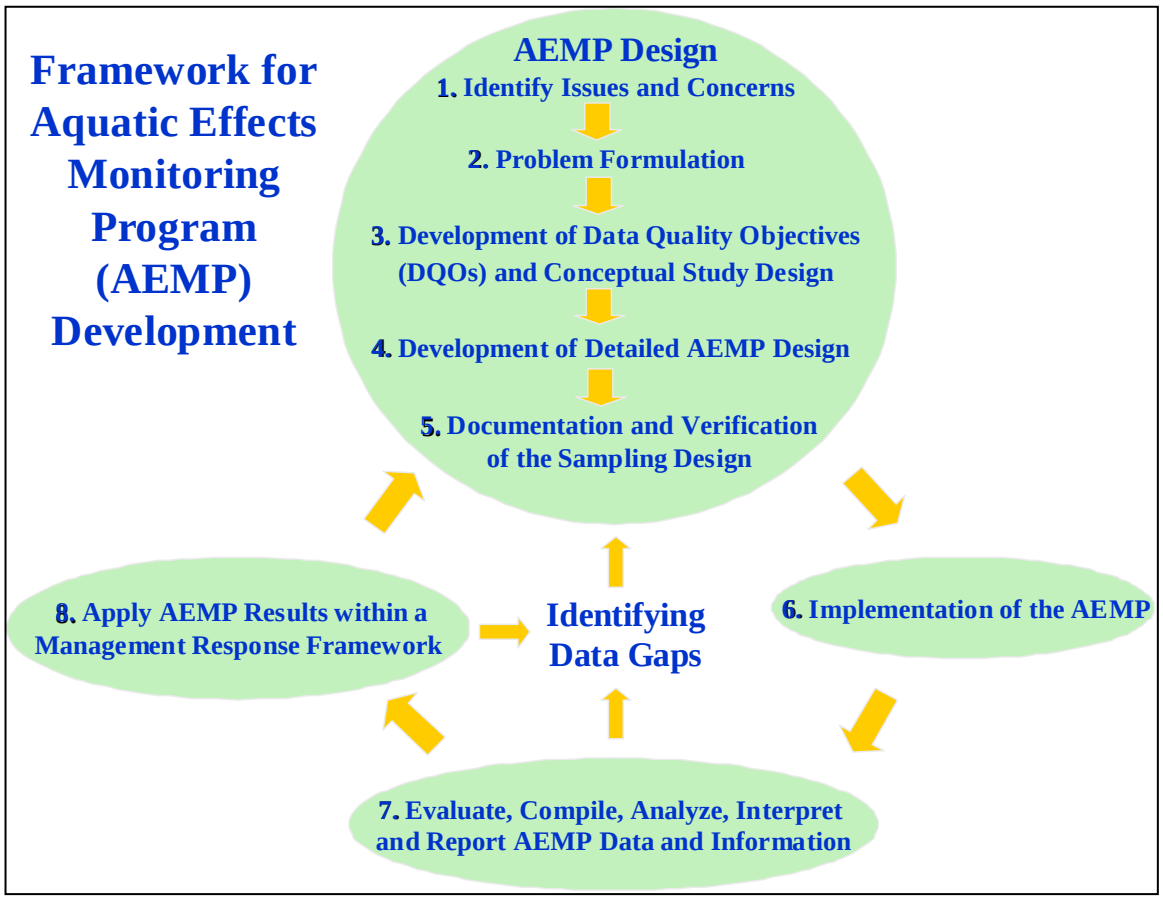
The recommended framework for designing and implementing AEMPs in the NWT provides a step-wise process for guiding the development of monitoring programs to assess the physical, chemical, and biological characteristics of aquatic ecosystems within which development activities have been, or are proposed to be, conducted. Importantly, this framework is intended to support the design of monitoring programs

conducted prior to project development (i.e., collection of baseline data to support environmental assessment), during project construction and operations, and during project closure and reclamation. In addition, TK needs to be acquired and used throughout all steps of the AEMP development and implementation process. The recommended framework consists of the following steps (Figure 2):

- Step 1: Identification of issues and concerns associated with a development project relative to potential effects on the aquatic ecosystem (see Technical Guidance Document Volume 1);
- Step 2: Problem formulation for aquatic effects monitoring (see Technical Guidance Document Volume 2 and associated Appendix);
- Step 3: Development of data quality objectives (see Technical Guidance Document Volume 3) and conceptual study design;
- Step 4: Development of detailed AEMP design (see Technical Guidance Document Volume 4);
- Step 5: Documentation and verification of the sampling design (see Technical Guidance Document Volume 5);
- Step 6: Implementation of the AEMP;
- Step 7: Evaluation, compilation, analysis, interpretation, and reporting of AEMP data and information (see Technical Guidance Document Volume 6); and,
- Step 8: Application of AEMP results within a management response framework (see Technical Guidance Document Volume 3).

Each of these steps in the AEMP development and implementation process is briefly described in the following sections of this chapter and detailed in the technical guidance documents (also see MacDonald *et al.* 2009 for more information). In the north, integration of TK in the AEMP development and implementation process is essential. For this reason, a TK "Toolbox"/Guidance Document is under development and will be released for review in 2009.

Figure 2. Recommended framework for developing aquatic effects monitoring programs



5.1.1 Step 1: Identification of Issues and Concerns Associated with a Development Project

The first step in the AEMP development process involves the identification of issues and concerns associated with the proposed development activity relative to potential effects on the aquatic ecosystem. It is important to identify these issues and concerns early in the process since such information provides the proponent, Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties with a basic understanding of the project and the effects that may be associated with its implementation. This step is usually initiated when the proponent prepares a project description to support a water licence application,

which typically describes the nature and scope of the project-related activities and generally defines the scope of the study area. It is anticipated that a preliminary project description will be prepared to support discussions about the project and the monitoring that is required to evaluate associated effects. With the input provided by participants, such a preliminary project description can be revised and refined prior to submission with the water licence application. In this way, the project proponent can submit a project description to the applicable regulatory board(s) that reflects the issues and concerns identified by participants.

In addition, the project description should include information on the characteristics of the receiving water system, existing and future land use patterns in the study area, and the characteristics of effluents that may be discharged from the development site (and those of other discharges in the study area). Both TK and western science ought to be used to evaluate current conditions in the study area (see Chapter 4). This information provides a preliminary basis for identifying stressors of potential concern and areas of potential concern in the study area.

The preliminary project description should be distributed to Aboriginal governments/organizations (including TK holders), federal and territorial governments, regulatory boards, and other interested parties to facilitate the identification of issues and concerns associated with the proposed project. Initial consultations with these groups should be convened at this time to support the identification of sources of TK and western scientific information on the watershed and to develop a preliminary list of stressors of potential concern. Furthermore, the proponent would benefit from conducting one or more site visits with TK holders, Aboriginal governments/organizations, federal and territorial governments, regulatory boards and/or

The establishment of an AEMP Working Group by the proponent is encouraged to provide a formal mechanism for meeting with all interested parties. It could be comprised of representatives from Aboriginal governments/ organizations, federal and territorial governments, regulatory boards, and other parties with an interest in the project. The proponent would facilitate participation in this group by interested parties. The terms of reference for the AEMP Working Group would need to be established early in the process to detail the roles and responsibility of each participant (e.g. providing advice/input to the proponent on the AEMP).

other interested parties to further explain the nature of the project and the scope of the potential effects. Such face-to-face meetings also provide an opportunity to establish an **AEMP Working Group** (see sidebox) and to identify the roles and expectations for each of the participants. Such an AEMP Working Group can assist the project proponent throughout the AEMP development and implementation process by clearly articulating expectations and identifying the refinements needed to ensure that these expectations are met.

Provision of the project description and associated information to Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties early in the process is beneficial for several reasons. First, this information will provide all participants with a common understanding of the structure, function, and status of the aquatic ecosystem, of historic land and resource use patterns, and of the socioeconomic characteristics of the study area. In addition, evaluation of this background information provides a basis for identifying data gaps that will need to be addressed as the process progresses. Furthermore, identification of the issues and concerns by reviewers will assist the proponent in preparation for the environmental assessment process, if required. Finally, and of utmost importance, consultation with Aboriginal governments/organizations and other interested parties early in the process will help to foster a sense of mutual respect and teamwork that should expedite the subsequent steps in the AEMP development process. See Technical Guidance Document Volume 1 for more detailed information on this step of the AEMP development process.

5.1.2 Step 2: Problem Formulation for Aquatic Effects Monitoring

Problem formulation is the process of defining the questions that need to be addressed by an AEMP and involves eight key activities. The activities included in the problem formulation process are:

1. Refinement of the list of stressors of potential concern;
2. Evaluation of the potential effects of each physical, chemical and/or biological stressor on human health and aquatic ecosystems;

3. Evaluation of the transport and fate of chemicals of potential concern;
4. Characterization of potential exposure pathways;
5. Identification of receptors potentially at risk;
6. Development of a conceptual site model;
7. Selection of assessment and measurement endpoints; and,
8. Development of a preliminary AEMP Analysis Plan.

Collectively, these activities provide a basis for determining which components of the aquatic ecosystem may be at risk as a result of the proposed developmental activity and what the adverse effects on human health or the environment could be. By considering both TK and western science in the identification of multiple stressors originating from various aspects of the project (e.g., releases of heavy metals from dyke materials and blasting effects on fish eggs) and/or stressors originating from other human activities that affect the receiving water system (e.g., when a mine and a hydro power project are developed in the same area), it is possible to account for and evaluate the cumulative effects on the aquatic ecosystem. This step will provide clear linkages between the AEMP and regional cumulative effects assessment programs. In this way, the problem formulation process provides the information needed to focus resources on monitoring the ecosystem characteristics that are most likely to be adversely affected by project development.

Problem formulation is an iterative process that can and should be used to refine the AEMP as information on the study area expands and data gaps are filled (i.e., using both TK and western science). Importantly, preliminary problem formulation should begin as soon as the preliminary project description has been completed. In this way, baseline data collection efforts can become more focussed on the ecosystem components that are most likely to change in response to project development. Hence, the baseline data collected over several years are likely to be useful for before-after comparisons of environmental conditions, a key approach to aquatic effects assessment. The preliminary problem formulation should be refined following the collection of baseline data and completion of the environmental assessment (i.e., when changes to the project descriptions and/or further mitigation measures are likely to be identified; i.e., the environmental assessment process provides information that

is directly relevant to the problem formulation process). The problem formulation should be further refined periodically during project operation or modification (i.e., when there are changes in quality or quantity of effluent, effluent dispersion mechanisms) and in advance of project closure and reclamation. Such refinements to the problem formulation will ensure that the project proponent and all interested parties are provided with the information needed to ensure that the AEMP is appropriately revised and refined to meet its stated objectives.

Problem formulation is intended to support the development of data quality objectives and the conceptual study design (see Step 3). To ensure that the subsequent steps can proceed efficiently, it is imperative that project proponents consult with Aboriginal governments/organizations, federal and territorial governments, regulatory boards and other interested parties during and following the completion of the problem formulation process. The AEMP Working Group can serve as a starting point to work together to achieve agreement on six main items, including:

- The stressors of potential concern;
- Assessment endpoints;
- Exposure pathways;
- Risk questions (i.e., questions related to the potential effects of the project that will be answered by the results of the AEMP; also termed testable hypotheses);
- Measurement endpoints; and,
- AEMP Analysis Plan.

The conceptual site model describes key relationships between natural processes (i.e., natural stressors), human activities (i.e., project-related stressors), and the plants and animals that utilize habitats in the area (i.e. human and ecological receptors). It provides a means of highlighting what is known and what is not known about the area, thus it provides a basis for identifying data gaps and designing sampling programs. The conceptual site model and associated diagrams also provide efficient tools for communicating this information to interested parties and developing

consensus on these items. Lack of agreement between the project proponent, Aboriginal governments/organizations, federal and territorial governments, regulatory boards and other interested parties on the conceptual site model will almost certainly impair the selection of measurement endpoints and the development of the study design.

The AEMP Analysis Plan should describe the analytical approach that will be used to draw conclusions from the monitoring results. More specifically, this plan is intended to describe how the data collected under the AEMP will be used to determine the short-term and long-term effects of the project on aquatic ecosystems, to evaluate the accuracy of impact predictions, to assess the efficacy of mitigation measures, and to identify the need for further mitigation to reduce or eliminate project-related effects. See Technical Guidance Document Volume 2 for more detailed information on this step of the AEMP development process.

5.1.3 Step 3: Development of Data Quality Objectives and Conceptual Study Design

The third step in the AEMP development process involves the formulation of the data quality objectives (DQOs) and conceptual study design. The DQOs process provides a systematic framework for designing AEMPs that are sufficiently robust to support decisions regarding the management of industrial developments. More specifically, the DQOs development process determines the type, quantity, and quality of data needed to reach defensible conclusions regarding the effects of the project on the aquatic ecosystem and on those receptors that depend on the aquatic ecosystem (i.e., aquatic-dependent wildlife and human health). The DQOs process is a seven step planning approach that is used to develop a conceptual plan for acquiring data of sufficient quality and quantity to support the goals of the study (Figure 3). The steps in the DQO process include:

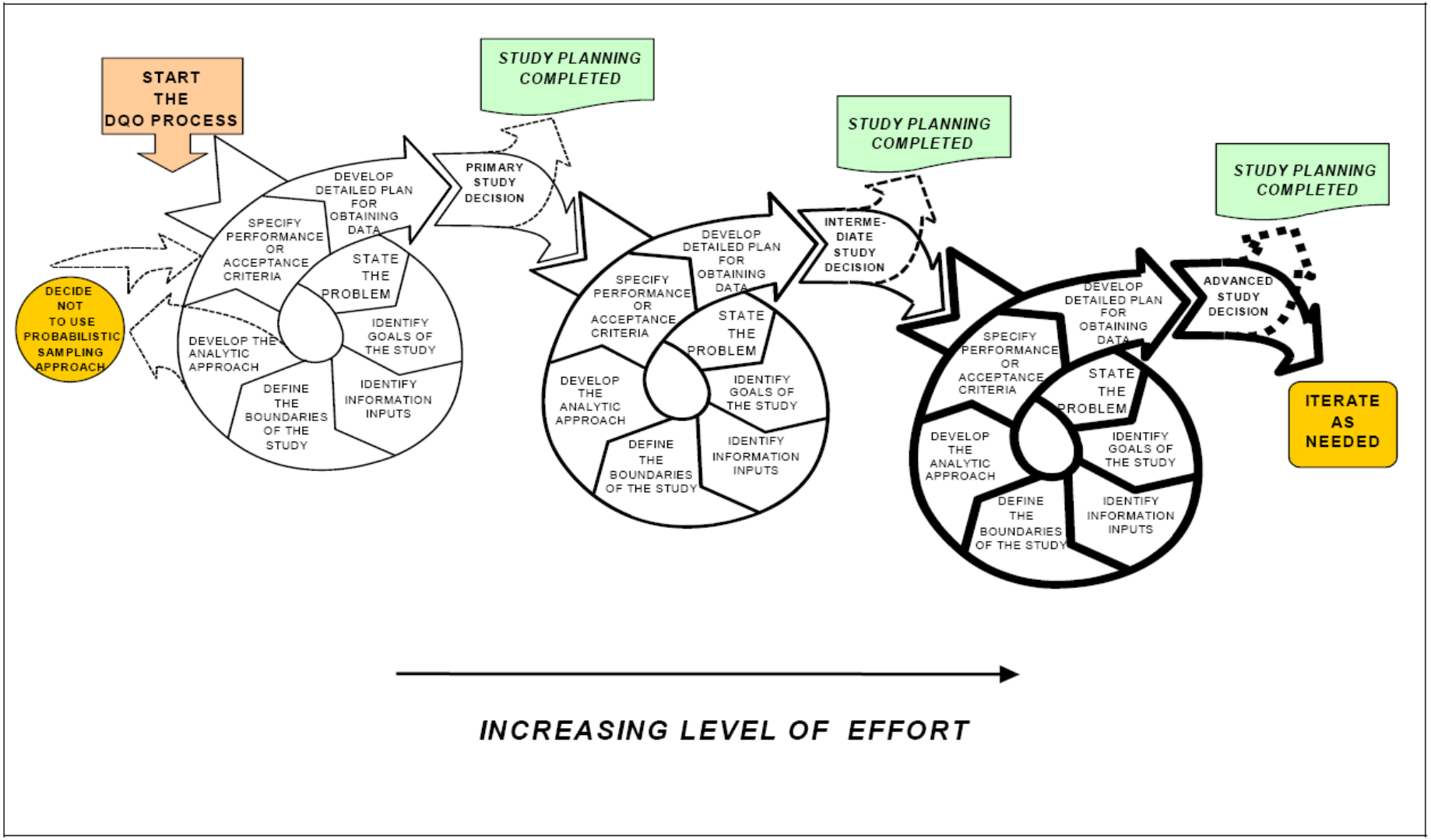
- State the problem to be investigated;
- Identify the goals of the study;

- Identify the information inputs required to achieve the study goal;
- Define the boundaries of the study;
- Develop the analytical approach;
- Specify performance or acceptance criteria; and,
- Develop the conceptual design for obtaining the required data.

This step in the AEMP development process culminates in the preparation of a brief report that documents the conceptual design of the AEMP and methods that will be used to evaluate and analyze the data that are collected under the monitoring program. As described in Step 2, development of an AEMP Analysis Plan represents the final element of the problem formulation process. The AEMP Analysis Plan describes how the data and information generated under the AEMP will be evaluated to determine if the aquatic ecosystem and its uses are being adequately protected. Incorporation of TK into the development of the DQOs and conceptual study design should be carefully considered, along with input from the AEMP Working Group.

During DQOs development, critical effect sizes are identified and used to establish the Action Levels that are ultimately used in the Management Response Plan (MRP; which has also been referred to as the Adaptive Management Plan). The MRP, developed by the proponent, describes the management actions that will be taken if effects of various magnitude occur in response to project-related activities. See Technical Guidance Document Volume 3 and Section 5.1.8 for more information on the development of Action Levels and their uses in MRPs.

Figure 3. How the data quality objectives process can be iterated sequentially through the project life cycle (USEPA 2006).



5.1.4 Step 4: Development of Detailed Aquatic Effects Monitoring Program Design

As part of the third step in the process, data quality objectives and a conceptual AEMP design were developed. Step four in the AEMP development process builds on the conceptual study design to develop a detailed AEMP design through:

- Selection of an appropriate monitoring program design;
- Selection of sampling locations;
- Confirmation of appropriate effects sizes;
- Determination of necessary sample sizes; and,
- Identification of appropriate sampling frequencies.

A variety of design options are available for AEMPs in the NWT. All of these designs rely on comparison of data collected in an exposed area(s) (i.e., impacted areas) to data collected in an unexposed area (i.e., reference area). In the context of AEMP design, an exposed area is considered to be an area that is likely to be affected by project-related activities or stressors. In contrast, an unexposed area is considered to be an area that is spatially removed from the project that has physical, chemical, and biological conditions that were similar to those in the exposed area prior to the release of project-related stressors. Unexposed areas are used as a control against which the effects of project-related stressors can be evaluated (i.e., in control-impact, before-after, before-after control impact, or similar monitoring program designs).

Other factors that need to be considered in designing a monitoring program include selection of reference stations, evaluation of variability, application of statistical analyses, and synergies with other monitoring programs, such as the EEM program. The statistical uncertainty of an AEMP when making decisions using sample data is also discussed. For example, various types of errors can be made when testing hypotheses; however, they may be controlled through dialogue between interested parties. Considerations for selecting appropriate design sampling locations,

confirming effect sizes, determining necessary sample sizes, and identifying sample frequencies are described in Technical Guidance Document Volume 4.

Incorporation of TK into the development of the detailed AEMP design should be carefully considered. For example TK can help determine appropriate monitoring locations and timing in both reference and exposure areas while ensuring the most important VECs are monitored. The draft and final AEMP designs should be reviewed by Aboriginal governments/organizations, federal and territorial governments, regulatory boards and other interested parties. The AEMP Working Group should also play an important role in reviewing the detailed study design.

5.1.5 Step 5: Documentation and Verification of the Sampling Design

The fifth step in the AEMP development process involves the documentation and verification of the sampling design. More specifically, a sampling and analysis plan is prepared that translates the AEMP design and associated analysis plan into tangible procedures that can be followed by staff involved in field sampling, laboratory analysis, and data validation, compilation, and interpretation. The sampling and analysis plan typically consists of three elements, including:

- Field sampling plan (FSP);
- Quality assurance project plan (QAPP); and,
- Health and safety plan (HSP).

The FSP is intended to provide guidance for all field work by providing a detailed description of the sampling and data-gathering procedures to be used for the project. By comparison, the QAPP describes the steps that need to be completed to generate data that meet the project DQOs. The HSP describes how the health and safety of project participants will be safeguarded during the data collection programs.

Before the sampling and analysis plan is implemented, it is important to verify that samples specified in the FSP can be collected at the site. During field verification of the sampling design, the testable hypotheses, exposure pathway models, and measurement endpoints are evaluated for their appropriateness and implementability. More specifically, information obtained previously and the feasibility of sampling should be verified through one or more visits to the site. For abiotic media, such as water and sediment, it is important to determine if the selected sampling methods are appropriate and applicable to the conditions in the study area. For biological sampling, it is important to confirm that target species occur at the site, to determine if adequate numbers of individuals of the required species can be collected, and to evaluate the efficacy of various sampling methods. In this respect, TK provides essential information for field validating the sampling design. The level of effort required to collect the required number of samples can be determined with such detailed information on sampling logistics. At this state of the process, it is prudent to develop a number of contingency plans that can be used to direct field sampling efforts if unexpected conditions are encountered (e.g., fish sampling contingency plan; alternate water or sediment sampling stations; decision criteria for selecting alternate sampling stations).

The FSP and QAPP should be reviewed by the Aboriginal governments/organizations, federal and territorial governments, regulatory boards and other interested parties prior to implementation of the AEMP. Any changes to the design of the monitoring program in response to field verification efforts must be made with the agreement of the applicable regulatory board and other reviewers (i.e., AEMP Working Group). It is important to demonstrate that the assessment endpoints and testable hypotheses developed during problem formulation are still being addressed by the revised AEMP. In addition, any new measurement endpoints must be evaluated according to their utility for assessing the status of the assessment endpoints and their compatibility with the conceptual site model.

Final agreement on the AEMP design will be considered to have been achieved when the AEMP Design document, FSP, QAPP, and HSP have been approved by the applicable regulatory board. This general approach to planning should be applied

initially during baseline data collection, subsequently during project construction and operation to assess project related effects (i.e., in the AEMP), and finally during project closure and reclamation. Once the AEMP documents have been approved, the AEMP can be implemented through a combination of field sampling and laboratory analysis. See Technical Guidance Document Volume 5 for more detailed information on this step of the AEMP development process.

5.1.6 Step 6: Implementation of the Aquatic Effects Monitoring Program

Implementation of the AEMP involves the collection and analysis of environmental samples in accordance with the FSP and QAPP. During the implementation stage, it is important to adhere to the DQOs and to any requirements for synoptic sampling activities (e.g., collection of sediment samples for evaluation of whole-sediment chemistry and whole-sediment toxicity from a sample homogenate prepared from one or more grab samples). Failure to collect even one sample properly or to coordinate samples temporally can significantly affect interpretation of the data. Changing field conditions and/or new information on the nature and extent of contamination can require a change in the FSP. Importantly, any deviations from the FSP or QAPP must be fully documented to enable interested parties to determine if the requisite information has been collected and to support interpretation of the data. Such deviations need to be discussed with the responsible regulatory board, Aboriginal governments/organizations, federal and territorial governments, and other interested parties in an open consultative process, with decisions on the actions needed to address the deviations ultimately made by the responsible regulatory board.

While the project proponent is responsible for implementing the AEMP as designed (i.e., as documented in the AEMP design document, FSP, and QAPP), the responsible regulatory board and/or their designate (e.g., INAC inspectors) should be prepared to provide oversight on sampling and analysis activities. More specifically, field sampling activities should be collected by trained environmental technicians and audited on site to ensure that environmental samples are being collected using the agreed-to methods and procedures. In addition, the laboratories that have been

selected by the project proponent should be periodically audited to confirm that they are generating reliable data. Furthermore, a portion of the environmental samples that are collected under the AEMP should be split or duplicated and analyzed at an independent laboratory to provide interested parties with confidence that the data generated by the proponent are comparable to those that are generated by others (i.e., to confirm that systematic biases do not occur). Ultimately, the DQOs provide the technical basis for evaluating the extent to which the data generated meet the requirements of the AEMP. Please note that a Technical Guidance Document has not been prepared for this Step of the AEMP Framework.

5.1.7 Step 7: Evaluation, Compilation, Analysis, Interpretation and Reporting of Aquatic Effects Data and Information

This step in the AEMP development and implementation process consists of four activities, namely data evaluation, data compilation, data interpretation, and data reporting. Each of these activities are briefly described below.

Data Evaluation - The data and information that are generated under the AEMP must be evaluated relative to the project DQOs to determine if they can be used in the assessment of project-related effects. The performance criteria for measurement data that are established as part of the overall DQOs process provide a systematic basis for evaluating the accuracy, precision, sensitivity (i.e., detection limits), completeness, and representativeness of the AEMP data. Ultimately, it is the responsibility of the project proponent to ensure that sufficient quantities of data of appropriate quality are generated to support effective evaluation of project-related effects. Therefore, it is important to report any issues related to data usability to the responsible regulatory board immediately, along with any corrective actions that are proposed for addressing these issues.

Data Compilation - The data that are generated under the AEMP must be compiled in a format that facilitates access by Aboriginal governments/organizations, federal and territorial governments, regulatory boards and other interested parties. To facilitate broad access to the data and to support diverse data analyses, it is

recommended that AEMP data be compiled in a GIS-compatible, relational database format (e.g., MS Access). All of the data that are compiled in the project database need to be verified against the original data source to assure data quality. The AEMP data should be delivered to the responsible regulatory board, Aboriginal governments/organizations, federal and territorial governments, and other interested parties in electronic format and in an annual AEMP data report.

Data Analysis and Interpretation - The procedures for interpreting the AEMP data are specified in the AEMP Analysis Plan that was prepared during problem formulation and refined in the DQOs process. Therefore, data interpretation involves implementation of the AEMP Analysis Plan to evaluate the status and trends of key indicators of aquatic environmental quality (as evaluated using TK and western science). The results of these analyses should be presented in an annual AEMP interpretive report and in a more detailed interpretive report every three years, or as required by the responsible regulatory board. These interpretive reports should describe any changes in the abiotic characteristics of the ecosystems that have occurred, any effects on aquatic receptors, aquatic-dependent wildlife, or human health that have been documented based in interpretation of individual lines-of-evidence (e.g., surface-water chemistry, sediment chemistry, benthic invertebrate community structure, fish palatability) and integration of multiple lines-of-evidence (see Technical Guidance Volumes 2 and 3 for more information). ***Both technical and plain-language versions of each report should be prepared by the project proponent.*** Any data gaps that are identified should be reported to the responsible regulatory board and to the members of the AEMP Working Group in the annual interpretive report and agreement should be sought with Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties on the most appropriate way to address data gaps.

AEMP Reporting - Review of the reports prepared under the AEMP represents an essential step in the overall aquatic effects assessment process. Facilitation of such reviews necessitates timely dissemination of the AEMP data, the AEMP data reports, and the AEMP interpretive reports. In addition, it is strongly

recommended that workshops be scheduled on an annual basis to present the data and the results of data analyses to the responsible regulatory board, Aboriginal governments/organizations, federal and territorial governments, and other interested parties. It is important to recognize that reviewers are likely to provide a diverse variety of comments, some of which may necessitate additional analysis of the data, reformatting of reports, and/or revision of conclusions by the proponent. See Technical Guidance Document Volume 6 for more detailed information on this step of the AEMP development process.

5.1.8 Step 8: Application of Aquatic Effects Monitoring Program Results within a Management Response Framework

Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed polices and practices. In the NWT, adaptive management should be integrated into every development proposal since our understanding of northern ecosystems and the effects of developmental activities on them is incomplete. As a result, predictions of the impacts of development projects on aquatic ecosystems are often inaccurate and the efficacy of associated mitigation measures is often uncertain. For this reason, aquatic effects monitoring has become a central element of the overall natural resource management process in the NWT.

To be effective, however, the AEMP must be integrated into the overall project management framework. More specifically, the environmental assessment process (when required) provides a vehicle for developing predictions regarding the effects of the project on the environment and the efficacy of mitigation measures. In turn, development and implementation of a well-designed AEMP provides the data and information needed to evaluate the accuracy of these predictions. By helping to identify any incorrect predictions that have been made relative to effects and/or mitigation, the results of the AEMP can and should be used to develop alternate management policies, approaches, strategies and/or practices that are expected to be more effective in terms of meeting project goals and objectives. For example, a project proponent may hypothesize that nutrient releases from its facility represent

minor contributions to the aquatic ecosystem and that eutrophication will not be an issue in receiving waters. If properly designed, the AEMP should provide the data needed to confirm or refute this prediction. If the prediction is refuted, then additional mitigation (i.e., a management response) will be required to address project-related effects and ongoing monitoring results will provide the information needed to determine if that mitigation is effective.

The above example emphasizes the importance of the AEMP for providing the data needed to effectively manage major development projects. The linkages between AEMP results and management responses are articulated in the MRP for the project. More specifically, the MRP should present the Action Levels developed in the DQO process and describe the candidate management responses that could be implemented if the Action Levels were exceeded. Since background conditions are likely to be used to define certain types of Action Levels, it is essential that adequate baseline monitoring data are available to establish background conditions prior to water licencing and that procedures for calculating background concentrations are defined in the AEMP Analysis Plan. Ongoing review and refinement of the AEMP ensures that it will continue to be relevant for supporting decisions on the management of the project as a whole. See Technical Guidance Document Volume 3 for more detailed information on this step of the AEMP development process.

Chapter 6 Summary and Conclusions

6.0 Introduction

In recognition of the need for consistent guidance on the development of AEMPs, INAC initiated the AEMP Guidelines project in 2006. The project is intended to support the preparation of a guidance document that would provide project proponents, Aboriginal governments/organizations, federal and territorial governments, regulatory boards, and other interested parties with greater certainty regarding requirements and expectations for developing and implementing AEMPs in the NWT. As a first step, INAC convened a technical workshop in April, 2006 to establish guiding principles for AEMPs and evaluate best practices regarding aquatic effects monitoring. Subsequently, a series of literature searches were conducted to acquire further information on approaches and procedures for conducting aquatic effects monitoring, including both TK-based and western science-based methods. This information was used to develop a preliminary framework for designing AEMPs. Next, a number of meetings and a workshop (October, 2008) were convened with Aboriginal governments/organizations, regulatory boards, federal and territorial governments, and other interested parties to obtain feedback on a preliminary framework for aquatic effects monitoring. This report integrates input provided to date from all sources to recommend a framework for designing and implementing AEMPs in the NWT.

6.1 Overview of the Recommended Framework

Considerable effort has been expended in Canada and elsewhere worldwide to develop guidance for monitoring the effects of human activities on aquatic ecosystems. These efforts have resulted in a variety of guidance documents that could be used to support the design of AEMPs (e.g., Ecological Monitoring and Assessment Network, Environmental Effects Monitoring, International Organization for Standardization, United States Environmental Protection Agency). While project proponents are encouraged to review these documents during the AEMP design

process, such guidance may not be directly applicable to the NWT because they were typically developed for use in other areas that have already been affected to a greater degree by developments. None of the available guidance was explicitly developed to support the design of monitoring programs in areas that have been essentially unspoiled by human activities to provide early warning systems to avoid harm to aquatic ecosystems and their uses in the future. Therefore, monitoring programs developed from such guidance are unlikely to be sufficiently sensitive to identify effects on pristine northern ecosystems.

The recommended framework for designing and implementing AEMPs in the NWT is intended to provide a step-wise process for guiding the development of monitoring programs for assessing the physical, chemical, and biological characteristics of aquatic ecosystems within which development activities have been, or are proposed to be, conducted. Importantly, this framework is intended to support the design of monitoring programs conducted prior to project development (i.e., to collect baseline data to support environmental assessment; preliminary problem formulation will inform the design of baseline sampling programs), during project construction and operations, and during closure and reclamation of the project. The integration of TK and consultation with Aboriginal governments/organizations and other interested parties plays an integral role in the AEMP Guidelines. This is unique to aquatic effects monitoring guidance in Canada. More specifically, TK needs to be acquired and used throughout the AEMP development and implementation process, as determined necessary and appropriate through consultation with Aboriginal governments/organizations.

In summary the recommended framework consists of the following steps (see Figure 2):

- Step 1: Identification of issues and concerns associated with a development project relative to potential effects on the aquatic ecosystem (Technical Guidance Document Volume 1);
- Step 2: Problem formulation for aquatic effects monitoring (Technical Guidance Document Volume 2);

- Step 3: Development of data quality objectives and conceptual study design (Technical Guidance Document Volume 3);
- Step 4: Development of a detailed study design (Technical Guidance Document Volume 4);
- Step 5: Documentation and verification of the sampling design (Technical Guidance Document Volume 5);
- Step 6: Implementation of the AEMP design;
- Step 7: Compilation, evaluation, analysis, interpretation, and reporting of AEMP data and information (Technical Guidance Document Volume 6); and,
- Step 8: Application of AEMP results within an management response framework (Technical Guidance Document Volume 3).

A TK "Toolbox"/Guidance Document is currently being developed to accompany the AEMP Guidelines. It will provide guidance to proponents and interested parties on community consultation and engagement of Aboriginal governments/organizations in the AEMP development process, as well as specific protocols and reference documents, including a review of TK based literature. Adequate consultation and engagement is the first step to discussing the use of TK in project AEMPs. This new "Toolbox"/Guidance Document will be released as a draft for review (summer 2009) since it has not yet been reviewed by Aboriginal governments/organizations and interested parties.

6.2 Application of the Recommended Framework

The framework presented in this document is explicitly recommended for developing and implementing AEMPs for major development projects in the NWT. It is important to understand that adherence to this framework throughout the life of the project will maximize the effectiveness of the AEMP in terms of determining the effects of the project on the aquatic ecosystem, evaluating the accuracy of impact

predictions, assessing the efficacy of impact mitigation measures, and identifying the need for additional mitigation measures to reduce or eliminate environmental effects.

The recommended framework should be used to support the collection and interpretation of baseline data prior to environmental assessment and project licencing, to design and implement the AEMP for the project construction and operation periods, and to evaluate effects on the aquatic ecosystem during and following project closure and reclamation. By doing so, the data and information that are collected throughout the life of the project are likely to be as comparable as possible, making long-term trend assessment possible and before-after effects assessment more reliable. Each of the steps in the framework identifies opportunities for consultation with Aboriginal governments/organizations and other interested parties, as well as opportunities for the incorporation of TK, in the AEMP development process. Through establishment of an AEMP Working Group project proponents are strongly recommended to avail themselves of opportunities to strengthen the AEMP design, to streamline the AEMP approval process, to solicit involvement during AEMP implementation, and to enhance interpretation of AEMP results. Importantly, when applicable, the requirements of the Environment Canada's EEM program can be addressed through focussed application of the AEMP Guidelines and consistent coordination with EEM during the AEMP development process (that is, the AEMP development process is sufficiently flexible to generate data that can be used for both purposes).

6.3 Linkage of Aquatic Effects Monitoring Programs to Project Management

To support effective water resources management and the long-term sustainability of aquatic ecosystems, the results of well-designed AEMPs must be used to guide decisions regarding the management of the development project as a whole. That is, the AEMP results must be used to identify the need for further mitigation to avoid or minimize project-related effects on the aquatic ecosystem and/or its uses. To do so, project proponents must be willing to adopt a management approach that effectively addresses any aquatic effects that are associated with the project. Responsible

regulatory boards should in turn ensure that project proponents establish MRPs that include conservative Action Levels and utilize these benchmarks to implement mitigative measures in a timely manner (i.e., before project-related effects exceed environmental assessment predictions). These Action Levels are to be explicitly identified in the AEMP Analysis Plan and are linked to the critical effect sizes identified in the environmental assessment.

An MRP represents a useful management tool if it appropriately identifies key issues relative to effects on the aquatic ecosystem and its uses, and establishes Action Levels that are sufficiently conservative to provide adequate time to implement any required mitigation measures. Since background conditions are likely to be used to define certain types of Action Levels, it is essential that adequate baseline monitoring data are available to establish background conditions prior to water licencing and that procedures for calculating background concentrations are defined in the AEMP Analysis Plan.

6.4 Conclusions

In the NWT, AEMPs are required to provide the data and information needed to:

- Determine if aquatic ecosystems and their uses are being adequately protected in areas affected by major development projects;
- Determine the short-term and long-term effects on aquatic ecosystems that occur in conjunction with the construction and/or operation of a project;
- Evaluate the accuracy of the predictions that are made in environmental assessments regarding the impacts of a project on aquatic ecosystems, if applicable;
- Assess the efficacy of impact mitigation measures that are used to minimize the effects of the project on aquatic ecosystems; and,
- Identify the need for additional impact mitigation measures to reduce or eliminate project-related effects on aquatic ecosystems (i.e., to be addressed within a management response framework).

Both TK and western science must be used to obtain the data and information needed to support these objectives. AEMPs should also provide the data and information needed to evaluate the cumulative effects on the aquatic environment that may occur due to the presence of multiple human activities within an area or region. In this context, project-specific AEMPs must support regional cumulative effects assessments. This objective can be met through appropriate problem formulation and AEMP planning.

The AEMP Guidelines provided in this document are intended to assist project proponents in developing AEMPs that are acceptable to Aboriginal governments/ organizations, federal and territorial governments, regulatory boards, and other interested parties. By doing so, these AEMP Guidelines and the series of AEMP Technical Guidance Documents, along with the TK "Toolbox"/Guidance Document (forthcoming summer 2009), should enable project proponents to develop AEMPs that can be reviewed and approved in a timely and efficient manner by the responsible regulatory boards.

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Appendix

Appendix 1 Results of a Survey Conducted to Establish Guiding Principles to Guide the Development of Aquatic Effects Monitoring Programs in the NWT

A1.0 Survey Results

Terriplan Consultants (2006) conducted a series of interviews with representatives of selected Aboriginal governments/organizations, regulatory bodies, monitoring agencies, consulting firms, and industry to support determination of expectations and best practices related to baseline monitoring, limnological assessment, and aquatic effects monitoring. As part of this survey, respondents were asked to identify a series of principles that could be used to guide the development of AEMPs. In response to that request, the interviewees provided the following input (as reported in Terriplan Consultants 2006):

- AEMPs must be scientifically defensible and rigorous;
- The AEMP development process must be clear, transparent, realistic and enforceable;
- AEMP Guidelines should be fair and consistent to allow for sustainable development;
- AEMPs must be designed to detecting changes in the aquatic environment early in the project development process (i.e., provide an early warning of aquatic effects) so that proponents can respond to these aquatic effects in a timely manner (e.g. within an adaptive management framework);
- Baseline data should be collected in a manner that facilitates comparison with data collected during project construction and operation (locations, timing, frequency of sampling, determination of limits, etc.);
- An integrated and cost-effective approach to aquatic effects monitoring should be used in AEMPs;
- AEMPs should be designed to detect project-related effects with a specified level of confidence;
- AEMPs should contribute to broader cumulative effects assessment initiatives and enhance the understanding of stressors and variability that occur at a regional scale;
- AEMPs should be integrated within an adaptive management framework that maximizes the potential for early detection of effects and implementation of specific mitigation measures;

- A consistent approach to monitoring and the sharing of information should be used in the design and implementation of AEMPs;
- Clear objectives for AEMPs must be established early in the design process and the AEMP must be designed to support these objectives (i.e., an objective-driven approach should be used);
- AEMP Guidelines must be flexible and adaptable, so they can be applied to different projects in the north and to changing conditions (climate change, operational changes). Such flexibility is required to enable proponents to adjust management and mitigation to incorporate learning/ new information, and to incorporate unexpected results into management and mitigation plans;
- The Precautionary Principle should be applied in the AEMP development and implementation process (i.e., err on the side of caution because there are so many unknowns with respect to large-scale development in the north);
- Monitoring plans should be scaled to the size of the development;
- AEMPs should focus on common ecosystem components (benthos and algae), with a decreased focus on destructive parameters (e.g. lethal fish sampling) and how to interpret them;
- Traditional Knowledge and western scientific knowledge should be equally considered in the AEMP development process;
- While providing consistency and standardized approach, the AEMP Guidelines should reflect project-specific and sector-specific differences. That is, the AEMP Guidelines should recognize that different projects occur in different environmental settings, and that the effects of, for example, a pipeline will be different from those of a diamond mine;
- Project proponents should focus on timely, clear and accurate communication of the results of AEMPs to all interested parties and the broader scientific community;
- Project proponents should be held accountable for properly developing and implementing AEMPs;
- Environmental protection should be identified as the primary goal of AEMPs and associated adaptive management initiatives;
- AEMPs should effectively identify the primary receptors in aquatic ecosystems (e.g., fish and water quality) provide the data and information needed to protect these resources;
- The monitoring and assessment required under the AEMPs must be conducted by the project proponents;
- The results of AEMPs must be communicated in such a manner that they are readily understood by communities, regulators and scientists;

- Monitoring requirements should be directly linked to the Environmental Assessment (EA). More specifically, the EA results should focus monitoring programs by determining what is important to monitor. In addition, some of the tools used for the EA can be carried over to monitoring programs (e.g. predictive models used for EAs can be added to, updated and refined during monitoring programs). This will improve understanding and forecasting and allow proponents to react to what was predicted;
- AEMPs must be designed to support the different types of monitoring that are needed to evaluate project-related effects, including: compliance monitoring (water licence, Environmental Agreements); operational monitoring (surveillance network programs); and regional cumulative effects monitoring;
- AEMPs must be designed to provide the data and information needed to evaluate: 1) The status of the aquatic environment (i.e. monitoring to evaluate the conditions in the receiving environment; i.e., do they meet the licence requirements, do they agree with the EA predictions, are water quality guidelines exceeded); 2) Trends in the characteristics of the aquatic environment (i.e., spatial and temporal trends; i.e., to determine if conditions changing over time or space); 3) The effects of project-related activities on the aquatic environment (i.e., there may be temporal trends, but they may not result in 'effects');
- The measures and indicators that are selected for inclusion in AEMPs must have clear purposes (i.e., monitoring programs must have a purpose and not be monitoring for the sake of monitoring);
- Clear criteria must be established for selecting indicators;
- Action Levels and the actions that will be taken if they are exceeded must be defined early in the AEMP development process;
- Difference between effects monitoring and research must be made clear (i.e., companies should focus on effects monitoring and if research is a requirement, it must be clear how this will add value to an AEMP);
- Limitations on the existing knowledge about arctic ecosystems should not stand in the way of decision making;
- AEMP programs should meet principles of smart regulation;
- Where AEMPs bump up against the limitations of scientific knowledge and Traditional Knowledge, decisions regarding the AEMP must be reasonable;
- Once a monitoring program is established, few changes should be made to the program as it must stand the test of time. Changes diminish the value of a program by making it impossible to compare results from one sampling time to another;
- Be clear about the difference between 'monitoring for no changes' and 'monitoring for changes' where change is predicted. Sampling and interpretation

of data may be different. In general, standard sampling methods are designed to monitor to detect for no change and may not be useful for monitoring for change where change is predicted;

- Clarity of roles and responsibilities of interested parties: 1) It is the responsibility of the proponent to operate within the terms and conditions of water licences/permits and to manage environmental impacts of the project; 2) It is the responsibility and role of the intervener to participate in the approval process and stick by their decisions; and,
- Evaluation of projects that will significantly impact aquatic environments must combine monitoring and research components in a defensible and flexible (adaptive) manner, over time frames sufficient to meet management and scientific needs. A combination of short- and long-term evaluations is required.