Jacques Whitford AXYS

Environmental
Engineering
Scientific
Management
Consultants

4370 Dominion Street
5th Floor
Burnaby BC
Canada V5G 4L7

Bus 604 436 3014
Fax 604 436 3752

www.jacqueswhitford.com
www.axys.net

Review of the Diavik and Ekati Diamond Mines

ADAPTIVE MANAGEMENT PLANS

INITIAL REPORT

Prepared for:
Environmental Monitoring Advisory Board
Yellowknife, NWT

Prepared by:
Jacques Whitford AXYS Ltd.
Burnaby, BC

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Jacques
Whitford
AXYS

PROJECT NO.	**1037316.**
REPORT TO	**Environmental Monitoring Advisory Board** Yellowknife, NWT Attention: Mr. John McCullum, Executive Director
FOR	**Initial Report**
ON	**Review of the Diavik and Ekati Diamond Mines' Adaptive Management Plans**

April 28, 2008

Jacques Whitford AXYS Ltd.
4370 Dominion Street, 5th Floor
Burnaby, British Columbia
V5G 4L7

Phone: 604.436.3014
Fax: 604.436.3752

Background

The Environmental Monitoring Advisory Board (EMAB) and the Independent Environmental Monitoring Agency (IEMA) have requested assistance from Jacques Whitford AXYS Ltd. (JWA) in the review of the Diavik and Ekati Diamond Mines' Adaptive Management Plans, respectively. These plans have been submitted to the Wek'èezhìi Land and Water Board (WLWB) as a condition of each company's Water Licence. This report is an initial review of these AdMPs. Participants at a May 14-15, 2008 workshop will provide input to the review. JWA will then submit by May 22, 2008 a final report incorporating workshop findings.

From its work order, the primary tasks of JWA are to:

1. Present a framework and/or elements of an effective AdMP
2. Assess each AdMP against the Framework (N.B. a detailed assessment of the specific contents such as validity of threshold levels selected is not expected, rather the review is to address overall adequacy in relation to the ideal framework)
3. Present initial reviews and facilitate workshop discussions of the objectives and elements of adaptive management and of the mines' Adaptive Management Plans.
4. Submit final reviews of the Davik and Ekati Adaptive Management Plans.

Table of Contents

List of Tables

List of Acronyms

AdM	Adaptive Management
AdMP	Adaptive Management Plan
AEMP	Aquatic Effects Monitoring Program
EMAB	Environmental Monitoring Advisory Board
IEMA	Independent Environmental Monitoring Agency
WLWB	Wek'èexhìi Land and Water Board

1 Adaptive Management – a learning process

1.1 Overview

The Diavik and Ekati Diamond Mines, like any large projects, have potential for significant positive and negative effects. In project design and management we attempt to maximize the positive and mitigate or eliminate the negative.

Uncertainty of outcomes is unavoidable, even with the best design. Even with plans based on the best knowledge, the knowledge will be imperfect. Adaptive management acknowledges the uncertainty and treats the management itself as an experiment. It is a disciplined process of learning by doing—learning from management outcomes, and adjusting project management based on what is learned.

Clearly defined management objectives to guide decision making are required. The adaptive approach involves:

- exploring alternative ways to meet management objectives
- predicting the outcomes of alternatives based on the current state of knowledge
- implementing one or more of these alternatives
- monitoring to learn about the impacts of management actions
- using the results to update knowledge and adjust management actions

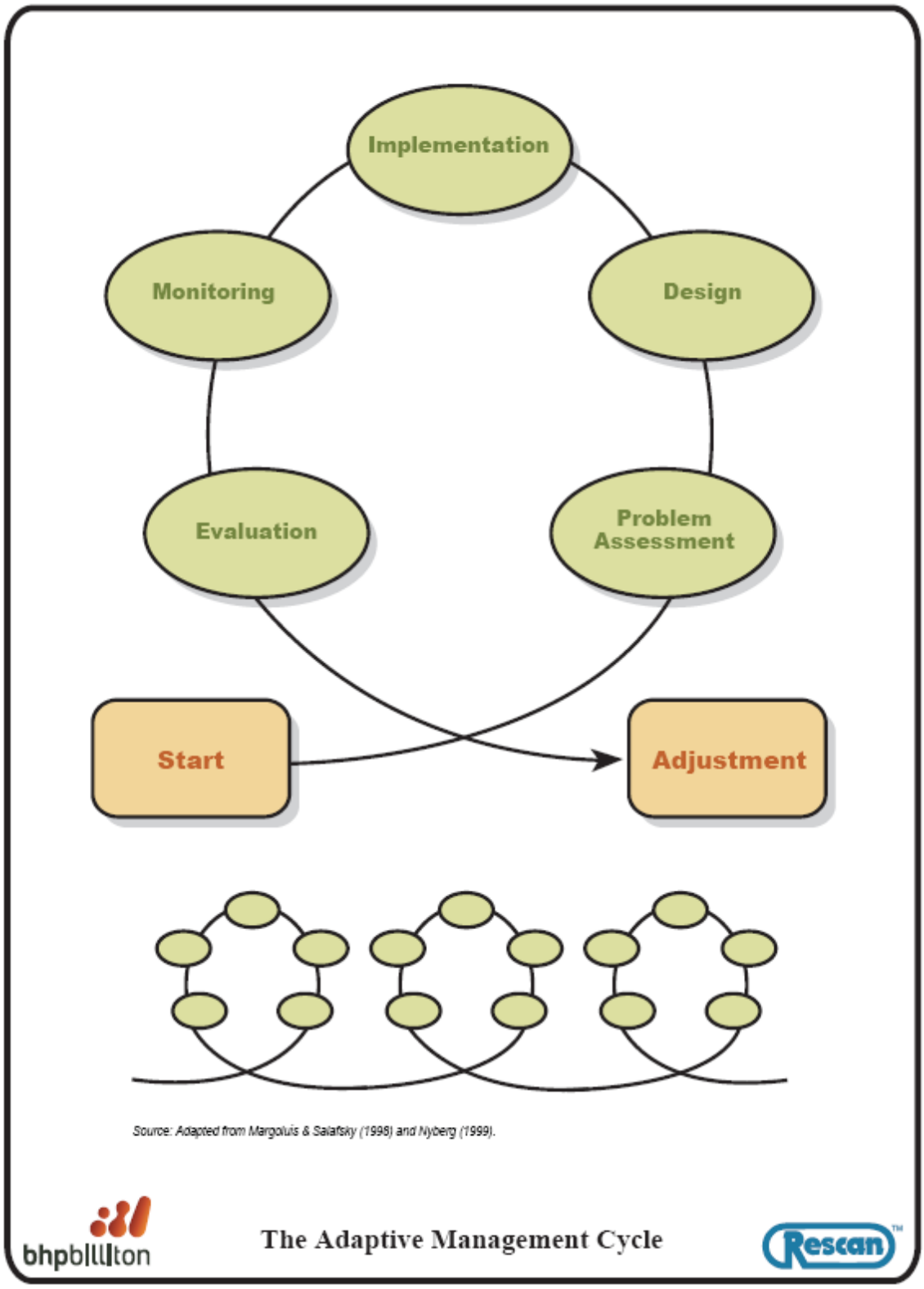
The adaptive management process provides a systematic means for maximizing learning and making adjustments that improve project implementation and management of overall project effects. The process has six steps, which are repeated over time as needed: (1) assessment, (2) Design, (3) Implementation, (4) Monitoring, (5) Evaluation, and (6) adjustments/revisions. Monitoring of impacts is a critical element of implementation. It provides information for the second cycle of assessment leading to adjustments in project design and implementation.

The adaptive management process needs to involve all stakeholders, not just the technical experts, and the commitment of the management team to carry out the plan. Therefore, the establishment of objectives and the evaluation of project impacts—what is negative, positive, or inconsequential, and what are tolerable levels of risk—are value judgments, essentially a set of social decisions.

1.2 Framework and Elements

There is extensive literature on adaptive management. This review drew upon the summaries of the adaptive management process prepared for Fisheries and Oceans Canada (Greig, et. al. 2008) and for the U.S. Department of the Interior (Williams, et. al 2007). The discussion below presents the commonly accepted view of the framework and the six elements of the adaptive management process. A diagram from the Ekati plan is reproduced here in Figure 1 as it shows the cyclic nature of adaptive management.

Figure 1: The Adaptive Management Cycle



1. Assess

The first element is taking stock of the available knowledge and data to identify potential project impacts, positive and negative, and areas of uncertainty. This information is used to develop clear, measurable, and agreed-upon management objectives to guide decision making and evaluate how effective the management is over time. The objectives also need to allow for suitable timeframes for action, to allow adjustments to be made before adverse effects can occur. An adaptive management approach is not appropriate or possible when an activity is likely to result in irreversible consequences.

Objectives need to incorporate the social and economic interests of stakeholders. Engagement of stakeholders from the beginning and throughout is, therefore, essential to inform and guide the adaptive management process.

The assessment stage should result in a clear understanding of current knowledge and the identification of objectives and issues that the management plan is to address.

2. Design

The experimental design for the adaptive management plan is developed in this element. Scenarios or models are created that incorporate different ideas and uncertainties about how the natural system functions and hypotheses or ideas about what will happen as a result of various alternative management actions. Management alternatives are then designed to test the identified uncertainties. These are tested in subsequent steps, which will allow the most suitable management actions to be selected from among the alternatives.

A key component to the design phase is the establishment of measureable indicators and a sound monitoring plan.

Adaptive management can be either “active” or “passive”. Either approach uses the same six steps. With active management, alternative management actions with explicitly different predicted outcomes are simultaneously tested as different treatments in an experiment and the results compared. With passive adaptive management, there is one management alternative that is believed to be the best and actual results are tested against the predicted results. Passive management does not provide as robust an experimental design and the learning is slower as one alternative is tested at a time. However, active management is not an option when the testing of different alternative management actions is too costly or not feasible, or the resource being managed is so vulnerable that only the best judged practice should be applied.

3. Implement

Implementation is a straightforward element in adaptive management; however its success depends on the commitment of the required resources—staff, equipment, etc.—to conduct the plan as designed.

4. Monitor

Monitoring programs are designed to provide data on the status of the natural resources of interest, the success in meeting management objectives, and the different effects among the alternative management actions tested. The success of the evaluation and adjustment stages of adaptive management depends on the quality and adequacy of the monitoring data, and these data must be available within a time frame that allows for adaptive decision making.

5. Evaluate

Evaluation is the learning stage of adaptive management. Monitoring results are compared against management objectives and the predicted results for each of the tested alternative management actions. The evaluation process needs to involve all stakeholders, for the significance of the results will vary depending on the value placed on the resources, differences in the level of risk that is tolerable, and other subjective issues.

6. Adjust

Based on evaluation findings models, hypotheses, and management actions can be revisited and adjusted.

1.3 Links between Environmental Assessment, Environmental Monitoring and Adaptive Management

From the initial concept for a mine to full operation, there are several steps and processes in place to reduce the potential for negative effects on the environment, in these cases, the aquatic environment. There are permits and monitoring requirements, and ongoing regulatory and stakeholder review. The planning phase includes an environmental assessment, which includes predictions about potential effects that could occur and commitments to environmental management to mitigate effects. The construction, operations and closure phases include environmental monitoring programs to evaluate whether there are any unexpected adverse effects on the environment. It makes sense that if the monitoring results indicate conditions are worse than predicted, the company changes their management plans and adopts new mitigation strategies in a timely manner. This latter aspect is the core purpose of an adaptive management plan.

The following information is provided as a review to place each of the processes in context.

1.3.1 The Environmental Assessment

The environmental assessment is a planning document that:

- identifies potential effects of the project on the environment
- describes mitigation measures to reduce the potential for adverse effects
- assesses the residual (or remaining) effects on the environment
- determines whether these residual effects will be significant
- considers whether there will be any cumulative effects or interactions with other projects in the area
- includes commitments by the proponent to certain environmental and other management plans, monitoring programs and other requirements associated with a water license and other permits

Since the environmental assessment is a planning document, it needs to be “ground truthed” when operations begin. There can be uncertainty about the effects that can occur, how effective certain mitigation measures will be, or how much better or worse than predicted water quality may be. High natural variability or global processes such as climate change may influence the outcomes.

1.3.2 The Environmental Monitoring Programs

Typically, the mine is built as described in the Project Description, following the various environmental management plans, although there may be changes to incorporate newer technology. The mine develops environmental monitoring plans (e.g., Aquatic Effects Monitoring Programs for Diavik and EKATI) and conducts the monitoring to evaluate how well its operations meet standards to protect the environment. These plans need to include a statistically and ecologically sound approach to answering the question “Does the mine have an effect on the environment?” The science of Environmental Effects Monitoring is well developed in Canada, based on requirements of Environment Canada for metal mines and pulp mills. Considerable effort is spent conducting these programs, which include both physico-chemical (water and sediment) and biological (fish, plankton, benthic organisms) components.

There is a certain amount of uncertainty in environmental monitoring due to natural variability and statistical considerations. An experiment (or monitoring program) is set up to test a hypothesis or idea, for example, “there is no effect of mine discharges on the aquatic environment and all the current mitigation strategies are working as designed.” Statistical experts have shown that even the best-designed studies have a chance of error, although the probability can be reduced by expanding the monitoring program. The errors are referred to as Type I and Type II errors, as shown in Figure 2.

Figure 2: Types of Errors Encountered in Studies

Type I Error	Hypothesis	Type II Error
False positive – rejecting a hypothesis that should have been accepted	There is no effect of mine discharges on the aquatic environment – all the current mitigation strategies are effective	**False negative** – accepting a hypothesis that should have been rejected

There are implications to either type of error. A Type I Error can be considered as, "you think you have a problem but you don't." In this case, a mine would invest in additional infrastructure and new mitigations that don't make a difference in environmental conditions (the risk is to the mine company). A Type II Error can be considered as, "you don't think you have a problem, but you do." The implication for a Type II Error is that the mine continues operating according to current plans and standards, but the ongoing changes in the aquatic environment are not recognized and can continue to grow in magnitude (the risk is to the environment).

The scientists preparing the study designs for monitoring programs use both ecological and statistical tools to define how much effort should be required to determine if there are significant effects on the environment. The challenges include:

- distinguishing natural variability from any effects resulting from mine operations
- deciding how many samples should be collected, how often, how many sites; with fish, for example, it is important to not over-sample so that natural populations decline due to the monitoring program
- defining what thresholds or guidelines should be used to recognize an effect (approaches such as weight-of-evidence are useful in dealing with the many interrelated studies and data from the monitoring programs)
- understanding the ecological implications of potential effects (tools such as weight-of-evidence and risk assessment can be useful in understanding how organisms can be affected, and to what extent)

1.3.3 The Adaptive Management Plan

The role of an adaptive management plan is to make sure results of the monitoring programs are incorporated into ongoing environmental management of the facility. This ensures that the environmental management plan is adaptable and responsive to any negative changes identified by monitoring.

The key questions to consider in evaluating an Adaptive Management Plan are:

- Does the plan describe how to identify whether the current strategy is working or is not working as well as predicted?
- Does the plan have a way of determining if the effects are related to mining operations and not to some other cause?
- Does the plan offer options (alternative mitigations) that are realistic and likely to be successful in reducing negative effects?
- Is there a suitable timeframe between identifying a problem and implementing a solution, to limit the extent of any adverse effects?

2 Evaluation of the Diavik Diamond Mine Adaptive Management Plan for Aquatic Effects

Diavik Diamond Mines Inc. (Diavik) submitted an Adaptive Management Plan to the Wek'èezhìi Land and Water Board in August 2007. The Diavik Site is located on East Island in Lac de Gras, NWT and has operated under the terms and conditions of a Class A Water License since 2000.

An Aquatic Effects Monitoring Program (AEMP) is conducted annually to "determine the short and long-term effects on the aquatic environment resulting from the project, test impact predictions, measure the performance of operations and evaluate the effectiveness of impact mitigation" (Part K (6) of Water License). There are five monitoring programs within the AEMP: effluent, dust and snow, seepage and runoff, special effects studies (e.g., dikes) and traditional knowledge monitoring activities.

The Wek'èezhìi Land and Water Board directed Diavik to prepare an Adaptive Management Plan for the AEMP to describe "how data from the AEMP will be used to identify the need for additional mitigation strategies to minimize the impacts of the project on the aquatic environment."

The overall evaluation of the Diavik plan in terms of the formal elements of an adaptive management plan is summarized in Table 1 and discussed below.

Table 1: Summary of Review of Diavik Mine Aquatic Effects Adaptive Management Plan

Stages/Elements of Adaptive Management	Diavik Diamond Mine Aquatic Effects Adaptive Management Plan
1. Assess	
• Engage Stakeholders	✓ Environmental Monitoring Advisory Board and Wek'èezhìi Land and Water Board
• Assess existing knowledge	✓ Aquatic Environmental Monitoring Program
• Identify management goals	✓ Water License
• Identify uncertainties	✓ Aquatic Environmental Monitoring Program
2. Design	
• Models/hypotheses	?✓ Some are described in Section 2 of AdMP, but they are related more to the AEMP than to the adaptive management. The main hypothesis of the AdMP is not explicitly stated.
• Management action(s) to be applied	?✓ Assume that this is to follow current Environmental Management Plan
• Measurable indicators	✓ Described in Section 3 of AdMP
• Monitoring and data analysis plan	✓ Described in Sections 2 and 3 of AdMP
3. Implement	
• Implement Plan	✓ Annual commitment to AEMP and AdMP
4. Monitor	
• Monitor Results	✓ Annual commitment to AEMP and AdMP

Stages/Elements of Adaptive Management	Diavik Diamond Mine Aquatic Effects Adaptive Management Plan
5. Evaluate • Compare results against model prediction	✓ Method described in Section 3 of AdMP
6. Adjust • Adjust model/hypothesis and management plan	?✓ Some management strategy options are described in Section 4 of AdMP, but details about how effective they are likely to be are not provided.
• Adjust Management implementation	✓ Implicit in the AdMP

Diavik's approach to an Adaptive Management Plan includes the four components below.

1. There are strong links to the AEMP, so that results of the AEMP are evaluated in terms of their effectiveness in meeting the management objectives (standards, guidelines or other clear indicators):
   - The AEMP includes water and sediment chemistry, and lake communities (phytoplankton, zooplankton, benthic invertebrates) of Lac de Gras
   - The AEMP includes a commonly accepted scientific and statistical framework to identify whether there is an effect – this includes sampling effort, frequency, investigation of cause, distinguishing of sites in the "near field", "mid field" and "far field"
   - A "weight of evidence" approach is used to evaluate the various lines of evidence about environmental conditions and considers both statistical and environmental relevance of the findings
2. Identifiable triggers or drivers for decisions and actions within the AEMP that would lead to changes in environmental management are described in Table 1-1 and Section 3 of Adaptive Management Plan:
   - defined early warning, moderate or high effects levels
   - a process to follow when an effect level is exceeded - the cause is evaluated and, if found to be caused by mine operations, Intensive Monitoring occurs
   - Intensive Monitoring will be conducted to better define the nature, magnitude and extent of the effect, and can also include additional sampling to link environmental implications of the change (i.e., implications of a change in a water quality parameter would be assessed in terms of the biological community that could be affected)
   - In the event of a moderate or high level effect that is mine-related, an ecological risk assessment will be conducted and the information used for the Adaptive Management Plan. Ecological risk assessment considers whether lake organisms are being exposed to contaminants or habitat alteration. Indicators of nutrient enrichment (eutrophication) in the lake will be examined using a weight of evidence approach to integrate the various indicators.
   - Changes to environmental management lead to additional monitoring
3. Environmental management practices at the mine and potential sources of effects to Lac de Gras are discussed in Section 2 of the Adaptive Management Plan:
   - A perimeter collection system around the island collects and contain mine source waters prior to treatment.
   - A water treatment plant treats water from various mine sources (including country rock piles, pit and plant site and processed kimberlite containment area) prior to discharge to Lac de Gras. This is the main discharge to the lake.

- Environmental protection practices are described for water, dust, waste and hazardous materials management.
- Potential issues identified include nutrient enrichment (nitrate and ammonia from blast residues), increased suspended sediment levels, introduction metals from leaching of country rock used in the dike or in mine effluent, fish mortality, alteration of fish habitat, or changes in fish tissue.

The Environmental Assessment and Monitoring Program identify three key questions – what effect would the proposed mine have on water quality, on water supply and on fish? A complex system of pathways and linkage charts is used to describe potential project-environment interactions. Significance of the potential effects were assessed and classified (Level I, Level II, Level III, depending on spatial extent and other characteristics).

4. Actions to be taken in the event an effect is recognized are discussed in Section 4 of the Adaptive Management Plan. These include:
   - Assessing the need for additional mitigation strategies
   - Identifying the source of the effect (e.g., one or more constituents of the effluent, a compound leaching through the dike, dust fall)
   - Implementing mitigation strategies (discussed in a general sense, with the comment that Diavik has already studied several of these mitigations and will be able to use the information in a timely review of options
   - Analyzing benefits versus costs and impacts for moderate and high level effects

2.1 Summary and Conclusions for Diavik

The premise of adaptive management is to deal with inherent uncertainty about potential outcomes by treating the management itself as an experiment, assessing a variety of strategies, and learning from the outcomes to make adjustments to the management plan where necessary.

The Diavik Adaptive Management Plan as presented appears to be a “passive” rather than “active” plan. It describes the current mitigation measures, management plan and monitoring program that will help evaluate any changes in Lac de Gras and a decision-making framework to address those changes. It is passive in that it presents only one, presumably optimal, option with adjustments if needed, rather than applying simultaneously more than one option to be evaluated, as would be found in an active plan.

There are various strategies possible (e.g., source control of specific contaminants through material stubstituion or management, increased recycling and reuse, reduction in source loading, water treatment, or changes to performation or location of the diffuser), but details are not provided. A short reference to their efficacy would be useful (e.g., successful use at other mines, or ongoing studies at Diavik).

The Diavik Adaptive Management Plan appears robust from a technical and decision-making perspective, capable of predicting adverse environmental effects and responding to avoid such effects. Diavik has conducted studies into possible additional mitigations, which will be helpful in timely decision-making, and indicate their commitment to sound environmental practice. However, the Adaptive Management Plan itself would benefit from a fuller description of management options should the current operating strategies result in a trigger. It is important to convey to stakeholders that there is confidence that the options available in the event of an environmental trigger are sufficient to reverse any negative trends and prevent irreversible damage to the environment, in a timely manner. A discussion of how easy and timely it is to assess results of the complex monitoring programs, work through risk assessments and implement new mitigation strategies would also be useful.

3 Evaluation of the EKATI Diamond Mine Adaptive Management Plan for Aquatic Effects

BHP Billiton has developed a Watershed Adaptive Management Plan for its EKATI mine (Rescan, 2008) as a condition of its Water Licence. As requested by the Wek'èezhìi Land and Water Board, the plan includes numerical thresholds and triggers, and is linked with the Aquatic Effects Monitoring Program.

The EKATI mine includes open pits and facilities in the Koala Watershed and King-Cujo Watershed. This assessment of EKATI's Adaptive Management Plan focuses mainly on the Koala Watershed (Beartooth, Koala, Koala North and Panda pits), as activities at the Misery pit in the King-Cujo watershed were suspended in 2005. It is assumed that the same management approaches and potential issues apply to both watersheds.

Although the Adaptive Management Plan focuses on water quality of the receiving environment, the Aquatic Effects Monitoring Program also considers environmental effects of the mine effluent discharges by monitoring the biological characteristics of the lakes, which provides ecological relevance.

The overall evaluation of the EKATI Plan in terms of the formal elements of an adaptive management plan is summarized in Table 2 and discussed below.

Table 2: Summary of Review of EKATI Mine Aquatic Effects Adaptive Management Plan

Stages/Elements of Adaptive Management	Ekati Diamond Mine Watershed Adaptive Management Plan
1. Assess	
• Engage Stakeholders	✓ Wek'èezhìi Land and Water Board and Independent Environmental Monitoring Agency
• Assess existing knowledge	✓ Aquatic Environmental Monitoring Program
• Identify management goals	✓ Water License
• Identify uncertainties	✓ Aquatic Environmental Monitoring Program
2. Design	
• Models/hypotheses	?✓ Some are described in Section 2 of AdMP, but they are related more to the AEMP than the adaptive management. The main hypothesis of the AdMP is not explicitly stated.
• Management action(s) to be applied	?✓ Assume that this is to follow current Environmental Management Plan
• Measurable indicators	✓ Described in Section 3.3 of AdMP
• Monitoring and data analysis plan	✓ Described in Section 3 of AdMP
3. Implement	
• Implement Plan	✓ Annual commitment to AEMP and AdMP
4. Monitor	
• Monitor Results	✓ Annual commitment to AEMP and AdMP

Stages/Elements of Adaptive Management	Ekati Diamond Mine Watershed Adaptive Management Plan
5. Evaluate	
• Compare results against model prediction	✓ Method described in Section 3 of AdMP
6. Adjust	
• Adjust model/hypothesis and management plan	?✓ Some management strategy options are described in Section 4 of AdMP, but details about how effective they are likely to be are not provided.
• Adjust Management implementation	✓ Implicit in the AdMP

The EKATI Adaptive Management Plan contains the following six components:

1. Description of water management practices for its facilities in the Koala Watershed and King-Cujo Watershed, including clean water diversion, waste rock storage areas, containment facilities (for seepage water, mine processing wastes and sanitary wastes) and interactions of mine water with the receiving waters. Principal elements of the practices are:
   - clean water diversion of 5.41 Mm3/year (2006), entering Kodiak, Little and Moose Lakes, mixing in Moose Lake with the outflow from Leslie Lake and the mine
   - recirculation and re-use of water wherever feasible
   - a series of treatment cells in the Long Lake Containment Facility that provide areas for settling of particulate matter and movement of cleaner water to downstream treatment cells prior to release to the receiving environment
   - discharge from Long Lake Containment Facility to Leslie Lake (first receiving waterbody) of 10.1 Mm3/year (2006) and eventual discharge to Lac De Gras
   - discharge from KPSF to Cujo Lake of 0.33 Mm3/year, with eventual discharge to Lac Du Sauvage
2. Description of current water quality monitoring results and potential issues:
   - the AEMP monitors quality of effluent from the containment facility, and water quality and aquatic life in several lakes and streams downstream of the discharges, including Lac De Gras and Lac Du Sauvage. The AEMP considers both statistical and ecological relevance in detecting changes to characteristics of the receiving environment. There is a defined methodology for evaluating long-term changes in the downstream watersheds (based on statistical tools and best professional judgment).
3. Identification of the main potential trends and concerns for water quality:
   - chloride – increase in lakes due to the addition of saline groundwater (pit dewatering); a Tier I ecological risk assessment and additional toxicology tests have been done
   - hardness – increasing in lakes, mainly from groundwater (pit dewatering); the lakes are low in hardness, and the increased hardness provides protection from metal toxicity (many water quality guidelines increase with increasing hardness)
   - nitrate – increasing in lakes – presumably related to blast residues, nitrate is a primary nutrient for aquatic plant growth, can lead to eutrophication
   - overall increase in total dissolved solids due mainly to groundwater (pit dewatering)
   - increases in some metals in the lakes, which to date are well below the thresholds. These include copper (temporary situation related to slope instability at one stream, addressed through site remediation and a Tier I ecological risk assessment), molybdenum (due to elevated

concentrations in kimberlite ore from Misery Pit, expected to decline since mining has been suspended there, addressed through a Tier I ecological risk assessment – this should be clarified, as it is unclear why ore from Misery Pit would end up at the Long Lake facility) and nickel

4. Development of thresholds and triggers for adaptive management strategies:
   - thresholds are selected to be protective of 95% to 100% of all aquatic plants and animals (depending on the statistical model used). They include CCME guidelines for protection of aquatic life; site-specific guidelines that modify CCME (based on hardness, baseline conditions, etc.); and site-specific thresholds that describe departure from baseline (a statistical definition of baseline: within 3 standard deviations of mean), to distinguish natural variability from mine-related changes
   - triggers are established to identify when action is needed to confirm the trend and take corrective action (adaptive management strategies). They give early warning of potential problems and use regression models to describe trends over time and predict conditions over the next three years
5. Monitoring of the environment and assessment of conditions against the thresholds and triggers:
   - these monitoring programs are carried out as part of the Aquatic Effects Monitoring Program
6. Identification of the response procedures and reporting:
   - if conditions are not predicted to reach a threshold, there is no trigger and BHP Billiton will continue its existing monitoring programs without altering the mine or water management strategies (unless desired for other reasons)
   - if conditions are predicted to reach the threshold within three years , a trigger is activated and BHP Billiton will respond with management strategies – the response will be tailored to the magnitude, spatial extent and reversibility of potential effects

However, there is little information about the possible management options and their effectiveness. Section 4.1 of the EKATI Adaptive Management Plan states that, “The inherent nature of an adaptive management plan is that the most appropriate response can only be developed at the time, based on the information at hand. Nonetheless, there is a ‘toolbox’ of standard responses, many of which would likely be considered at EKATI”. The toolbox describes initial responses to verify the trigger (e.g., additional sampling, QA/QC checks, risk assessment, water quality criteria) and strategies to improve conditions (modifications of the management plans and practices, or of mitigation structures and facilities), but these strategies are not discussed in any detail, nor are their effectiveness or likelihood of success discussed.

3.1 Summary and Conclusions

The premise of adaptive management is to deal with inherent uncertainty about potential outcomes by treating the management itself as an experiment, assessing a variety of strategies, and learning from the outcomes to make adjustments to the management plan where necessary.

The EKATI Adaptive Management Plan appears to be a “passive” (using one management strategy that is believed to be the best or most effective), rather than “active” plan. The premise appears to be that the current management plan is sufficient to protect the environment unless shown otherwise through monitoring (e.g., a null hypothesis that the current approach does not result in triggers for change). There are various strategies possible (e.g., adjusting pumping rates or timing of pumping from the containment facility, designing new mitigation structures or facilities), but details are not provided. A short reference to their efficacy would be useful (e.g., successful use at other mines).

The EKATI Watershed Adaptive Management Plan appears robust from a technical and decision-making perspective, capable of predicting adverse environmental effects and responding to avoid such effects. Previous responses to monitoring programs, such as instigation of ecological risk assessments, show the commitment of BHP Billiton to sound environmental practice. However, the Adaptive Management Plan

itself would benefit from a fuller description of management options should the current operating strategies result in a trigger. It is important to convey to stakeholders that there is confidence that the options available in the event of an environmental trigger are sufficient to reverse any negative trends and prevent irreversible damage to the environment.

4 Challenges and Limitations of Adaptive Management Plans

Adaptive Management is not appropriate or possible in all cases. If management decisions cannot be revisited and adjusted or if there are no alternatives, then adaptive management is not possible. A one-time decision such as whether or not to dam a river, fill in a lake, or clear cut a forest are examples of irreversible effects. Adaptive management is also not possible if reliable monitoring information cannot be obtained within a timeframe that allows adjustments to be made before irreversible or unacceptable changes to the resources occurs. Adaptive management is also not possible if an understanding of the resource system is so poor that reasonable models and hypotheses cannot be designed. This can be the case when there are too many factors to be considered and their relationship is too poorly understood to allow for meaningful experimentation.

5 Closure

Respectfully submitted,

Jacques Whitford AXYS Ltd.

Reviewed by:

Original signed by:

Original signed by:

Karen Munro, M.Sc., R.P.Bio.
Practice Lead, Aquatic Ecotoxicology,
Western Region

Jeffrey Brokaw, Ph.D.
Senior Scientist, Fisheries Group

KM/JB/mp

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