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Overview of the Metal Mining Environmental Effects Monitoring Program

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The amended *Metal Mining Effluent Regulations* (MMER), will include a requirement for mines to conduct Environmental Effects Monitoring (EEM) under the authority of the *Fisheries Act*. The EEM program will determine if mine effluent is having an effect on fish, fish habitat and the use of fisheries resources. The metal mining EEM program strives to balance site-specific requirements with the need for national consistency. The program uses a tiered approach to monitoring, where the results of previous monitoring determine the frequency and extent of monitoring subsequently required. The frequency and extent will therefore vary depending on whether there are observed effects.

Key words: **monitoring, mining, effects, effluent, regulation**

Development of the Metal Mining EEM Program

The development of the Environmental Effects Monitoring (EEM) program for metal mining began in 1993 with the Assessment of the Aquatic Effects of Mining in Canada (AQUAMIN). This multistakeholder program evaluated the effectiveness of the current *Metal Mining Liquid Effluent Regulations* (MMLER), federal regulations under the *Fisheries Act*. The AQUAMIN Final Report (AQUAMIN 1996) made detailed recommendations to Environment Canada for the design of an EEM program for metal mining, as well as amendments to the MMLER. In 1997, Environment Canada initiated a second multistakeholder consultation to develop requirements and detailed guidance for the metal mining EEM program, using the AQUAMIN recommendations as a starting point. Leading this process was a multistakeholder Working Group co-chaired by representatives of Environment Canada and the Mining Association of Canada. The Working Group also included representatives of other federal departments (i.e., Department of Fisheries and Oceans, Natural Resources Canada, Indian and Northern Affairs Canada), several provinces (i.e., Ontario, Saskatchewan, British Columbia), the Cree Regional Authority and the Canadian Environmental Network. The Working Group made decisions by consensus as two key deliverables were prepared: a document outlining proposed requirements for EEM,

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and a detailed guidance document providing details to assist with the implementation of the requirements. To assist in preparing these deliverables, the Working Group established four subgroups to develop technical requirements and guidance in the following areas: fish monitoring; benthic invertebrate monitoring; effluent, water and sediment monitoring; and sublethal toxicity testing. Each of these subgroups was also multistakeholder, and like the Working Group, all subgroups worked to achieve consensus on issues related to both the requirements and the guidance. In total, more than 60 people were involved in the process, as members of the Working Group or one of the subgroups.

In parallel with AQUAMIN and the subsequent consultations on the design of the EEM program, Natural Resources Canada led an initiative called the Aquatic Effects Technology Evaluation (AETE). The objective of AETE was to evaluate environmental monitoring technologies to be used by the mining industry and regulatory agencies in assessing the impacts of mine effluents on the aquatic environment and to recommend specific methods or groups of methods that will permit accurate characterization of environmental impacts in the receiving waters in as cost-effective a manner as possible (e.g., AETE 1997, 1999). This program included participation of several technical experts from Environment Canada, as well as numerous experts from the Department of Fisheries and Oceans, provinces such as Ontario, Saskatchewan, and British Columbia, and the mining industry. There was extensive cross participation of experts in AETE and the EEM consultation process. AETE conducted detailed case studies at several mine sites across Canada, and also completed 20 detailed technical evaluations of a range of monitoring methods. The results of these case studies and technical evaluations, together with the final conclusions of AETE (ESG 1999) were given significant consideration by the EEM Working Group and the subgroups in the development of the proposed requirements and guidance for the EEM program. For more information on AETE, please visit the AETE web site: *http://www.nrcan.gc.ca/mets/aete*.

The consultation on the EEM program culminated in 1999 with a consensus agreement on proposed EEM requirements and the completion of a guidance document (Environment Canada 2001) which includes information on fish and benthic invertebrate monitoring, and the testing of effluent, water and sediment using chemical and toxicological measures.

This paper provides an overview of the metal mining EEM program which was agreed to by the Working Group. Other papers in this issue provide details on recommendations of the associated subgroups on the monitoring of fish, benthic invertebrates, and testing of effluent, water and sediment using chemical and toxicological measures. The EEM requirements proposed through the consultation process were submitted to Environment Canada for legal and policy review as part of the process of drafting of the amended regulation, to be called the *Metal Mining Effluent Regulations* (MMER). Following the legal review, the MMER and associated EEM requirements were published in the Canada Gazette, Part 1, for public comment (Canada Gazette 2001).

Key Aspects of the Program

All mines regulated under the MMER will be required to conduct EEM. The objective of metal mining EEM is to evaluate the effects of mining effluent on the aquatic environment, specifically fish, fish habitat and the use of fisheries resources. To evaluate effects on fish, mines will be required to conduct fish population surveys, while fish tissue analyses will be used to evaluate effects on the use of fisheries resources. To evaluate effects on fish habitat, mines will be required to conduct benthic invertebrate community surveys. An effect is defined as a statistically significant difference in measurements taken between an exposure area and reference area for fish and benthic invertebrates. Fish and benthic invertebrate monitoring, together, constitute the biological monitoring component of the EEM program. Mines will also be required to conduct effluent and water monitoring.

The MMER are technology based, and as a result, the level of environmental protection offered by the regulations may not be sufficient at all mine sites in Canada. EEM provides a feedback loop on the health of aquatic ecosystems potentially affected by mining activity, and the information from EEM will be used to assess the adequacy of the regulations, and to ensure proper environmental management, conservation and protection.

The metal mining EEM program is designed to ensure flexibility and avoid duplication of effort, and it strives to balance site-specific requirements with the need for national consistency. The program allows for use of historic data and data from monitoring programs required by other regulatory agencies. Further, the program is based on the guiding principles of cost-effectiveness and scientific defensibility. The EEM program is a monitoring tool and is not designed or intended to be a research program. All data from the EEM program will be reported to Environment Canada, and a national database of EEM data will be compiled. This database will be available to the Canadian public and to the scientific community.

One of the most important aspects of the metal mining EEM program is that it is a tiered program, with the design of monitoring for a site being determined, in part, by the results of previous monitoring at that site. If EEM identifies effects at a site, then subsequent EEM studies will be more intensive, to determine the magnitude and extent of the effect, and ultimately identify the cause of the effect. On the other hand, if EEM studies consistently indicate that there are no effects, then the frequency of some monitoring activities may be reduced. The tiered nature of the EEM program is illustrated in Fig. 1. The entire metal mining EEM program will undergo a review five years after it comes into effect.

Biological Monitoring

There are three main elements to biological monitoring: preparing a study design and conducting the monitoring; analyzing and interpreting the data collected during monitoring; and preparing an interpretive

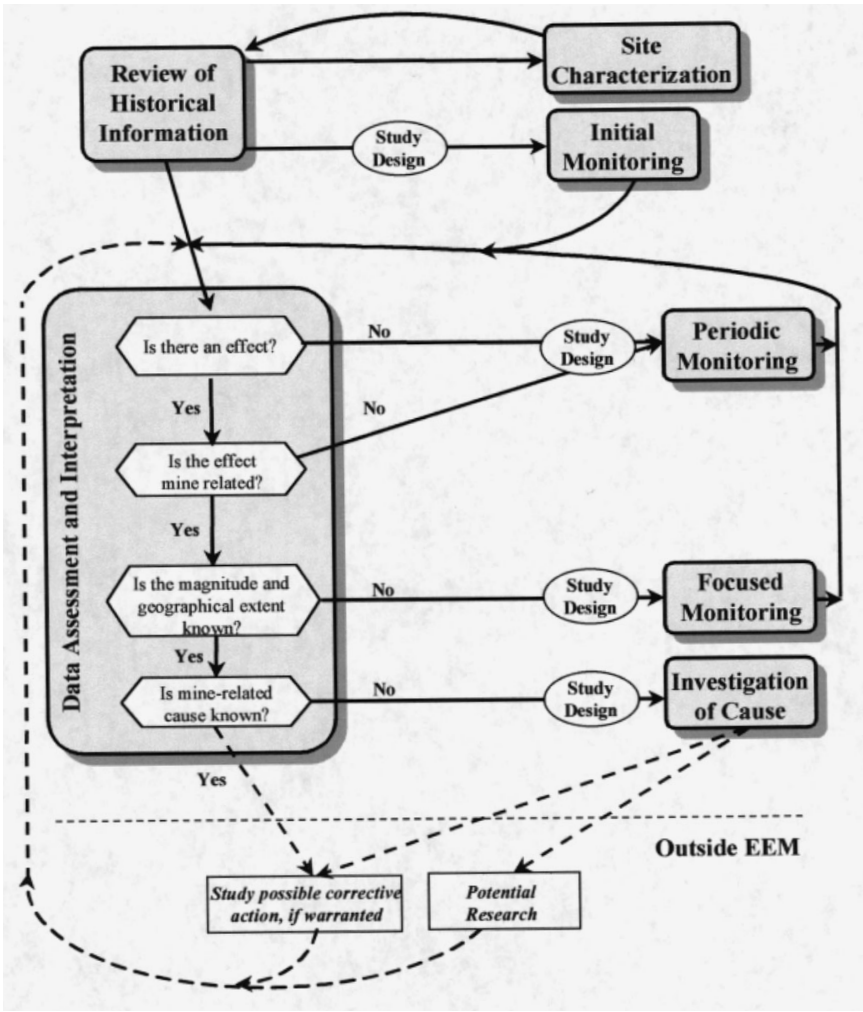

Fig. 1. EEM program activities, demonstrating the tiered nature of the program.

report, which includes the date, results and conclusions of biological monitoring, as well as a schedule outlining when the interpretive report on the next EEM monitoring study will be submitted.

There are three different types, or phases, of biological monitoring: periodic monitoring, focused monitoring, and investigation of cause.

Periodic Monitoring

Mines will be required to conduct periodic monitoring of fish populations and benthic invertebrate communities to determine if there are effects, or to confirm the results of previous monitoring. Periodic monitoring will also allow for the generation of temporal trend data. Mines will be required to submit interpretive reports every three years, detailing the results of periodic monitoring. However, after two consecutive inter-

pretive reports, if there are no reported effects on fish, fish usability and benthic invertebrates, then the frequency of monitoring may be reduced to once every six years.

If effects on fish, fish usability or benthic invertebrates are reported, then periodic monitoring may be used to confirm that the observed results are reproducible. Mines may also add additional sampling sites to confirm that the effluent is the source of the effects observed. If effects on fish, fish usability, or benthic invertebrates are reported in two consecutive interpretive reports submitted for periodic monitoring, then the mine will conduct focused monitoring.

Focused Monitoring

Once effects are identified and confirmed in periodic monitoring, the mine then proceeds to focused monitoring. The objective of focused monitoring is to determine magnitude and geographical extent of effects identified in periodic monitoring. The scope and emphasis of focused monitoring will be site-specific, and will depend on previous EEM results. Interpretive reports for focused monitoring are to be submitted two years after the previous interpretive report for periodic monitoring was submitted.

Investigation of Cause

Investigation of cause studies will be conducted once the magnitude and geographical extent of effects are known. Investigation of cause monitoring studies will be designed in a site-specific manner, using various monitoring tools as appropriate to identify the cause of the previously identified effects. Interpretive reports for investigation of cause are to be submitted two years after the previous interpretive report for focused monitoring was submitted.

Once the cause of an effect has been determined, the cause will be tracked through further periodic monitoring. Although outside of the requirements of EEM, mines with observed effects will be encouraged to examine and implement possible corrective actions.

Effluent and Water Monitoring

The effluent and water monitoring requirements of the metal mining EEM program include water quality monitoring, effluent characterization and sublethal toxicity testing. Effluent and water monitoring will provide additional, supporting information on effluent quality as well as water quality in the exposure area. This information may be helpful in designing and interpreting biological monitoring studies. Mines will commence effluent and water monitoring six months after they becomes subject to the amended MMER, and the results of effluent and water monitoring will be reported annually.

Water quality monitoring and effluent characterization will be conducted quarterly, and samples will be analyzed for a range of parameters. A battery of four sublethal toxicity tests will be conducted twice a year for the first three years of the program, and once a year thereafter.

Conclusions

Once the metal mining EEM program is in place, it will be recognized as an important tool for environmental management in the mining sector. Within a consistent and rigorous framework it will provide new information on the effects of mine effluents on fish, fish habitat and the use of fisheries resources. This information will add a new dimension to the information available to decision makers, nationally, regionally, and site-specifically, and it will facilitate the consideration of environmental effects in decisions related to environmental management and protection. It will also provide an extensive database of information on the environmental effects of mine effluents across Canada, and this database will be available to the Canadian public as well as the scientific and international community.

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