

Independent Environmental Monitoring Agency



TECHNICAL ANNUAL REPORT

2002-2003

A PUBLIC WATCHDOG FOR ENVIRONMENTAL MANAGEMENT AT EKATI DIAMOND MINE™



• ASSESSING THE REGULATORS • ASSESSING
BHPB • TRADITIONAL KNOWLEDGE • AQUATIC
EFFECTS • WILDLIFE EFFECTS • MINIMIZING
TERRESTRIAL AND AQUATIC IMPACTS • AIR
QUALITY EFFECTS AT EKATI





2002-2003

TECHNICAL ANNUAL REPORT

Recommendations:

Traditional Knowledge, Consultation and Communications

1. BHPB, the Government of Canada and the Government of the NWT should support the concept of a regional traditional knowledge (TK) panel, as recommended by the Aboriginal representatives at the TK workshop co-hosted by the Agency.

Minimizing Terrestrial and Aquatic Impacts

2. BHPB should adopt a more balanced design for haul roads and stream crossings in its attempt to minimize impacts on both aquatic and terrestrial environments. Regulators who approve haul roads and stream crossings should also ensure that a balanced assessment has been done, and that impacts both to aquatic and terrestrial environments are minimized.

Wildlife Effects Monitoring Program

3. RWED, in partnership with the Nunavut Department of Sustainable Development, should publicly report the number of wolverines harvested in the North Slave and West Kitikmeot Regions in order to determine the total number of wolverines removed from the wildlife study area.

4. DFO, in consultation with the Canadian Wildlife Service, should consider revisions to the criteria used to conduct fishout studies to reduce the potential for *by-catch* of birds.

Aquatic Effects Monitoring Program

5. DFO should conduct studies to further assess the potential *toxicity* of *nitrate* to local fish species.

Air Quality

6. We recommend that a new air dispersion modelling analysis be conducted by BHPB, and be used as the basis for future air quality monitoring work, including the siting of sampling stations.

Waste Rock Management

7. BHPB should assess the long term, i.e. post closure implications of poor quality seepage from the coarse kimberlite storage area.

Reclamation

8. BHPB should continue to explore the uptake by grazing animals of metals in plants being considered for revegetation of processed kimberlite.

9. BHPB should improve its reporting of the type and amount of materials stored in waste landfills.

10. BHPB should conduct an analysis of its spill records to determine the reasons and trends for spills as a means of improving its operating and management practices.



Introduction

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Regulators

DFO
Department of Fisheries
and Oceans.

DIAND
Department of Indian
Affairs and Northern
Development.

GNWT
Government of the
Northwest Territories.

MVLWB
Mackenzie Valley Land
and Water Board.

RWED
GNWT's Department of
Resources, Wildlife and
Economic Development.

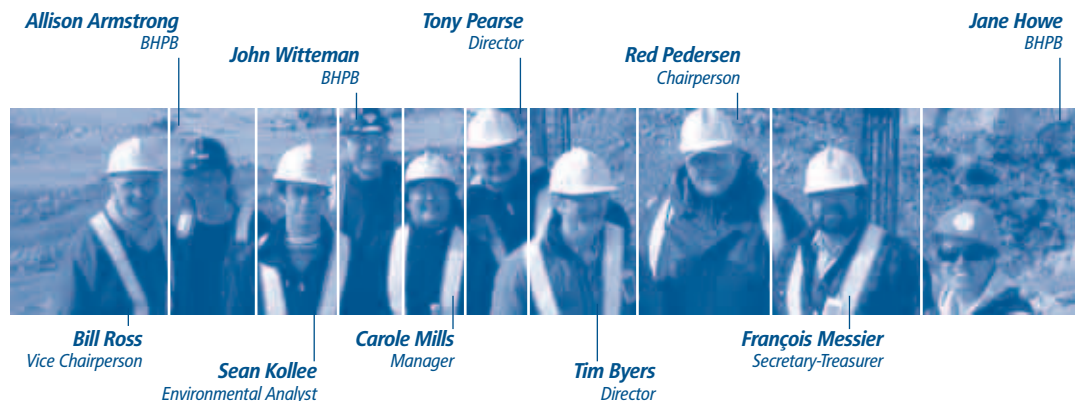
Introduction to the Technical Report

Welcome to the fifth annual report of the Independent Environmental Monitoring Agency (referred to as the Agency). Due to the many positive comments we received on last year's production of both a technical report and a plain English report we have produced two reports again for 2002/03. This publication is the technical report. If you would like to read the information in a less technical format, please refer to the plain English version.

Under the *Environmental Agreement* negotiated in 1997, the Agency has the mandate to monitor the environmental management activities of BHP Billiton Inc. (referred to as BHPB) and the regulators and to work with the company and the regulators to help address issues identified by our Aboriginal members. We start the report with assessments of ourselves, the regulators and BHPB. For the first time, we have included a table in the section "Assessing BHPB" which reports on the activities undertaken towards implementing the recommendations from our annual report of last year. We follow with chapters on the technical aspects of the Ekati Diamond Mine™ project (referred to as Ekati). Each technical chapter includes a summary of the mine's activities followed by the Agency's assessment of those activities and if necessary, recommendations for improving environmental management practices.

If you have comments on this report or the environmental performance of BHPB and its regulators please contact us using the information provided on the back cover of this report. ■

Below: Agency and BHPB employees at Ekati. Missing: Directors David Osmond, Pete McCart.





Assessing Ourselves

Review of Agency Operations

The workload of the Agency has increased due to the expansions and modifications of activities at the Ekati mine. The Agency continues to fulfill its mandate through regular meetings with regulators and Society members, review of reports, licences and plans and maintenance of a website and resource centre. One of our biggest achievements in the past year was co-hosting a traditional knowledge (TK) workshop which resulted in a unanimous recommendation from our Aboriginal Society members on how to proceed with incorporating TK into environmental practices at Ekati. Representatives at our Annual General Meeting commended the Agency on producing a plain English annual report to accompany the technical report, and noted both were well written and easy to read. ■



Agency Director Pete McCart at the BHPB annual environmental workshops. JERI HERMANN/BHP BILLITON DIAMONDS INC.

Agency Mandate

To meet its mandate in 2002 the Agency:

✓	Review, report and make recommendations on BHPB and Government reports and plans.	<ul style="list-style-type: none"> Reviewed and provided comments to the appropriate regulatory authorities on the 2002 Seepage Monitoring Plan for Beartooth and Beardlaw, the Fox Pit Waste Rock Management Plan, AEMP Re-evaluation and Refinement, Leslie Lake fish habitat compensation, BHPB's Annual Report and the Impact 2003 Report. Reviewed wolverine harvest data from Nunavut, DIAND inspection reports, wildlife incident reports and Surveillance Network Program reports.
✓	Make recommendations on the integration of traditional knowledge and experience of Aboriginal Peoples into environmental plans and programs.	<ul style="list-style-type: none"> Co-hosted with the Diavik Environmental Monitoring Advisory Board a workshop on traditional knowledge for government, Aboriginal members, BHPB and Diavik. Recommended that Government of Canada, NWT and BHPB support the recommendations from the TK workshop.
✓	Participate as an intervenor in regulatory processes.	<ul style="list-style-type: none"> Intervened in the public hearings for the Sable, Pigeon and Beartooth expansion project, provided comments on the Misery Surplus Water Atomization project.
✓	Provide an accessible public repository of all environmental information relevant to the project.	<ul style="list-style-type: none"> Maintained a web-site which contains copies of reference documents, minutes, correspondence inventories and photos. Maintained and updated a reference centre of relevant correspondence and reports.
✓	Provide ways of distributing information to Aboriginal Peoples and the public.	<ul style="list-style-type: none"> Produced and distributed an annual report, a plain English summary and a poster outlining our mandate and activities. Provided copies of all minutes from our board of directors meetings, Inter-Agency Coordinating Team meetings and major correspondence to our Aboriginal members. Participated in a multi-party workshop to explore approaches to regional environmental monitoring. Provided a technical summary to our members on potential nitrate toxicity issues to fish. Directors and staff formally responded to concerns and provided technical advice at our Annual General Meeting, community visits and meetings with environment committees. Informally, directors and staff frequently responded to concerns of individuals in side conversations during workshops and meetings and while conducting day-to-day business not necessarily related to diamond mining.
✓	Provide an effective means to bring to BHPB and governments the concerns of Aboriginal Peoples and the general public.	<ul style="list-style-type: none"> Coordinated Inter-Agency Coordinating Team (IACT) meetings. Conveyed concerns of the communities during IACT meetings, workshops, public hearings and meetings with regulators and BHPB. Provided copies of notes from our Annual General Meeting to regulators and BHPB. Hosted our Annual General Meeting to identify concerns. We were informed by our Aboriginal members that they were pleased with our performance.

Assessing the Regulators



The Regulators and Our Mandate

Regulators play an important role in ensuring that the impacts on the environment from the Ekati mine are minimized. Through public processes, regulators provide a venue for public concerns to be heard and addressed and an opportunity for regulators to provide advice to communities. The Ekati project operates under a number of licences, permits, authorizations and leases regulated primarily by the Department of Fisheries and Oceans (DFO), the Department of Indian Affairs and Northern Development (DIAND) and the Mackenzie Valley Land and Water Board (MVLWB). Ekati is also governed by the guidelines and regulations of the Government of the Northwest Territories, particularly of Resources, Wildlife and Economic Development (RWED).

We have a mandate under the *Environmental Agreement* (EA) to:

- serve as public watchdog of the regulatory processes;
- to review, report or make recommendations on government compliance monitoring reports and BHPB self-assessment reports pursuant to regulatory instruments; and
- to review, report or make recommendations on monitoring, regulatory and related management programs and activities of Canada and the GNWT.

Agency Assessment of the Regulators

The Agency commends BHPB and the regulators for managing Ekati without major infractions of the regulatory instruments. We note that a cooperative approach between regulators, the company and

other interested parties contributes to a successful implementation of adaptive management techniques and principles.

Mackenzie Valley Boards

We also note that expertise continues to build within the MVLWB despite staff turnover and increasing workload. The application for renewal of BHPB's Class "A" Water Licence water, for example, will be submitted to MVLWB in late 2003, coinciding with the submission of licence applications for other large projects such as Cantung, Colomac and Giant mines. We encourage the board to ensure that the expertise of its staff and board members is enhanced to facilitate the rigorous yet efficient review of project applications.

In July of 2002, BHPB submitted a Class "B" Water Licence application to the MVLWB for the land treatment of surplus wastewater from King Pond at the Misery pit development. After adjustments to decrease the size of the project to reflect the experimental nature of the project, the application was approved in December 2002. Drafts of a water licence were circulated for comments and a licence was issued in February 2003. We note that plans required under the main water licence such as the Abandonment and Restoration Plan frequently take many years for approval. The Agency commends MVLWB on its thoroughness but encourages it to improve the process without compromising the ability of Aboriginal Peoples to participate in the review of licence applications and relevant plans.

We applaud the Mackenzie Valley Environmental Impact Review Board for hosting a workshop in

November 2002 on incorporating traditional knowledge (TK) into environmental assessment practices, and for providing training to Dene interpreters on resource management concepts in March 2003. Although these efforts are not specific to Ekati they will contribute to the improvement of environmental assessment of projects and will facilitate a better understanding by Aboriginal Peoples during the review processes.

Department of Indian Affairs and Northern Development (DIAND)

The Agency is pleased to see DIAND once again has full time diamond mine inspectors. The site inspection reports produced by the DIAND inspector for Ekati provide a valuable contribution to the monitoring of activities at Ekati and to effective environmental management at the mine generally. We encourage the joint inspections of Diavik and Ekati thereby ensuring there will always be one inspector accessible and knowledgeable for inspections and emergencies, should the other inspector be unavailable.

At the end of the year, the Agency noted the diminished participation of DIAND on environmental issues related to diamond mining. As this comes at a time when diamond mining is expanding rapidly, we are concerned about this development.

Government of Northwest Territories

The Agency commends RWED on its continued participation in the review of environmental monitoring and management at Ekati, particularly with respect to recent discussions with the Agency on



DIAND Inspector
Darnell McCurdy.
AGENCY

Assessing the Regulators

Review of the Environmental Agreement

The *Environmental Agreement* covers broad topics such as air quality, waste management, consultation processes, the content, review, revision and approval of reports and, as well, provides our mandate.

In 2002, the three signatories (BHPB, DIAND and RWED) met to discuss changes to the *Environmental Agreement*. A 10-day review period was provided to the Aboriginal members to review the agreement and make comments. At that time, the Agency recommended greater consultation with the Aboriginal representatives. In our view, the resulting process was not sufficient.

The *Environmental Agreement* is reviewed every five years, and provisions exist to amend it at any time. Prior to the next round of amendments, we strongly encourage the signing authorities to plan well in advance, and to provide a substantial review period to allow communities adequate opportunity to suggest or comment on proposed amendments.

air quality monitoring at the mine. The efforts RWED has made in trying to improve monitoring reports while protecting the integrity of its inspection and enforcement mandate are recognized by the Agency.

Department of Fisheries and Oceans (DFO)

Under a Fisheries Authorization covering the de-watering of lakes, BHPB was required to conduct detailed *fishout* studies to gather biological information on fish communities such as population size, weight, length and age. We are pleased to note the cooperative study presently being conducted by Diavik, BHPB and DFO to analyze the results from the *fishout* studies. We look forward to seeing how the results from the fish-studies are used to better understand the impact of future developments.

The Agency is pleased to see that DFO is continuing discussions on the consultation processes for both the Fish Habitat Compensation Fund and for future fish habitat alteration authorizations.

Under the Fish Habitat Compensation Fund two projects have been completed: the Prelude Lake Fish Habitat Enhancement by the North Slave Metis Alliance, and the Stark Lake Fisheries Habitat Assessment Study by the Lutsel K'e Dene Band. A third project proposal was submitted for 2003 by Dillon Consulting Ltd. to look at restoring 11 previously contaminated or altered sites. The Agency offered to provide technical assistance in the review of proposals, but has been frustrated by federal contracting practices, which discouraged us from being proposal evaluators. We have not been informed to date about the status of this proposal. The Agency notes that while the completed studies are important in contributing to a better

understanding of fish habitat, to date it is not clear that the fund has contributed to actual fish habitat restoration.

Inter-Agency Coordinating Team (IACT)

IACT, set up for the Ekati project, is composed of representatives from each regulating body plus the Agency and BHPB, and meets monthly to discuss issues of common interest or concern. IACT continues to provide an important and productive role as a regular communications venue, providing continuity especially in light of regular staff change-overs in the various agencies. We support the use of IACT as an early identifier of technical issues to be addressed in BHPB's application for its main water licence renewal, expected in late 2003.

Recognizing that IACT does not have representation from Aboriginal Peoples at this time, we also note that the Ekati water licence renewal process must have a concurrent forum that includes the involvement of Aboriginal Peoples.

Guidelines

The Agency notes that three sets of guidelines are being developed for reclamation closure objectives, *cumulative effects* assessment and incorporation of TK into the environmental assessment process. To increase the effectiveness of environmental monitoring, management and impact assessment, the Agency encourages BHPB and DIAND to hasten the establishment of the reclamation closure guidelines and the Mackenzie Valley Environmental Impact Review Board to complete its guidelines on *cumulative effects* and TK. ■



Assessment of BHPB's Environmental Management Performance for 2002-03

BHPB continues to operate in a manner that is responsive to Agency, regulatory and community concerns and protective of the receiving environment.

We are pleased that BHPB's environment department continues to increase the environmental awareness of employees and contractors at the site. The Ekati Energy Smart Program has yielded large savings in diesel fuel consumption and therefore a reduction of emissions. We were particularly pleased to note the volunteer activities of BHPB staff in the establishment of an environment committee and the review of oil spill records to discover causes and develop ways of reducing spills. The company continues to carry out important research initiatives in revegetation techniques, effluent toxicity, waste rock behaviour and wastewater treatment. Progressive reclamation has begun on areas of the mine that are no longer active.

Monitoring programs have identified changes in the downstream aquatic environment attributed to mining activities, largely as expected and identified during the environmental assessment of the project. BHPB has agreed to conduct additional studies to investigate the extent and impact of these changes. Negligible impacts to the abundance and health of wildlife in contact with Ekati have been identified by BHPB. Additional work is required to determine the extent of BHPB's contribution to cumulative impacts to wildlife. The Panda Diversion Channel continues to provide spawning habitat but its long-term success for producing viable fish populations is still uncertain.

Improvements can be made to monitoring and management practices to identify impacts sooner and

to reduce them. Seeps from some waste rock piles continue to show elevated levels of metals and acidity. Although waste rock management has been adjusted to address some concerns, seepage might become problematic once the mine is closed. Air quality models and monitoring programs require significant improvements to determine the impact of mining on air quality and dust distribution.

BHPB is still reluctant to release data in a format that would facilitate others to verify the results of BHPB's analyses. The consultation on the preparation of BHPB's reports and plans requires improvement to ensure stakeholders have identified their concerns and information needs. While the quality of written reports has increased significantly in the past year or two, they are not always produced in a timely manner which would allow a thorough review, especially if such reports are to identify changes to on-going monitoring programs. The use of traditional knowledge and the results of Phase II projects to improve environmental management practices is still not clear. BHPB has not yet supported a regional approach for monitoring impacts of diamond mining and incorporating traditional knowledge (TK) into its practices as recommended by our Aboriginal Society members.

The mine closure plan needs to be upgraded soon to ensure that present-day activities support final closure goals, especially as they relate to final plans for the diversion channels and empty pits.

Adaptive Management

Complex projects in the north will benefit from the principles of adaptive management. BHPB defines adaptive management as "A formal process of

formulating and continually improving resource management policies and practices by learning from the outcomes of operational programs." We are pleased to see adaptive management practices adopted by BHPB are in BHPB's Impact Report 2003, as the Agency had suggested.

The company has been successful in adapting environmental monitoring and management programs based on new information received and input from regulators, Aboriginal Peoples, the Agency and others. For example, when it was determined that elevated levels of nitrates found in Kodiak lake were due, in part, to the proximity of the ammonium nitrate storage facility, the storage bags were relocated and the storage pad excavated and removed. When ducks were observed covered in oil due to their attraction to the land farm, physical deterrents were placed around the land farm and the land farm was drained more frequently. The Aquatic Effects Monitoring Program and the Wildlife Effects Monitoring Program are regularly modified based on the results from the previous seasons. Waste management practices at Ekati were successfully adapted to decrease the amount of wolverine incidents. ■

PHOTO: BHP BILLITON DIAMONDS INC.





Assessing BHPB

HEMA Recommendations from 2001/02 and BHPB's Response

Traditional Knowledge

1. **Last year's recommendation.** BHPB should work with Aboriginal Peoples to develop a method of documenting the suggestions and concerns of Aboriginal Peoples visiting the site.

BHPB's response. BHPB states that documenting what is said during visits would constrain the exploratory learning experience and that Aboriginal Peoples do not want what they say turned into distributed consultation memos.

HEMA's Comments: *BHPB's response is not a constructive answer to our concerns. Aboriginal concerns should be an important input into the management process which should be documented and responded to in a transparent manner by BHPB*

Wildlife

2. **Last year's recommendation.** The wolverine track survey should be expanded to four or five times per season. At the same time, BHPB should develop and implement the scent station monitoring program.

BHPB's response. BHPB has indicated that the suggested frequency for track surveys was too onerous given the extreme weather and limited light in winter. They have suggested a revised program. BHPB feels that RWED should first demonstrate the success of scent stations.

HEMA's Comments: *We agree with BHPB's response.*

3. **Last year's recommendation.** The data relating to caribou abundance and distance from mine infrastructure should be analyzed and presented independently for the northern migration and post calving period.

BHPB's response. BHPB agrees and will implement the recommendation.

Aquatic Effects Monitoring

4. **Last year's recommendation.** BHPB should expand the AEMP to include Leslie Lake.

BHPB's response. BHPB agrees and will implement the recommendation.

Special Effects Monitoring

5. **Last year's recommendation.** BHPB should determine the cause of elevated nitrates within Little Lake.

BHPB's response. BHPB believes the source of the nitrates is the ammonium nitrate storage area and is remediating the area under the direction of DIAND's inspector

6. **Last year's recommendation.** BHPB should conduct follow-up sampling in Little lake within three or four years to confirm that the lake has recovered completely from nutrient inputs.

BHPB's response. BHPB agrees and will implement the recommendation.

7. **Last year's recommendation.** BHPB should continue monitoring fish in the Panda Diversion Channel in 2002.

BHPB's response. BHPB agrees and will implement the recommendation.

8. **Last year's recommendation.** BHPB should develop a conceptual plan for the flooding of the Panda and Koala pits and either the long term maintenance or abandonment of the Panda Diversion Channel (PDC).

BHPB's response. BHPB indicates that it will include the flooding of the pits in its Abandonment and Restoration Plan due in 2003. The PDC is to be closed, as stated in the 1995 EIS.

Waste Rock

9. **Last year's recommendation.** BHPB should conduct a thorough mineralogical examination of all kimberlite types.

BHPB's response. BHPB completed static and kinetic geochemical characterizations of samples from Misery, Koala, Fox, Sable, Pigeon and Beartooth pipes. Because they are all similar, BHPB believes that the mineralogical examination of Panda kimberlite is sufficient.

HEMA's Comments: *While additional mineralogical work has been undertaken, all kimberlites have not been thoroughly characterized as required by the Class "A" Water Licence.*

10. **Last year's recommendation.** Next year the seepage survey report should explicitly highlight any occurrences of non-compliant seeps for easy reference.

BHPB's response. BHPB agrees and has implemented the recommendation.

Air Quality

11. **Last year's recommendation.** BHPB should establish a dust monitoring program along the Misery road similar to the one in place along the Sable Road.

BHPB's response. BHPB is taking the recommendation into consideration.

Reclamation

12. **Last year's recommendation.** BHPB should provide estimates of liability for the Ekati Diamond Mine™, that do not include the assumption that progressive reclamation has been carried out.

BHPB's response. BHPB agrees and will implement the recommendation.

13. **Last year's recommendation.** The company, regulators, government and other interested agencies promptly begin a process to develop clearly defined reclamation completion criteria.

BHPB's response. BHPB agrees. It has completed a literature review on closure criteria and is developing criteria in consultation with stakeholders. DIAND Minerals is preparing a document on mining best practices. DIAND Waters is working on reclamation guidelines related to water.

HEMA's Comments: *While it is still early to comment on the guidelines we are pleased that some action is being taken.*

Traditional Knowledge,

Communications and Consultation



Independent Environmental Monitoring Agency

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Traditional Knowledge

Under the *Environmental Agreement* BHPB is to give full consideration to available traditional knowledge (TK) and science when developing and implementing its environmental and monitoring programs. For the past few years the company has attempted to achieve this goal through:

- funding of Phase II TK projects submitted by individual communities or society members;
- provision of site tours to community members and elders; and
- inclusion of Aboriginal Peoples as mine employees and contractors.

Individual TK projects funded in 2002 include the continuation of the Inuit Naonaiyaotit Traditional Knowledge Study, the North Slave Metis and the Lutsel K'e geographic information systems. All of these projects are intended by BHPB to provide long-term capacity for these organizations to continue to help monitor Ekati as well as other resource development projects.

A potentially valuable community-based initiative that BHPB has undertaken in this regard is the monitoring of caribou behaviour along the Misery road. This was done in August 2002 with Lutsel K'e Dene and Kitikmeot Inuit. This participation was especially important to the Lutsel K'e people, as they have been particularly vocal in meetings with Agency directors on their perceptions that the mine roads were causing increased crippling of caribou. To support their claims, Lutsel K'e Dene videotaped caribou crossing the road as part of their monitoring.

This video did document that some of the caribou crossing the road were limping. However, the company contends that this was a very insignificant fraction of the total number of caribou crossing on that day. BHPB had planned to have Aboriginal representatives from this study present their findings and recommendations at the February 2003 technical workshop. Unfortunately, due to time constraints, this did not take place.

Another new initiative at Ekati in 2002 that we were pleased to see was the establishment of an environment committee of mine workers, which includes Aboriginal employees. This voluntary committee met regularly to learn about environmental projects at Ekati and share environmental concerns. The Aboriginal employees had the opportunity to offer suggestions in helping find solutions to specific problems in the existing road systems related to caribou crossing.

Aboriginal employees monitoring the Panda Diversion Channel. AGENCY





Traditional Knowledge, Communications and Consultation

According to their Environmental Assessment Report for the new pipes at Sable, Pigeon and Beartooth, BHPB intends to use the recommendations of the Yellowknives Dene in the placement of the waste rock pile at Sable so as to protect Ulu Lake and minimize the amount of harm to the environment.

BHPB-funded traditional land use studies have been completed or are near completion by Inuit, Dogrib and North Slave Metis. Inuit, Dogrib, Yellowknives Dene and Lutsel K'e Dene assisted Points West Heritage Consulting Ltd. in archaeology surveys.

Agency's Assessment of TK and Environmental Monitoring

We support the community-based monitoring of the interaction of BHPB operations and wildlife, such as was undertaken along the Misery road. One of the obvious potential benefits is the establishment of open dialogue between BHPB staff and Aboriginal people about what people see in the field.

BHPB is using Aboriginal employees in its environmental monitoring programs, as well as the *fishout* operations for Sable, Two-Rock and Beartooth Lakes. There may be opportunities here for these employees to interact with company managers in a way that allows the company to utilize the traditional knowledge of the workers in improving the activities it is carrying out. At this point, we have no way of determining how useful this relationship is to the promotion of traditional knowledge in environmental management. The company states that it solicits advice from Aboriginal communities, but we still hear concerns that constructive criticisms made by

Aboriginal visitors to the site are not being documented by BHPB.

In the past we have urged BHPB to document both concerns and suggestions that Aboriginal Peoples on site (employees or visitors) put forward. Documented examples are very few, and so we remain frustrated at not being able to gain a clearer picture of how employees' and visitors' TK may be finding its way into management activities at the mine.

Based on concerns we have heard from some Aboriginal members, the Agency believes the Phase II TK studies require more input from the Aboriginal members. Although each Aboriginal group is to determine the extent they wish to participate in TK studies, the Agency has heard from some community members that they prefer a more coordinated approach. This might help ensure that TK funds are dedicated to projects that actively contribute to environmental management at Ekati. Some time has passed now since the *Environmental Agreement* was negotiated, and we note that many key resource people from the Aboriginal groups are unaware of previous Phase II TK projects or their results. It would be helpful to all if BHPB was to summarize the projects and distribute this to Aboriginal Society members.

Traditional Knowledge Workshop – March 12-14, 2003

The Independent Environmental Monitoring Agency has a mandate to provide an integrated approach for the use of traditional knowledge in BHPB's monitoring and management programs. Since our inception, we have supported having the Aboriginal

members meet to determine if there was enough support for a common approach to working with the company in the use of TK in its environmental practices.

At our 2002 Annual General Meeting a resolution was passed by society members which stated:

"The Board consider establishing a TK advisory panel with a mandate to include TK in environmental management of the Ekati Diamond Mine™. The Agency in the course of its deliberations will consult with EMAB and other parties regarding the makeup of such a panel."

In pursuit of this directive, we co-hosted with the Diavik Environmental Monitoring Advisory Board (EMAB) what turned out to be a very productive workshop for the membership of both organizations. Its purpose was to get all Aboriginal members to explore whether there was a common approach that could be adopted for incorporating TK in environmental management at the Ekati and Diavik mines. The chief recommendation coming out of this

Community representative speaking at the traditional knowledge workshop. AGENCY





Traditional Knowledge, Communications and Consultation

workshop was a call for the establishment of a traditional knowledge panel. This panel could work in an advisory capacity to both EMAB and IEMA. It would attempt to ensure that TK was being incorporated accurately and effectively in environmental monitoring programs at both mines, as well as being used in the assessment of any *cumulative effects* to which the mines might contribute. We believe such a panel would present a significant opportunity to advance the role of TK in

Caribou crossing structure on Misery haul road. AGENCY



the environmental protection of the diamond fields.

We note the following key features of the recommendation:

- The recommendation to create a regional TK panel was unanimous amongst Aboriginal representatives. The unity of the Aboriginal caucus is critical to success of such an initiative.
- The TK panel proposed is to be regional in scope, as reflects the community concerns about the

important components of the environment that need to be considered, particularly the Bathurst caribou herd.

- The panel is to consist of elders and others with TK expertise who are representatives of the affected Aboriginal groups. This will augment other forms of community input into environmental management at the mines.
- Membership of the panel will be variable from time to time to permit the expertise of TK-holders to be matched with specific issues under discussion (e.g., caribou, fish, or wolverine would likely each require different people).

As a follow-up to the recommendation, we stated in a letter to the three signatories to the *Environmental Agreement* (BHBP, Government of Canada and Government of the NWT), and to Society members:

"The Agency strongly encourages BHPB, the Government of Northwest Territories and the Department of Indian Affairs and Northern Development, as signatories to the *Environmental Agreement* for the Ekati mine, to work towards the expedient implementation of the Regional TK Panel. IEMA would be pleased to work jointly with EMAB towards the establishment of such a Regional TK Panel."

Other TK Initiatives

In another initiative, the Mackenzie Valley Environmental Impact Review Board hosted a workshop in November 2002 to create a better understanding of traditional knowledge use and access and how it can be incorporated into the environmental assessment process. The workshop was attended by over 90 representatives



Traditional Knowledge, Communications and Consultation

Suggestions for Improving BHPB's Annual Public Environmental Workshop

- Keep technical presentations separate from the general public presentations. It is preferred that all technical data be presented in December. If this is not possible, a separate, small technical session should be held immediately prior to the public sessions. The new technical data should still be presented in a plain English format during the general public sessions.
- Provide workshop participants and interpreters with hand-outs prior to the presentation. Although technical reports are usually distributed prior to the workshops not all participants, particularly community members, have the opportunity to review them.
- Provide a CD containing all the presentations to interested parties immediately after the workshop.
- Have someone review presentations prior to their delivery to ensure plain English is being used, that the presentations are not too complicated and that clear messages are being delivered.
- Provide communications training to consultants and employees especially with respect to communicating in cross-cultural environments.
- Offer more time for workshop participants to review and discuss the information, perhaps in smaller working groups near the end of the workshop. It is not possible to ask for acceptance of monitoring program changes when a participant has heard the suggestions and the monitoring information for the first time. Participants need time to digest the information and talk to their peers. Generally, participants are more comfortable offering their input on the second and subsequent days of a workshop.

from Aboriginal communities, government, regulatory agencies and others. To date, the proceedings of this workshop have not been published.

Consultations and Communications

Part of our mandate is to ensure that Aboriginal Peoples and the general public have a good understanding of BHPB's activities and an opportunity to explain to the company their information needs and concerns. Over the last few years we have seen improvements in how the company achieves this, and a good example is the annual environmental workshop in February 2003. The workshop continues to be an effective mechanism for relaying environmental information to Aboriginal Peoples and others who attend. The Agency believes the workshop is less effective as a mechanism for consulting and receiving input into the proposed monitoring programs.

The consultation processes used by BHPB require improvement. The *Environmental Agreement* specifically interprets consultation as "a minimum:

- (i) the provision, to the party to be consulted, of notice of a matter to be decided in sufficient form and detail to allow that party to prepare its views on the matter;
- (ii) the provision of a reasonable period of time in which the party to be consulted may prepare its views on the matter, and provision of an opportunity to present such views to the party obliged to consult; and
- (iii) full and fair consideration by the party obliged to consult of any views presented."



Traditional Knowledge, Communications and Consultation

Agency Assessment of Communications and Consultation

Although a review period is provided after the reports are released, this arrangement is not consistent with the *Environmental Agreement*, which indicates that consultation during the preparation of environmental reports (i.e. while BHPB is compiling information, identifying issues, and designing the report) is required. The *Environmental Agreement* specifically outlines consultation requirements for the preparation of BHPB's annual report and the three-year environmental impact report, stating that, to provide for early disclosure and discussion of problems, the company will consult with federal, territorial and Agency representatives.

BHPB's consultation process for the preparation of the Impact 2003 Report, for instance, was not conducted in this fashion, and we found it frustrating. In this case, the impact assessment report is very important, as it is only produced every three years to summarize the extent and trends of environmental change at the

mine site. The process needs substantive upgrading for all future reports and programs where consultation is required, and we suggest the following actions for BHPB's consideration:

- BHPB should prepare a description of a proposed consultation process that it will use in the future, and distribute this as the earliest possible time for review by us (and other regulatory agencies where appropriate or desired by BHPB).
- Scoping sessions should be held with ourselves and relevant regulatory agencies to identify the main issues that need to be discussed in the report.
- Summaries of main issues, discussion highlights, and follow-up recommendations, should be provided to us by BHPB in the initial stages of report preparation.
- Data and supporting documents should be distributed to us well in advance to ensure accurate and complete input into report preparation, plans and programs.

- Technical advice on revisions to the monitoring plans should be based in part on the monitoring information collected previously.

- Any required plain English summary should accompany the parent technical document, and not follow later.

The *Environmental Agreement* states that BHPB will provide data and information to the Agency in timeframes and formats developed in consultation with us. On several occasions we have requested environmental monitoring data in digital form so that we can verify the results of analyses conducted by BHPB. To date, the company has not readily complied with these requests, and we urge the company to make greater effort in accommodating these requests. Independent evaluation of some programs is not possible without this kind of cooperation from the company. ■

Recommendation:

1. *BHPB, the Government of Canada and the Government of the NWT should support the concept of a regional traditional knowledge (TK) panel, as recommended by the Aboriginal representatives at the TK workshop co-hosted by the Agency.*



Elders at the traditional knowledge workshop. AGENCY



Expansions, Amendments and Additional Activities

Expansions, Amendments and Additional Activities

The Agency participated in reviewing three main expansion activities at Ekati in 2002. These were the Misery land treatment project application and monitoring program, the Sable, Pigeon and Beartooth open pit mines and the Fox open pit mine.

Misery Land Treatment

Background

In July of 2002 BHPB applied to the MVLWB to operate a new kind of wastewater treatment from its sedimentation pond at the Misery site. Called 'land treatment', the discharge water will be pressurized, mixed with compressed air and discharged from tower-mounted nozzles. When sprayed into the air

dissolved *ammonia* in the water changes to a gas and dissipates into the atmosphere, while other contaminants in the water fall to the ground. These are then taken up by tundra soils and vegetation or, in case of nitrates, broken down through a bacterial process. Other solutes in the water such as salts (sodium, magnesium and calcium) will potentially be assimilated by the tundra vegetation. The process is intended to spray into the air only discharge water that already meets current water licence discharge limits, resulting in enhanced treatment of the effluent. In partnership with BHPB, Environment Canada has agreed to lead the development and implementation of a monitoring program for the project in order to understand how it will affect the environment.

The original application contained a request to treat 400,000 m³ of water annually through the land treatment process. This volume of water would have required a 'Type A' water licence from the MVLWB, and would have necessitated construction of eight discharge towers.

The MVLWB denied the application for the water licence in October of 2002. In its reasons for decision the board stated it had determined the scale of the project was greater than should be necessary to test the technology within the arctic environment. Further, it stated that uncertainty remains with respect to the consequence of the prototype project on the tundra ecosystem, including possible effects on soils, wildlife and *groundwater*.

Director Bill Ross at Fox Pit. AGENCY





Expansions, Amendments and Additional Activities

In response to the MVLWB decision, BHPB re-submitted its application for a one-quarter-scale project utilizing only two atomization towers with a capacity to process 100,000 m³ of wastewater instead of the original 400,000 m³. This application was approved by the MVLWB in December and a licence was delivered to BHPB from the MVLWB in March 2003.

Agency Assessment of the Atomization Project

In a letter to the MVLWB in August 2002 the Agency noted the prototype treatment system appears to hold promise as a technique for dealing with the loading of *ammonia* and nitrogen to receiving water bodies from blasting operations. We highlighted the need for a proper monitoring program for the project to ensure that the necessary data for protecting the

tundra and receiving environment of Cujo Lake would be collected. We support the prototype project in its reduced scale and look forward to receiving the results when they become available.

Beartooth Open Pit Development

Background

Beartooth Pit is the first new development of the Sable, Pigeon and Beartooth mine expansion approved by the MVLWB on October 30th, 2002. In January 2003 DFO authorized BHPB to disturb or destroy fish habitat associated with the expansion. As compensation, Leslie Lake was offered back as an unimpacted lake. BHPB intended to mine Leslie Lake and had provided compensation for its destruction. Leslie Lake will become part of the aquatic effects monitoring program (AEMP) and is the receiving water body immediately downstream of the Long

Below: Bearclaw jetty, used to pump water around the Beartooth Pit. Right: Frozen core dam at the outlet of Bearclaw Lake. AGENCY



Fox dewatering pipe outlet. AGENCY

The Value of Environmental Inspection for Avoiding Possible Future Problems:

DIAND's inspector for the Ekati project instructed BHPB to take corrective action on the placement of a section of the Fox Lake dewatering pipeline that was laid on the east side of Fox road. If a break in the pipe and related spill occurred water could have flowed towards an undisturbed lake rather than the Long Lake Containment Facility (LLCF). BHPB responded by rerouting the critical sections of pipeline along the west side of the road, effectively ensuring any spill would flow towards the LLCF.



Expansions, Amendments and Additional Activities

Lake Containment Facility (LLCF). In spring of 2003 a report assessing the geochemical characteristics of the rock and a waste rock management plan were submitted to the MVLWB by BHPB.

Development of this kimberlite pipe requires dewatering of Beartooth Lake and permanent re-routing of Bearclaw Stream around the future pit through a pipeline. The diversion at the outlet of Bearclaw Lake comprises a dam and pipeline from Bearclaw around Beartooth Pit into North Panda Lake. The system is designed to withstand the volume of peak flows during freshet and base flows

during the remainder of the open water season. The Agency recommended that BHPB screen the pipe outlet to prevent the entry of fish that are possibly attracted by the discharge into North Panda Lake.

The Panda Diversion Channel (PDC) flow will be lowered by the loss of the Beartooth Lake drainage basin by approximately 60,000 m³ of water each year (out of a total of approximately five million m³). All other drainage through the PDC (i.e. from the Vulture Lake drainage basin through North Panda Lake and from Grizzly Lake) will continue as before.

Development Status

In early 2003 work began on construction of a frozen core dam at the outlet of Bearclaw Lake, the Bearclaw Pit ring road and the dewatering pipeline of Beartooth Lake that will pump water directly to the Long Lake Containment Facility (LLCF). Removal of Beartooth Pit overburden and waste rock will commence in July 2003 after the lake has been fully dewatered and will continue for approximately 18 months.

In January 2003 BHPB submitted to DIAND the security deposit of \$14.4 million required under the water licence for the three new pits. DFO requested a further security deposit be submitted under its Fisheries Authorization for the mine expansion. At this time BHPB and DFO remain in discussions about the necessity for this additional security deposit.

Moving rock at Fox Pit. AGENCY



Fox Open Pit Development

Background

BHPB received permission to dewater Fox Lake, the site of the future Fox Pit in January 2002. Dewatering began on February 21st, 2002 into Fox 2 Lake, immediately downstream of Fox Lake. During dewatering, the water level below the ice lowered until eventually the ice collapsed. This disturbed sediments on the bottom of Fox Lake and led to the suspended solids in the remainder of the lake water exceeding the discharge limits earlier than planned. BHPB requested to the MVLWB that it be allowed to discharge the remaining decant water through a *flocculant* plant to reduce suspended solids and onto a boulder field that drains naturally to cell D of the LLCF rather than into cell C as previously approved. The MVLWB granted permission for the discharge of



Expansions, Amendments and Additional Activities

the Fox Lake decant water to cell D after a satisfactory response from BHPB to its information request on the justification for the dewatering change. Draining of the remaining water in Fox Lake commenced again in late January of 2003. Site preparation of Fox Pit began in the summer of 2002 after the haul road to Fox Lake was completed. As stripping of overburden is now under way at Fox, runoff and *groundwater* entering the pit area is collected and pumped into cell D along with the remnant lake water. BHPB expects overburden removal to require two years of excavation.

Agency Assessment of Fox Pit Dewatering

The Agency did not support BHPB's request to use cell D for discharging turbid Fox Lake water. In a letter to the MVLWB we recommended that BHPB avoid using the cell at this time. Our reasoning is that discharges to cell D this early in the mine development would reduce the ability to track water quality improvements as process water passes through the cells of the LLCF and is not an example of a precautionary or conservative approach to managing environmental risk. We further suggested that premature use of cell D should be avoided as long as possible in order to increase the retention time and filtering effects of dykes C and D upstream to aid in the removal of suspended solids, the settling of residual *floculants*, and the oxidation of *ammonia* compounds to *nitrate* and nitrite before reaching cell E and the receiving environment at Leslie Lake. ■

Agency Pushes for Caribou Protection on Mine Roads

Sable Haul Road Traffic Management

Due to concern about caribou and grizzly bear movement and habitat along the new Sable haul road, the Agency recommended during licencing that traffic volume on the road be limited when the animals are in the area. The Sable haul road application was separated from the rest of the mine expansion permitting in August 2001 to allow BHPB to start construction of the road prior to receiving the main water licence and land use permits for the Sable project. Our recommendation to control traffic volume during periods of caribou movement was not adopted in the Sable road permit.

We subsequently recommended to BHPB that traffic should be managed in and out of the Sable lease area, in last year's annual report and in a letter sent to the MVLWB in June 2002. This recommendation was incorporated by the MVLWB when it issued the Sable land use permit in August 2002. BHPB must ensure that during periods of caribou migration through the claim block the total number of one-way vehicle trips entering or leaving the Sable lease area is less than 200 per 24-hour period.



Sable haul road. AGENCY



Cumulative Effects and Regional Monitoring

Cumulative Effects and Regional Monitoring

As more projects are proposed and approved within the Slave Geological Province, the Agency continues to hear concerns from Aboriginal Peoples, government and other public agencies about the cumulative effects of these projects. We believe that caribou and the aquatic environment are the most significant components of the environment that may demonstrate cumulative effects. The increase in the number of projects and boards that require participation of Aboriginal representatives has led to a serious capacity issue for the communities affected. A regional monitoring agency is being discussed as one way to alleviate capacity issues as well as provide a more comprehensive and integrated picture of environmental change for the Slave Geological Province.

Cumulative effects are commonly defined as the environmental changes that occur from a project or activity combined with effects from other human activities.

Typical Regional Environmental Issues of Concern
air quality
water quality (chemical and physical components)
water flows and quantities
loss of habitat
wildlife with large habitat or migration ranges
aquatic life (fish)
birds

When BHPB began construction at Ekati in 1996 there was a good deal of exploration but no other large operating projects in the Lac de Gras area. This changed in 2000 when Diavik began its construction activities ten kilometres from Ekati's Misery open pit. In 2003 De Beers submitted a proposal to develop a diamond mine at Snap Lake. While not within the Lac de Gras watershed, Snap Lake may have impacts on the same caribou, other wildlife and air quality as Ekati. A winter road connects Ekati, Diavik and other mines to the southern road system in Yellowknife. Within the Slave Geological Province additional existing or proposed projects include Lupin gold mine, Tahera diamond mine and the all-weather Bathurst Inlet road and port.

We have heard many concerns from our Aboriginal Society members about the impacts that increased resource development activities are having on the environment. The Inuit of the Kitikmeot region are particularly concerned about the cumulative impacts on fish and water quality in the Coppermine River watershed, which drains the diamond fields; the Inuit, Dene and Metis are unanimously concerned about the impact the mines appear to be having on caribou, specifically migration routes. The Agency continues to participate by invitation in the initiatives currently under way: the NWT Cumulative Impact Monitoring Program (CIMP) and the NWT Cumulative Effects Assessment Management (CEAM) Strategy and Framework. Our focus is on how the Ekati mine may be interacting with other existing and proposed projects in the region.

The NWT CIMP program was established under the Mackenzie Valley Resource Management Act and provides for an independent audit of the

environment to be conducted in 2003, coordinated by the Department of Indian Affairs and Northern Development (DIAND).

The NWT CEAM Strategy and Framework was established by the federal government as a result of the environmental assessment of the Diavik diamonds project in 1999. Under this strategy regional plans of action are being developed for most areas of the NWT. Although not formally part of the project group, both BHPB and the Agency have participated in workshops to develop a regional plan of action for the Slave Geological Province. This plan identifies activities that should occur in the areas of baseline monitoring, audit and reporting, research, regulation and enforcement, traditional knowledge and information management. One of these activities is the possible formation of a regional monitoring agency, something we have consistently supported.

Although the CEAM Strategy and Framework may not apply in Nunavut, representatives from Nunavut Inuit and government organizations participate in relevant activities due to the possible transboundary impacts of diamond projects in NWT on the Kitikmeot region of Nunavut.

Regional Monitoring

Monitoring *cumulative effects* usually implies a look at issues on a regional level. A regional approach to baseline data collection and monitoring is obviously desirable. For the Slave Geological Province two project-specific agencies exist with environmental monitoring responsibilities related to major developments; ourselves for Ekati and the Environmental Monitoring Advisory Board (EMAB) for



Cumulative Effects and Regional Monitoring

the Diavik diamond mine. Two other agencies, the West Kitikmeot Slave Study (WKSS) and the Bathurst Caribou Management Planning Committee, are also involved in environmental monitoring and management activities within the region.

All of these environmental initiatives have boards with varying degrees of involvement from the same affected Aboriginal Peoples. The proliferation of such boards has meant increased stress for the communities with respect to their ability to participate in them effectively. There are not enough community resource people to participate on all the boards, review stacks of relevant technical documents, consult with their communities and attend meetings and workshops. A regional monitoring agency could alleviate much of this pressure by providing a "single-window" approach and a central coordinating function for much of this work.

In November 2002, we participated in the workshop "Towards a Single Regional Monitoring Agency for the Slave Geological Province". Its purpose was to bring together the parties to the Diavik and BHPB *Environmental Agreements* and other government, Aboriginal and public stakeholders to explore the options of creating one monitoring agency for the Slave Geological Province.

Two primary objectives for such an agency were identified:

- project-specific monitoring and oversight (the watchdog role, as currently carried out by IEMA and EMAB); and
- regional-scale environmental and *cumulative effects* monitoring and research (as conducted, in part, by WKSS).

The following guiding principles have been identified by DIAND for the process of developing a regional monitoring agency:

- Efforts cannot supercede Aboriginal and treaty rights, existing or future land claims and self-government agreements, federal or territorial legislation. They must respect existing institutional structures, policies, legislation, initiatives and tools.
- The approach must be an inclusive, community-based partnership.
- The outcome of the process must be administratively efficient for all parties.
- Additional financial burdens cannot be imposed on BHPB or Diavik.

Winter road between Diavik and Ekati. AGENCY



Based on the movement towards a regional agency, the *Environmental Agreement* has recently been amended to read:

"4.7 Transitional - The parties shall at the request of any party upon sixty (60) days notice consider the timing and advisability of the replacement of the Monitoring Agency created under this Article IV and the Advisory Board created pursuant to the Diavik *Environmental Agreement*, with a Regional Agency with a similar mandate, provided that if BHPB, as a result of the creation of such Regional Agency, is required to provide annual funding for such Regional Agency, the amount of such annual funding shall not be in excess of the Core Budget for the last year prior to the creation of such Regional Agency."



Cumulative Effects and Regional Monitoring

Agency Assessment

BHPB has indicated that because Ekati has not produced any significant environmental impacts, it does not contribute to cumulative impacts. The Agency agrees with other regulators that an impact does not have to be significant itself in order to contribute to larger cumulative impacts that may be significant. Several small, less significant impacts may eventually produce a significant cumulative impact.

We encourage BHPB to continue its involvement in the *cumulative effects* assessment and regional monitoring agency initiatives.

Although legislation and regulatory frameworks exist to deal with *cumulative effects*, practical guidelines and tools are required to establish baselines, research thresholds and carrying capacities and to effectively monitor cumulative impacts. We encourage the federal government to work expeditiously toward the development and implementation of such guidelines

and tools in order to ensure regulators can deal effectively with *cumulative effects*.

The formation of a regional monitoring agency faces many jurisdictional, logistical and operational challenges and consequently may not emerge in the next few years. The De Beers Snap Lake project is presently in the environmental review stage and will likely be approved prior to the formation of a regional agency.

For the first several years of existence, the Agency and BHPB focused on developing a good environmental monitoring program specific to Ekati. With the advent of the Diavik project, the Agency has begun to recommend that the wildlife (and other) monitoring programs for the two mines be compatible, since they are adjacent and affect the same local environment. We noted that because each company's programs are different the results can not be meaningfully compared. BHPB has taken the initiative and worked out an arrangement with Diavik such that the annual caribou surveys are now harmonized and, in fact, run as a single integrated field program. Caribou data for the two mines should now be comparable, and will be useful for gaining a better understanding of the two mines' effects on the annual migrations.

It is clearly desirable that all monitoring should be required to share a common protocol for data collection and the analysis of results. The key is that BHPB's monitoring program should determine not only the impacts of the Ekati mine on the environment but also provide useful information for managing any cumulative impacts caused by Ekati in combination with other activities such as Diavik, Snap Lake, winter roads and on-going mineral exploration.





Cumulative Effects and Regional Monitoring

For example, good information is required concerning how caribou behave in response to the various components at Ekati - the roads, the pits and rock piles, the airport, the tailings pond, and the accommodations. Such information can then be used in an "energetics" model of caribou behaviour that is used to evaluate the cumulative impacts of all activities on caribou.

The use of a common protocol is necessary but not sufficient for effective *cumulative effects* management. In addition, it is essential for this purpose that the data collected through the monitoring programs be accessible to resource managers and regulatory agencies such as RWED, the Bathurst Caribou Management Board and DFO. ■

Map of development within the Slave Geological Province and West Kitikmeot region. BHP BILLITON DIAMONDS INC.





Minimizing Terrestrial and Aquatic Impacts

Minimizing Terrestrial and Aquatic Impacts

The Agency has focused on the construction of the Pigeon culvert as an example of the challenges regulators and the company face when assessing an activity that affects both the terrestrial and aquatic environments. Stream crossings have the potential to affect the environment, but measures must be taken to ensure the design of such crossings does not alleviate impacts on one environmental component only to increase the impacts on another. In this case, the Pigeon culvert was designed to avoid encroaching on fish habitat so that an authorization from the Department of Fisheries and Oceans (DFO) would not be required. The unintended consequence of this is that the large rock-fill on each side of the culvert has obstructed a natural movement corridor for caribou in this area.

Our main concern with the culvert is the increased waste rock volume deposited on the tundra, plus the height and length of the approach ramps, which act as barriers to caribou migration, particularly in this small valley which appears to be used heavily by caribou. A bridge, requiring lower approaches and much less rock, could likely have significantly reduced these effects on caribou movement. As constructed,

the crest of the road surface is now over eight metres above the original tundra.

BHPB applied to the Mackenzie Valley Land and Water Board to construct the large culvert at the Pigeon stream crossing along the Sable haul road in April 2001. The final design was submitted to the board and DFO in February 2002.

BHPB's Sable Road Land Use Permit (MV2001F0032) has the following condition:

"The Permittee shall minimize damage to wildlife and fish habitat in conducting this land use operation."

BHPB has reported a number of factors that influenced its selection of a culvert for the stream crossing. We queried BHPB's initial claims and requested a written rationale for the selection of the culvert. BHPB has since explained its choice of stream crossing. It included engineering feasibility, cost, delivery and permitting among other considerations. Due to the depth of organic material and compacted till at the stream crossing site, BHPB determined it would not be possible to construct abutments required for the bridge to be founded on bedrock. BHPB's cost comparison also showed that a bridge option at Pigeon Stream would be substantially more expensive than a culvert.

While BHPB's reasons for selecting the large culvert are clear, the terrestrial impact caused by the structure remains and is, in our view, greater than it should be. The decision was based mainly on regulatory and engineering reasons, with less attention paid to environmental concerns. This is not precautionary or conservative environmental management, and we hope that the company will improve its approach when making road-building decisions in the future. ■

Recommendation:

2. *BHPB should adopt a more balanced design for haul roads and stream crossings in its attempt to minimize impacts on both aquatic and terrestrial environments. Regulators who approve haul roads and stream crossings should also ensure that a balanced assessment has been done, and that impacts Both to aquatic and terrestrial environments are minimized.*

Two Agency Directors atop the Pigeon Culvert. AGENCY



Wildlife Effects Monitoring Program



Independent Environmental Monitoring Agency

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Wildlife Effects Monitoring Program

Infrastructure and activities at the Ekati mine have the potential to directly or indirectly affect the abundance or behaviour of wildlife. BHPB's Wildlife Effects Monitoring Program (WEMP) has been developed and refined over the last six years to monitor, for the purpose of adaptive management, the effect of the mine on wildlife species and habitat of greatest importance and concern. The wildlife species monitored include caribou, grizzly bears, wolves, wolverines, upland breeding birds, and raptors. These species (known as VECs, or valued ecosystem components) are selected as being key species for indicators of ecological changes, or species of significant importance to the people of the north.

BHPB monitors for impacts on wildlife using a number of different survey techniques, including aerial surveys, snow track surveys, and behavioural observations. Different survey techniques are used depending on the species and potential impact being monitored. For example, to identify the abundance and behaviour of caribou groups around the mine site, an aerial survey is flown once per week during the period from mid-April through early October along transect lines. Another example is the surveying of the Ekati and Misery landfill sites every two to six days during the summer, and less frequently during winter, for attractants and the presence of any wildlife. Expertise from Aboriginal Peoples in the form of traditional knowledge related to wildlife was also used in 2002 by BHPB. For example community members from the Yellowknives Dene assisted in the 2002 wolverine snow tracking survey.

Monitoring for all species is carried out within an area of 1600 km² (Figure 1) which covers a large portion of the BHPB claim block, and includes all mine site developments, including the new Sable, Pigeon and Beartooth developments to the north and the current Misery development located to the southeast of the main mine site.

As in previous years, we participated in a technical meeting with other stakeholders and BHPB to refine the 2002 wildlife report and monitoring program. This meeting allows the Agency to express its views on modifications and improvements to the program directly to the BHPB wildlife team. In addition, the wildlife section of the annual February BHPB environmental workshop was among the most effective presentations offered.

Effect of Mining

The wildlife monitoring program continues to show that infrastructure and activities at Ekati appear to be having a negligible effect on the abundance or health of wildlife coming into contact with the mine. One trend that has emerged in the last few years is the 7-8% reduction of feeding time by caribou cows with calves when they are within 5 km of mine infrastructure. There is also some suggestion that caribou close to roads or waste rock piles are at a greater risk of being killed by wolves.

Waste Management

In the past, we have been critical of BHPB waste management practices that have led to the destruction or relocation of wolverines. Discarded food packaging has consistently remained a common

attractant at Ekati landfills. The Misery site in particular required improvements in this area. Surveys during 2002 show that these problems are reduced, likely related to better landfill and waste management practices.





ROB GAURMEGWIN

Wildlife Effects Monitoring Program

Actions Taken by BHPB to Avoid Impacts Caused by the Landfarm

During the 2002 site visit by the Agency directors, three oil-covered ducks were found around the landfarm. The landfarm is used to store snow, ice and other materials that have been contaminated by spills of fuel or hydraulic fluid. During spring, water accumulates at the base of the landfarm, forming a shallow pond. Oil and hydraulic fluid float on top of the water. Migrating waterfowl can be attracted to open water. In order to ensure the landfarm does not cause further harm to wildlife, BHPB placed wires and flagging across the area soon after the initial incident. BHPB has made a commitment to cover the area of the landfarm collecting water, to ensure mortalities to birds will not happen again in the future. This action is an example of adaptive management practiced by BHPB to reduce impacts on wildlife.

Wolverine

No mine-related losses of wolverines have occurred since May 2001. In 2001, we noted that the monitoring program for wolverines needed upgrading, and recommended an increased frequency of winter track surveys. We also suggested the testing of new approaches for monitoring wolverine abundance in the wildlife study area, such as the use of scent stations to yield samples for non-invasive DNA tests. BHPB has since determined that the technology of scent station monitoring has not yet proved feasible for incorporation for the Ekati monitoring program. The 1997-2002 wolverine monitoring consisted of a single transect around the

mine footprint. In our view, this approach does not provide the necessary information to identify effects of the mine on the distribution of wolverines.

In response to our view that the existing wolverine monitoring program is deficient, BHPB has developed new procedures for 2003. The new protocol will use multiple, 4 km transects arranged throughout the study area, to test the relationship of distance from the mine and the frequency of wolverine tracks. It will consist of two separate surveys of 50 transects. The transects will be established throughout the study area, guided by criteria provided by traditional knowledge. Transects will be located within habitat types where wolverines are more likely to be found.

Flagging tape as a visual deterrent at the Ekati landfarm.

AGENCY





Wildlife Effects Monitoring Program

Caribou

A maximum of 6600 caribou were in the study area during the 2002 northern migration and 3000 during the post-calving migration. The six years of data collected on caribou migrations in the study area continue to show a large variation in number and timing of migrations among years. In 2001, the Agency noted the concerns of hunters and elders from the North Slave region about the possible causes of limping caribou. Based on general observations it appears limping caribou were more predominant in 2001 than 2002.

No caribou have been reported killed or seriously injured as a result of mine site activities. However, an adult bull caribou was caught in the electric fence surrounding the airstrip and had to be released once it had exhausted itself attempting to escape. Discussion has taken place between all parties regarding the appropriateness of the fence and possible alternative techniques to ensure safety of wildlife and airplane passengers.

Overall, it appears that the mine has a limited effect on caribou. The one observed behavioural change for caribou at the mine has been the reduction in time spent feeding by cows with calves near the mine. There is no evidence that the mine affects how caribou move through the area.

Wolf

A wolf pup carcass was found near the shoulder of the Misery road in October. A necropsy revealed the pup had been struck on the back of the head. This is the first time an animal that is part of the wildlife monitoring program has been killed at the site as a

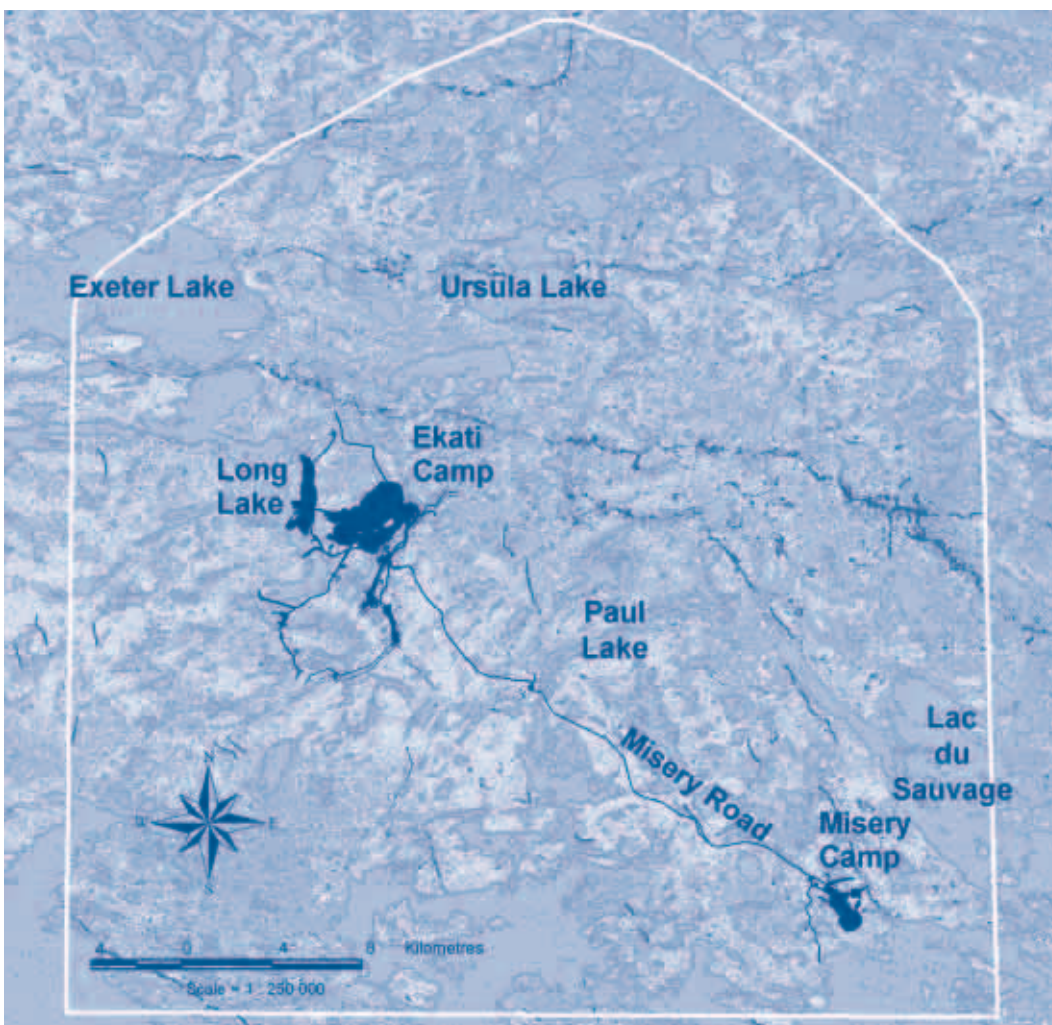


Figure 1. BHPB wildlife study area. BHP BILLITON DIAMONDS INC.



Wildlife Effects Monitoring Program

result of a vehicle collision. Animals not part of the wildlife monitoring program such as red fox, arctic hare and arctic ground squirrel have been killed in small numbers by vehicles at the site.

By-catch from Fishouts

During preparation for mining, fish-bearing lakes above the kimberlite pipes are fished out prior to draining the lakes. An unfortunate consequence of these *fishouts* last year has been accidental mortality to other species. Two adult red-throated loons were caught in fishing nets during *fishouts* of Cujo and Beartooth Lakes in August of 2002.

Agency's Assessment of Wildlife Effects Monitoring at Ekati

The wildlife monitoring program continues to provide the necessary information to identify impacts on key wildlife species, and to assess impacts that may not have been predicted previously. Improvements are needed with regard to the operation of sumps and holding ponds in order to minimize risks for migratory birds. There is also a need to better understand if and how haul roads and waste rock piles increase the chances of caribou being killed by wolves.

We recommend that RWED publicly report the

number of wolverines harvested in the North Slave region. Wolverine are legally harvested by commercial sport hunting operations. It is unclear how many wolverines have been harvested within the BHPB wildlife study area since monitoring began in 1997. In order to take action on this recommendation, RWED will require coordination with the Nunavut Department of Sustainable Development.

The Canadian Wildlife Service, along with DFO, should consider revisions to the criteria used to conduct *fishout* studies, in order to reduce the potential for *by-catch* of birds. Currently, once nets are set, the operator must leave the nets in the water for three days without any new fish being caught, providing ample opportunity for catching loons and other birds. In 2002 two loons were caught at each of the BHPB and Diavik mines.

BHPB's contribution to the *cumulative effect* identified by the Agency has been eliminated. There has been no mine-related mortality nor relocations of wolverines since May 2001.

Reporting of wildlife incidents improved at BHPB in 2002. The Agency encourages BHPB to continue recording wildlife incidents, as this information is most relevant in identifying issues that require management actions. ■

Recommendation:

3. RWED, in partnership with the Nunavut Department of Sustainable Development, should publicly report the number of wolverines harvested in the North Slave and West Kitikmeot Regions in order to determine the total number of wolverines removed from the wildlife study area.
4. DFO, in consultation with the Canadian Wildlife Service, should consider revisions to the criteria used to conduct *fishout* studies to reduce the potential for *by-catch* of birds.



RWED/GNWT.

Aquatic Effects Monitoring Program



Independent Environmental Monitoring Agency

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Aquatic Effects Monitoring Program

BHPB's Aquatic Effects Monitoring Program (AEMP) is a requirement under its Class "A" Water Licence and the *Environmental Agreement*. It is designed to detect any changes that the project has on aquatic ecosystems in the Koala and King-Cujo watersheds in order to enable effective environmental management. Significant effects are identified, first by comparing baseline data collected prior to construction activities with later post-development data and, second, by comparing data for potentially affected lakes and streams to data for control or reference water bodies (i.e. those presumably not affected by mine activities).

The AEMP measures various physical, chemical and biological features of aquatic ecosystems which serve as indicators of change. Data are collected and evaluated to identify any effects that may be caused by the mine. If appropriate, follow-up actions are to be taken by BHPB to minimize or correct any adverse effects that have been identified.

In addition to the monitoring program, BHPB is required to control water effluent quality and volumes at a number of regulated stations specified by its water licence.

Outline of Studies

Figure 2 shows the sampling locations for the 2002 AEMP. Two new potentially affected sites (Kodiak Lake and Kodiak-Little Stream) were added to the program for 2002. These had been previously studied as part of the special studies conducted for Kodiak Lake following discharge of sewage to the lake in 1997. This was the fifth year of post-baseline data

collection within the Koala drainage and the second year of post-baseline monitoring within the King-Cujo drainage at the Misery site and in Lac du Sauvage. Monitoring also occurs within three reference lakes and outflows.

In 2002, sampling was done in both lakes and streams during the open water season in July, August and September. Open-water sampling included physical *limnology*, *phytoplankton*, *zooplankton* in lakes, and *benthic macroinvertebrates* in both lakes and streams. Winter sampling under ice (lakes only) included late-winter water quality in April 2002, and

winter dissolved oxygen concentrations (measured at approximately monthly intervals). Streams were sampled during the open water season only since there is no winter flow. Open water sampling included water quality, stream benthos, and stream flow.

Fish communities are monitored every fifth year, and lake sediment quality is assessed every third year. The year 2002 was the first year of fish community monitoring since mine operations began. The parameters analyzed were catch per unit effort, length, weight, age, sex, maturity, diet and tissue

BHPB employees collecting Aquatic Effects Monitoring Program data. JERI HERMANN/BHP BILLITON DIAMONDS INC.





Aquatic Effects Monitoring Program

metal concentrations. Fish communities were sampled from five lakes in the Koala watershed (Vulture, Kodiak, Moose, Nema, Slipper), one from the King-Cujo watershed (Cujo) and two reference lakes in other watersheds (Nanuq and Counts).

Sediment samples were collected from 11 lake sites (Vulture, Kodiak, Moose, Nema, Slipper, Lac de Gras (two sites), Cujo, Lac du Sauvage, Nanuq and Counts) from three depths (shallow, mid and deep). Parameters analyzed included organics, nutrients, total metals and grain size.

Inputs to the Aquatic Receiving Environment

Processed kimberlite (tailings), treated sewage and pit water are discharged into the upper cells (Cell B and C) of the Long Lake Containment Facility (LLCF). Water released from the LLCF enters the receiving environment of the Koala watershed through Leslie Lake, flows downstream into the first monitored lake (Moose Lake), and eventually enters Lac de Gras.

The main source of project-influenced water in the King-Cujo watershed in 2002 was discharge from King Pond, the mine water sediment pond for the Misery Pit.

Effect of Mining on the Water Bodies Studied and Observed in 2002

Within each of the Koala and King-Cujo watersheds mining activities continue to change water quality and the aquatic environment, as predicted. A number of changes to the aquatic ecosystems have occurred as a result of mining activities, as Table 1 illustrates.

Koala Watershed

In the Koala watershed some of the changes (pH, sulphate, total dissolved solids and potassium) were identified as far downstream as Slipper Lake, although not in Lac de Gras. Other changes are localized and are not observed downstream of Moose Lake.

Nutrients (Ammonia, Nitrite and Nitrate)

Increased *ammonia* in Kodiak Lake appears to be caused by the improper storage of *ammonium nitrate* used for explosives in mining. Sampling near the *ammonium nitrate* storage facility located on the shore of Kodiak Lake suggests that it was the source of elevated *ammonia* in the lake water. BHPB has undertaken corrective actions to solve this problem; we will report on the performance of the measures taken.

Nitrite was slightly elevated in Moose Lake. *Nitrate* values were slightly lower in 2002 than in previous years (2000 and 2001), likely due to the low winter snowfall, hence the relative low water volume discharged from the LLCF. *Nitrate* levels were highest in Moose Lake and decreased downstream, remaining elevated beyond baseline levels in Nema Lake though not in Slipper Lake.

Metals (Nickel, Copper and Molybdenum)

Slight increases in concentrations of nickel and molybdenum are evident downstream of the LLCF, and copper remains elevated in Kodiak Lake. This year molybdenum was added to the monitoring program.

Nickel was elevated in Moose Lake and Kodiak Lake. Nickel concentrations in Moose Lake were higher in 2002 than in the baseline years and significantly higher than reference lakes, although nickel

Table 1. Effect of Mining on the Aquatic Ecosystem

2002 Aquatic Effects Monitoring Program Component	Number of parameters evaluated by BHPB in 2002 AEMP	Number of parameters where BHPB attributes an effect to mine activity
Stream and lake water quality	19	13 (including nutrients, metals, physical characteristics and major ions)
Physical Limnology	2	0
Sediment quality	8	1 (organic carbon)
Biological community	11	2-3 (<i>phytoplankton</i> biomass and abundance, possibly <i>zooplankton</i> abundance)
Fish Community	8	0



Aquatic Effects Monitoring Program

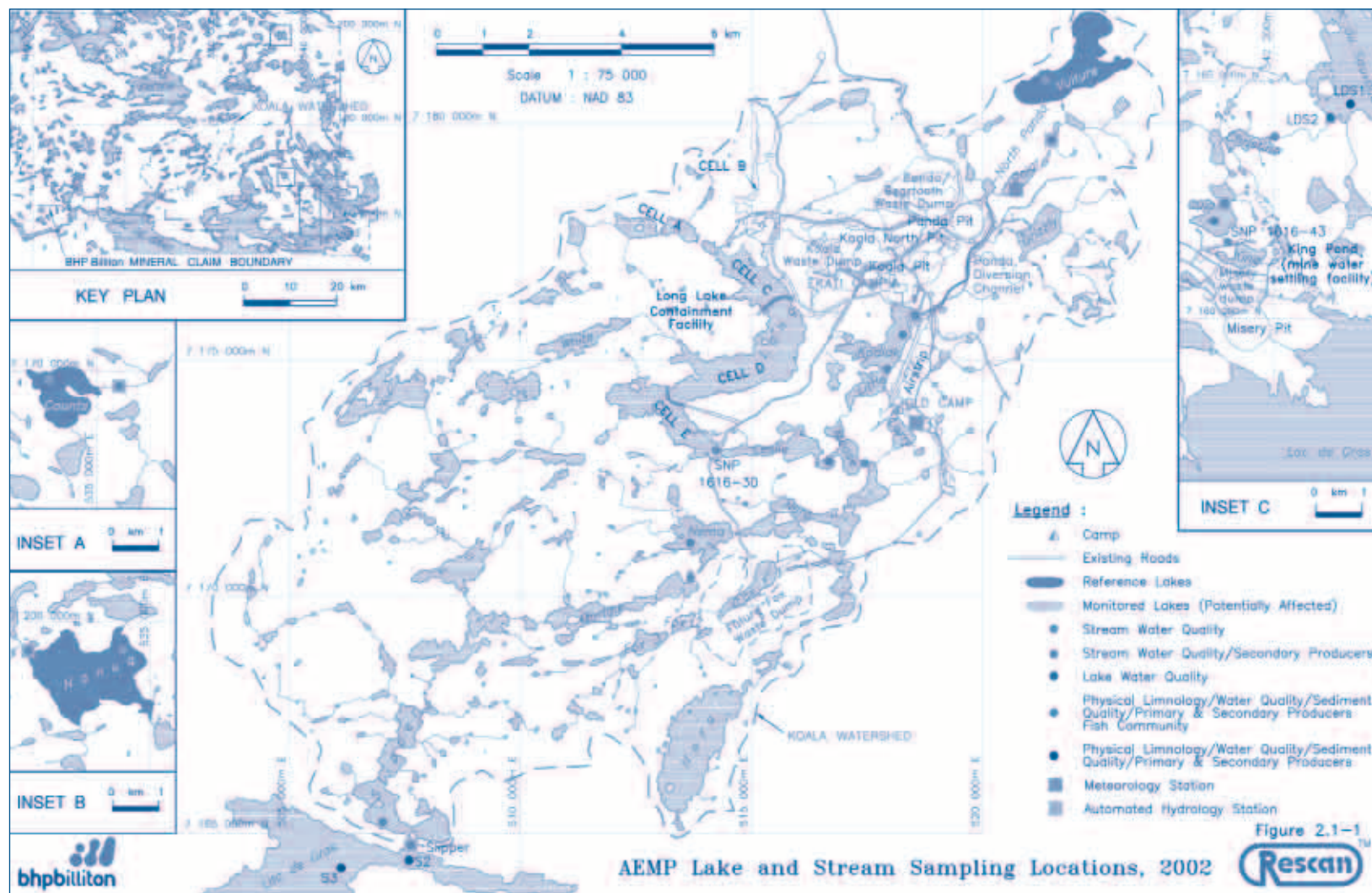


Figure 2. Aquatic Effects Monitoring Program Lake and Stream sampling locations, 2002. BHP BILLITON DIAMONDS INC.



Aquatic Effects Monitoring Program

Re-evaluation and Refinement of the Aquatic Effects Monitoring Program

In order to re-focus the AEMP on key issues and concerns, the Agency and other stakeholders participated in an extensive BHPB-led consultation initiative. The process of re-evaluating and updating the program is a good example of environmental management practiced by BHPB. Changes to the AEMP include adding Leslie Lake as a potentially affected lake, reducing unnecessary sampling replication, revising the list of evaluated parameters for water and sediment quality and sampling zooplankton and phytoplankton communities in August only. The enhancements to zooplankton monitoring include collection of samples from cells D and E of the LLCF, as well as Leslie Lake. We noted that BHPB, in its original plans to revise the aquatic monitoring program considered removing *zooplankton* monitoring from the program entirely, except in the event of a change to *phytoplankton*. However, in reviewing the results of the 2002 AEMP it became apparent to us that further *zooplankton* monitoring downstream of Ekati should continue. The objective of *zooplankton* monitoring is to determine if recent changes to the community are a result of natural variation (when similar change has also occurred within the reference lakes) or a result of project activity.

Another change to the AEMP for 2003 is the specific targeting of lake trout in Leslie Lake to sample for mercury in the flesh and liver of the fish. This should provide the data needed to aid in determining if project activities are having any effect on mercury concentrations in fish downstream of Ekati.



Pigeon stream (foreground) and culvert (background). AGENCY

increased in one reference lake (Counts Lake). The LLCF likely acts as a minor source of nickel to downstream lakes.

Copper concentrations in Kodiak Lake remain slightly elevated beyond baseline and reference levels, likely a project effect, and are near the Canadian water quality guideline for the protection of aquatic life.

Elevated concentrations of molybdenum were detected in Moose and Nema Lakes and possibly Slipper Lake, although levels remain much lower than the Canadian water quality guideline. BHPB has not identified the source of this molybdenum.

Physical Characteristics (pH and Total Dissolved Solids)

pH continues to increase in Moose, Nema, and Slipper Lakes compared to the baseline years. Concentrations of total dissolved solids (TDS) were higher in Moose, Nema and Slipper Lakes in 2002 than during the baseline period. The levels show a declining trend downstream from Moose to Slipper Lake indicating dilution from inputs other than the LLCF. TDS remained relatively constant in the reference lakes.

Major Ions (Sulphate and Potassium)

Sulphate concentrations were significantly higher in the potentially affected lakes downstream of the LLCF (Moose, Nema and Slipper) than in the reference lakes. Concentrations in Kodiak Lake also appeared elevated compared to previous years. The LLCF acted as a source of potassium to downstream water bodies in 2002. Only slightly elevated concentrations of potassium were detectable in Slipper Lake.



Aquatic Effects Monitoring Program

King-Cujo Watershed

In the King-Cujo watershed many of the same water quality effects were attributed to the mine as in the Koala watershed with some exceptions such as a slight increase in arsenic in Cujo Lake and *ammonia* in the Cujo outflow. Sulphate and total dissolved solids were found to be possibly elevated in the Christina-Lac du Sauvage stream.

Biological Effects

A biological effect detected in Cujo Lake was enhanced *phytoplankton* biomass due largely to diatoms (single celled algae with a siliceous shell). This was probably caused by a source of biologically available *phosphorous*; Cujo Lake had the highest average annual total *phosphorus* concentrations of any lake studied. *Zooplankton* biomass and shallow lake benthos densities were also elevated in Cujo Lake, possibly as a result of project activities.

Metals (Arsenic)

King Pond acted as a potential source of arsenic to downstream water bodies in 2002. Concentrations currently remain ten times lower than the Canadian water quality guideline for the protection of aquatic life.

Nutrients (Total Phosphorous and Ammonia)

Total *phosphorous* concentrations in Cujo Lake were elevated by project activities in 2002. Concentrations of *ammonia* in the outflows from Cujo Lake have been slightly increased by project activities.

Agency's Assessment of Aquatic Monitoring at Ekati

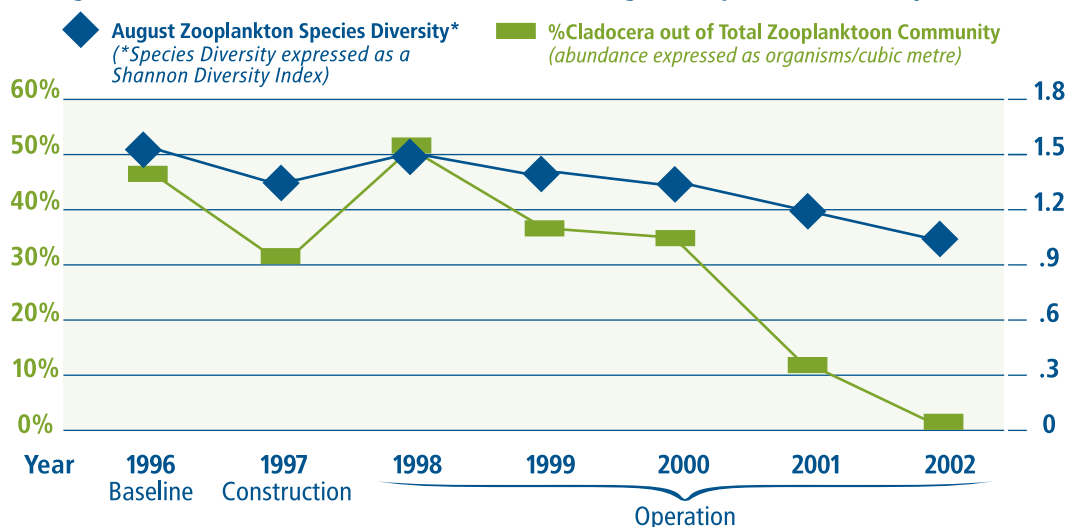
Zooplankton

We are concerned about the changes in the *zooplankton* community of Moose Lake. Since 1998, the overall diversity of the community has declined, largely the result of declines in both the numbers and taxa of Cladocera (water fleas). These are an important food for fishes, and in fact a change in diet of round whitefish seems to have occurred in 2002. The pattern of these declines suggests a persistent multi-year trend, and not just the year-to-year variation that occurs in all

zooplankton communities (Figure 3). The pattern may be related to the increasing influence of water originating in the LLCF. Total dissolved solids (TDS) concentrations, for example, have almost quadrupled from an open-water baseline of approximately 10 mg/L in 1996 and 1997 to nearly 40 mg/L in 2002.¹

In response to our recommendation, BHPB has agreed to expand its *zooplankton* sampling in 2003 to include Leslie Lake in the monitoring program along with two cells (D and E) of the LLCF. This expanded program may tell us whether the apparent shifts in the *zooplankton* community of Moose Lake are related to the discharge of *kimberlite tailings* effluent from the LLCF.

Figure 3: Moose Lake Cladocera Abundance and August Zooplankton Diversity* vs. Time



¹ Moose Lake TDS: 2002 open water season average 37.3 mg/L; 1997 August one day water column average <10 mg/L; 1996 July one day water column average 14 mg/L



Aquatic Effects Monitoring Program

Nitrate Toxicity

In late 2002, we reviewed a Government of Canada report "Nutrients and their Impact on the Canadian Environment" (Chambers et al. 2001). The report indicates, "Nitrate levels in the range of 1 to 10 mg/L of nitrate are lethal to eggs and, to a lesser extent, fry of salmonid fish." The original research on which this conclusion was based was conducted by Kincheloe et al. 1979.

Concerned about rising nitrate levels in the Koala watershed, we commissioned Dr. J.B. Sprague to review Kincheloe's original studies, which formed the basis of the original report. His conclusion was that the methodology used by Kincheloe seemed to be generally sound, and suggested that while the findings have not been confirmed (or invalidated) by other research, another study to corroborate the results should be done. He also stated it appears prudent to accept that concentrations in the vicinity of 10 mg/L of nitrate could have deleterious effects on developing young stages of sensitive fish.

The range of concentrations indicated by the Kincheloe et al. studies suggests that, for some species, lethal concentrations may be even lower than 10 mg/L of nitrate. Since none of the major species in the vicinity of the Ekati project has been assessed, their sensitivities are unknown.

With regard to diamond mining, we note:

- The ammonium-nitrate used in blasting inevitably increases nitrate concentrations in surface waters.
- Ammonia concentrations in lakes are typically much higher under winter ice than during the open water season.

- The surfaces of un-weathered blasted rock are contaminated with nitrates.

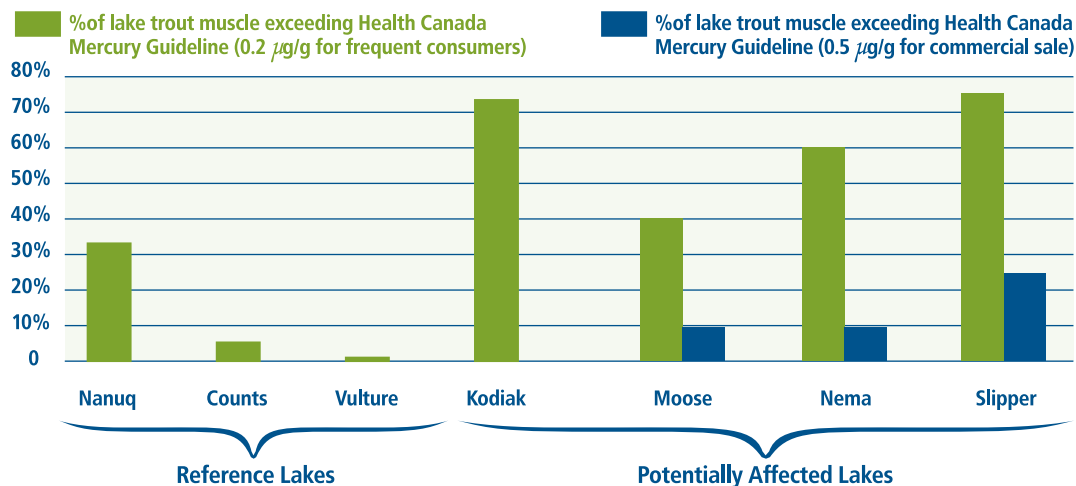
Several of the major species in the vicinity of the Ekati mine are either fall (lake trout and round whitefish) or winter (burbot) spawners, whose eggs and larvae might be exposed to elevated concentrations of nitrate over long periods of time. Consequently, it would be prudent for BHPB to avoid the placement of nitrate-contaminated rock in or near water (for example, as dike or dam facings) in any area where it might attract spawning fish. Since this is potentially a significant and widespread issue for the diamond fields generally, we recommend that DFO conduct studies to further assess the potential toxicity of nitrate to local fish species.

Mercury in Fish Flesh

Another issue that drew our attention last year was the concentration of mercury in the muscle and liver of lake trout, which increased markedly downstream of the mine (Figure 4). The 2002 aquatic monitoring report notes this, but concludes, because mercury is not known to be associated with diamond mining, that it is a natural effect and not the result of the mining operation.

Interpretation is complicated because there has been a lack of consistency in sampling locations over the years. The only potentially affected lakes (downstream of the LLCF) sampled in 2002 that had been previously sampled for lake trout during the baseline period (1997), are Slipper Lake and Nema

Figure 4: Percentage of Lake Trout Muscle Samples Exceeding Health Canada Guidelines for Consumers of Fish in 2002





Aquatic Effects Monitoring Program

Lake (not including the site in Lac de Gras). The lake trout sample size for mercury in tissue and liver from Slipper Lake in 1997 was also smaller than ideal, at only eight, and only five for Nema Lake. At that time of sampling, mercury levels in fish from Slipper Lake from tissue and liver averaged 0.4 and 0.48 $\mu\text{g/g}$.

Mercury that enters biological systems is typically converted to methyl mercury, which is produced by bacterial activity. This process requires both mercury and a source of organic carbon. While the mine operation may not have done much to increase loadings of mercury, it has certainly increased the availability of organic carbon. Sources of the latter include:

- the organic materials flushed down the Panda Diversion Channel (PDC) after it began flowing;
- sewage disposal to water bodies;
- increased primary production (the fixing of carbon) as a result of sewage disposal to Kodiak Lake; and
- the lowering and subsequent re-flooding of the margins of Long Lake.

BHPB has acknowledged our concern about mercury, and has agreed to sample fish flesh from Leslie Lake as part of the 2003 studies. ■

Trend Analysis

The Agency and several others indicated a need for more effective trend analysis to be presented in the annual AEMP report. This was discussed at the monitoring workshops and agreed to by BHPB, and will be implemented for 2003. ■



Panda Diversion Channel during the freshet. AGENCY

Recommendation:

5. DFO should conduct studies to further assess the potential **toxicity** of **nitrate** to local fish species.





Special Effects Monitoring Program

Special Effects Monitoring Program

Under its authorizations from the Department of Fisheries and Oceans (DFO), BHPB conducts special studies to determine and monitor the impacts of mine developments on water and biological communities in Kodiak Lake and the Panda Diversion Channel (PDC).

The PDC was under construction during the winter months from 1994 to 1996. As early as 1995, Kodiak Lake was influenced by drainage from the PDC when it received water from the lower section of the channel. From 1997 to early 1999, treated sewage effluent was discharged into Kodiak Lake, resulting in an increase in *phosphorous* loading to the lake, and

increased primary productivity (*eutrophication*) by algae and rooted aquatic plants. One effect of *eutrophication* was a marked reduction of winter oxygen concentrations in the lake, which BHPB mitigated by *aerating* during the winter months.

By 2001, the lake had largely recovered from the effects of *eutrophication* and the Agency supported the discontinuation of the Kodiak Lake Special Effects Monitoring Program (SEMP), and the transfer of Kodiak Lake and Kodiak-Little Stream into the Aquatic Effects Monitoring Program (AEMP). Monitoring of Kodiak Lake as part of the AEMP in 2002 indicated that winter dissolved oxygen had stabilized, though levels of *ammonia* and *nitrate* remained elevated. This was probably due, in part, to leakage of *ammonium nitrate* from the explosive storage area near the shore. BHPB has taken corrective action on this issue by improving the explosive storage area and relocating it away from Kodiak Lake.

Checking grayling and water quality parameters.

JERI HERMANN/BHP BILLITON DIAMONDS INC.



History of the Panda Diversion Channel

In order to mine the Panda and Koala *kimberlite* pipes, a 3.4 km long trench was constructed to divert incoming water from lakes located upstream in the watershed around Panda and Koala Pits. Construction of the channel was completed in 1997, and fish habitat structures were subsequently installed in the channel to compensate for stream habitat lost during construction of the mine.

2002 is the fifth consecutive year that fish habitat within the channel has been monitored and improved. The 2002 studies indicated the following:

- Arctic grayling continue to use the channel for spawning, rearing, forage, nursery and migration. The numbers of adult grayling entering the PDC in the spring of 2002 were the second highest on record. Difficulty with the Kodiak fish box during the first nine days of June prevented an exact count during that period.
- Five other species were found in the channel (lake trout, slimy sculpin, lake chub, round whitefish and burbot).
- Overall, channel residence and larval emergence times for grayling were similar to those in other low flow years; however, lower than expected numbers of young-of-the-year grayling (YOY) were collected in 2002. BHPB attributed this to a number of interrelated factors, such as potential early out-migration of YOY fish, and fewer eggs being deposited due to the smaller individual size of the adult spawning grayling population.
- The presence of juvenile grayling (aged 1+, first emerged in 2000 or 2001) suggests that some PDC reared YOY grayling may be surviving their first



Special Effects Monitoring Program

over-wintering period. This has been a concern throughout the history of the PDC.

- BHPB suggests the grayling hatched in the PDC are of a comparable size to grayling from other northern systems. The Agency suggests the size of the PDC grayling should be compared to a local, reference population from the Kodiak watershed.
- The PDC supports diverse *benthic invertebrate* and *periphyton* communities but it is difficult for us to determine how the biomass and diversity of the communities compare to those of natural streams.
- With the exception of persistent erosion and re-deposition within the steep 'canyon' section of the channel, monitoring suggests that the channel and the in-stream structures remain relatively stable.

The Future Status of the Panda Diversion Channel

In 2002, as in previous winters, the PDC was excavated in its entirety to remove ice and snow blockages. In part due to the need for annual maintenance, the Abandonment and Restoration Plan drafted previously by BHPB describes abandoning the PDC and restoring natural drainage through re-flooded pit lakes. BHPB has indicated the PDC will continue to function until all mining in Panda and Koala Pits and all underground mining activity are complete, probably 2012 or 2014. The company would be required by DFO to restore suitable stream habitat to compensate for the closure of the PDC, potentially through new streams connecting future pit lakes within the Koala Watershed.

Agency Assessment of the 2003 Panda Diversion Channel Special Effects Monitoring Program

The future of the PDC monitoring program has not yet been decided, and the Agency is working with BHPB on refining it for the 2003 season. We have also noted the delay of the five-year PDC summary document from BHPB that prevents further analysis of a key issue for us — the relative size of Arctic grayling spawning in the channel compared to those spawning in natural streams. Although the PDC seems to produce large numbers of grayling fry, they are considerably smaller than those produced in natural streams within the Kodiak watershed. The salmonid literature is replete with examples of reduced survival rates among slow-growing fry and juveniles in comparison with those of larger fish of the same population.

We continue to work with BHPB to develop techniques to address the long-term issues related to the performance of the diversion channel. It is encouraging to note that the company recently expressed willingness to re-allocate funds within the existing program to address this issue. ■

Fish box at the Panda Diversion Channel.



FRAN HURCOMB/BHPB BILLTON DIAMONDS INC.

Improving the Monitoring Program of the Panda Diversion Channel

A planning session on the future PDC monitoring program attended by the Agency, along with representatives from DFO and BHPB, occurred in early 2003. At the meeting, BHPB demonstrated its willingness to respond to a pressing environmental management concern at Ekati — the contribution of arctic grayling from the PDC to the Koala Watershed. It agreed to conduct a targeted fish-sampling program in Kodiak Lake in 2003 to better understand the arctic grayling fish population in the lake. BHPB was also willing to consider a new recommendation from us — to sample grayling that spawn in a nearby reference stream (Vulture-Polar Stream) as well as in the PDC to compare the relative sizes of the young-of-the-year (YOY) grayling.



Air Quality Effects at Ekati

Air Quality Effects at Ekati

Our current understanding of air quality changes occurring at Ekati as a result of mining activity is less complete than our understanding of changes to other environmental components such as water quality and wildlife monitoring. Last year, in furthering this objective, BHPB published a report that compiled and analyzed different sets of data collected between 1998 and 2001. These included monitoring results for suspended particulate matter (dust) and snow contaminant concentrations, as well as calculated emission contributions for airborne combustion products such as SO₂, NO_x, CO₂, CH₄, and N₂O.

BHPB's report concluded that data for the high volume air samplers and the snowpack chemistry are of excellent quality, and found, among other things, that:

- suspended particulate matter (i.e. dust) at the accommodations building is ten times the levels measured at Grizzly Lake;

- dust levels decrease as the frequency of blasting increases, likely as a result of less traffic and other mining activities which generate dust;
- concentrations of *ammonia*, *nitrate*, aluminum, copper and iron in the snowpack are elevated above background levels;
- dust-related metals and chemicals in the snowpack reveal a zone of influence on snow chemistry up to about 5 km from the mine;
- gaseous contaminants such as NO₃ and SO₄ are distributed more broadly to at least 20 km from the mine site, and it is difficult to separate Ekati-generated levels from background or long-range atmospheric transport of these materials; and
- air quality objectives are being met at the mineral claim boundary, and therefore further air dispersion modeling is not required.

Agency's Assessment of Air Quality Investigations

Our primary concerns continue to focus on the reported elevated levels of total suspended particulates and deposition of dust around Ekati. BHPB's report concludes that the monitoring data are of excellent quality, and that ambient air quality objectives are being met based on snowpack data and the dispersion modelling conducted in 1995. The Agency has reason to question these findings, based on our independent review.

The deficiencies in the air quality assessment mean that it alone is not sufficient to determine whether

ambient air quality objectives are being met, and even if the existing monitoring program is delivering reliable information on which to make this determination. To help resolve the deficiencies, we therefore recommend that a new air dispersion modelling analysis be conducted, and used as the basis for future air quality monitoring work, including the siting of sampling stations.

Dust

Our review of the data could not support BHPB's claim that blasting activity appears to have no significant effect on measured dust levels and that dust levels actually decreased during blasting periods. The reports conclude that dust levels are higher on days without blasting than on days with blasting due to decreased traffic activity between blasts. While traffic activity may decrease just before and just after a blast, there is no evidence that the total daily activity levels on days with blasting are any different from days without blasting. The report needs to show the location of the two sampling stations in relation to mining activity and to prevailing winds at the time blasting occurred. Without knowing which way the wind was blowing at the time of each blast, and with only two monitors installed, it is impossible to determine what effect blasting activity has had on dust levels in the vicinity of the mine, or with distance downwind from the mine. In addition, since blasting lasts for a short period, the dispersal of the plume would take less than hour and, as a result, the 24-hour average particulate concentration would hardly be affected. In addition to good wind data, many more monitoring locations would be required to ensure that there was a reasonable probability of intercepting the



Haul truck on the Misery road. AGENCY



Air Quality Effects at Ekati

plume from an explosive blast. Similarly, precipitation levels on the days when air sampling was carried out, something not considered in BHPB's assessment, will affect airborne particulate levels.

The result is that the study's conclusions have been formed in the absence of critical data, and have not considered the effect of wind speed, direction, location of the monitors, and precipitation. Our review found that the most demonstrable conclusion that can be drawn from the data is that overall levels of measured particulate matter in the air have steadily increased from year-to-year at both monitoring locations.

Meeting Air Quality Objectives

The BHPB report noted that the highest suspended particulate levels were recorded at the monitor located on top of the accommodation building, but then dismisses these readings as anomalous because of interference from the cleaning of kitchen ducts and ventilators located in the immediate vicinity of the monitor. Contamination by kitchen emissions aside, our view is that none of the data from this monitor can be considered useable, since its placement violates commonly recognized guidelines for the siting of such samplers.

Our review also found that the BHPB report's conclusion that annual air quality objectives are being met at the mineral claim boundary, as supported by modelling from 1995 and snow chemistry data, is flawed.

First, the 1995 air dispersion model does not account for the reduction of dust levels due to deposition as the plume moves outward. Second, the 1995 model

used assumptions about mining operations and *emissions* that must now be verified, and possibly adjusted, to accurately reflect current conditions. Third, snow chemistry data reflects the impact of dust deposition, not ambient particulate concentrations. As coarse particles settle out first as distance from the source activity increases, snow survey data will not provide a direct measure of suspended particulate levels with distance from the mine. As well, the current dust monitoring is conducted during the warm summer months and the snow chemistry data is collected in winter. Conditions for dust dispersion are unlikely to be the same in the winter and summer seasons, and so no conclusions can be drawn about the attainment of air quality objectives based on snow chemistry and modeling alone.

The Agency concludes that there is currently insufficient information to reach a determination about whether current operations at Ekati meet the air quality objectives at the mineral claim boundaries. In addition, we do not support the use of the mineral claim boundaries for determining environmental effects from the mine's airborne *emissions*. The property is many times larger than the actual mine footprint, and vegetation, water and wildlife could be affected by airborne contamination well within the property limits. In our view BHPB should give serious consideration to refining the boundaries of where guidelines are to be met to a more realistic zone of influence around the mine's activities.

Lastly, BHPB's report concludes that non-aerosol associated chemicals such as NO₃ and SO₄ are distributed at least 20 km from the source and that more assessment must be done to determine the

influence of long range transport of atmospheric pollutants. As well the report indicates the need for more distant control sites. BHPB's more recent plans for 2003 and 2004 air quality monitoring do not include any reference to how the monitoring program will be adjusted to address the recommendations in its survey report.

Our review of the air quality survey report and the proposed 2003-2004 monitoring program has been forwarded to BHPB for its consideration. In the interim, it is our initial view that the air quality modeling and monitoring programs need substantive reworking to produce a reliable picture of how mining may be affecting air quality at Ekati. If air quality has been found to be unacceptably affected, the studies will assist in suggesting changes to environmental management practices at Ekati, including the determination of new locations for the dust monitors. ■

Recommendation:

6. *We recommend that a new air dispersion modelling analysis be conducted by BHPB, and be used as the basis for future air quality monitoring work, including the siting of sampling stations.*



Wastewater and Processed Kimberlite Management

Wastewater and Processed Kimberlite Management

Once *kimberlite* ore passes through the mill, and diamonds have been extracted, the crushed material is transported and deposited either as a fine-grained slurry fraction (processed *kimberlite*) in the Long Lake Containment Facility (LLCF), or as coarse-grained solid fraction in the Panda-Koala waste rock dump (see Figure 5). The latter material will eventually be encapsulated entirely by granite waste rock so as to minimize water and air infiltrating the *kimberlite* waste and producing undesirable drainage. There are some potential concerns associated with chemical stability of *kimberlite* that are not yet resolved, and we have discussed these in our section on "Waste Rock".

The LLCF is a former chain of small lakes now dammed at the lower end, and subdivided internally

into four cells by pervious dykes (plus one separate cell) in which processed *kimberlite* tailings are deposited. Since commencement of production in 1998 processed *kimberlite* has been deposited in the two uppermost cells (B and C), while the lower cells serve as clarifying ponds before water is discharged from the facility into the downstream Koala watershed. During the 2002 open water season tailings discharges were to cell B, and in September discharges were moved to cell C in order to reduce ice entrapment and enhance settling of the processed *kimberlite*. In 2002 3.7 million tonnes of ore were processed at Ekati. To date some 10.2 million tonnes of fine *kimberlite* have been placed in the LLCF. The pervious dykes contain the *kimberlite* solids, but allow water to drain through into downstream cells so that maximum storage of solids can be achieved for each cell. As the water moves

downstream to cell E, it clarifies and reaches levels that, to date, have met regulatory limits for discharge into the downstream environment.

In addition to processed *kimberlite*, *pit water* from Panda, Koala, and Koala North developments, treated sewage, and site drainage, are being discharged into the LLCF. At the Misery site located 26 km to the southeast, *mine water* from the pits is discharged into the King Pond sediment pond for settling and clarifying prior to its discharge into Cujo Lake when water quality criteria are met.

Toxicity Studies

Last year we reported that two studies were under way in the Long Lake Containment Facility (LLCF). One was a continuation of earlier work to investigate the source of *toxicity* causing observed

Remnant of Fox Lake during site preparation. DARNELL MCCURDY/DIAND



Wastewater and Processed Kimberlite Management

declines in *zooplankton* abundance and diversity within some of the Long Lake cells. Early indications are that the toxic agents may be the *flocculants* and *coagulants* used in the mill to remove the *kimberlite* clays from suspension in the process water. Methods are being developed to accurately quantify the concentrations and behaviour of these synthetic compounds, and no results have been reported to date.

The other study was an experiment at the bottom of cell E (the least affected cell) to see how well benthic communities would establish on *kimberlite* substrates, and to determine the kinds of physical and chemical changes of *kimberlite* sediment as it ages underwater. Test plots were compared to reference plots of natural sediments in cell E. One of the results was the growth over the past year of a brown, organic carbon-rich layer on both the *kimberlite* and reference samples, and that this layer reduced the toxic effect of newly deposited *kimberlite* on the amphipod *H. azteca*. This indicates that the presence of this organic layer may be an important factor in enabling benthic re-colonization of processed *kimberlite* sediment.

This experiment continues into 2003, and we will report on the results of this work in the future.

Tailings Characterization Studies

Last year we reported that BHPB was in the process of completing the field phase of studies designed to better understand the physical behaviour of processed kimberlite once deposited in the LLCF. The results of this work were reported to the Mackenzie Valley Land and Water Board last summer, and we

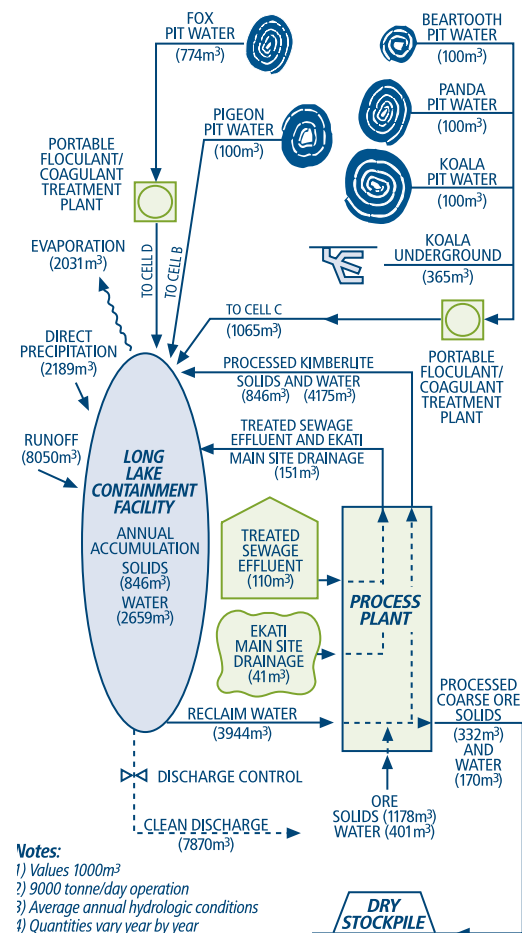
submitted our comments to the Board not long after. Our assessment noted that only some of the original study objectives as defined in the Class "A" Water Licence had been achieved in the field study.

One water licence objective was to determine whether treatment of effluent will be required in order to meet license requirements. This issue may be especially important when Fox process water enters Long Lake - something that has not yet commenced. BHPB's early lab work in 1995 with simulated processed *kimberlite* tailings showed that, while adding *flocculants* (BHPB's preferred treatment to date) to Panda tailings helped them settle more rapidly, Fox tailings had almost no response, and remained in suspension. This issue remains unresolved, and has important management implications in terms of managing processed *kimberlite* in the LLCF. Since actual Fox ore will not be definitively produced until 2006, this question cannot be answered. BHPB's report might have acknowledged that, with respect to complying with the water licence, this important objective has yet to be achieved. These, plus a few other minor concerns, led us to recommend last year to the MVLWB that it would be premature for the MVLWB to approve this study as being complete, and that BHPB should present a plan to the MVLWB on how the outstanding requirements from the Class "A" Water Licence will be addressed.

Fox Development and Misery Land Treatment

Please view the "Expansions and Amendments" section of our report for a description of these activities. ■

Figure 5. Proposed Wastewater and Processed Kimberlite Management Plan



BHPB Water Balance Schematic (draft document).

BHP BILLITON DIAMONDS INC.



Waste Rock Management

Waste Rock from the Mine

Some 41 million tonnes of waste rock were excavated at Ekati during 2002. Development at the Fox pipe has now added a third waste rock pile to the Ekati operation. While ore production is not scheduled to begin until 2006, pre-stripping of waste rock was initiated in late 2002 at Fox pipe. The current footprint of mining on the property is about 1400 hectares, and the waste rock dumps comprise approximately one half of this area.

Waste rock storage area with Panda Pit in background. AGENCY



In accordance with the Class "A" Water Licence requirements, the company continued an excellent program of monitoring seepage from the waste rock dumps during the summer of 2002. Results were generally consistent with the results of earlier surveys, and show that the granite waste rock (the major rock type being deposited in the Ekati waste rock dumps) is currently not producing water quality impacts, although there are concerns with *ammonia* in several locations.

Water quality issues, however, are present for areas within the dumps that contain biotite schist from the Misery pipe, along with waste *kimberlite* and coarse *kimberlite* tailings being deposited in the Panda and Misery dumps. We comment further on these two areas below.

Waste Kimberlite

In addition to granite, both *barren kimberlite* and processed coarse *kimberlite* tailings are being deposited in portions of the Panda-Koala dump. High sulphate concentrations in drainage from this material, as well as acidic pHs, are found at the base of the coarse *kimberlite* reject pile and appear to increase in acidity down-gradient.

BHPB interprets the elevated sulphate concentrations within the *kimberlite* storage areas as likely originating from oxidation of iron *sulphide* minerals, with possible freeze concentration of the resulting pore waters. Acid produced by oxidation is probably neutralized by contact with calcium and magnesium carbonates and silicates resulting in high alkalinity of water within the *kimberlite* storage area.

As for the acidity in drainage downstream of the actual rock piles, the company attributes these not to sulphur oxidation, but the oxidation of iron in naturally acidic tundra pools, the precipitation of ferric hydroxide, and resulting depressed pH which, in turn, leaches metals (predominantly aluminum and zinc) from the tundra soils.

BHPB notes that the drainage from the waste *kimberlite* portions of the Panda-Koala dump flows into Long Lake and, hence, is "not discharged into the receiving environment."



Waste Rock Management

Misery Pipe

At least three seeps at the Misery waste rock pile showed evidence of acid generation from *sulphide* oxidation. The most likely source of this is the biotite schist, which comprises about half the volume of waste rock at this pipe. There is also a *barren kimberlite* stockpile and a temporary ore storage pile at Misery, both of which showed elevated levels of calcium, sulphate, magnesium and nickel. One seep at the west end of the waste rock pile showed elevated levels of arsenic, copper and cadmium.

Seepage survey results have led the company to change its approach to waste rock management, and to place greater emphasis on freezing as a strategy to control poor quality drainage. The observed undesirable waste rock seepage in some locations has resulted in dump design now being modified to include a foundation layer of granitic waste rock on the tundra, with the dump perimeter being defined by a frozen waste rock berm constructed during the winter so that it remains permanently frozen.

Where potentially problematic rock such as the Misery schist is being deposited, it is confined to layers within the core of the dump, which are then encapsulated by the geochemically stable granite. The concept is that the blocky texture of the granite allows for efficient convection of cold air into the dump during winter so that “super-cooled” temperatures within the dump are achieved, and the core of the dump remains frozen permanently. This is supposed to contain, by freezing, any water that infiltrates into the waste rock pile, so that seepage from the toe of the dump will be minimized.

Temperature data from the core of the Panda and Misery granite dumps reveal that the dumps are frozen.

Agency's Assessment of Waste Rock Management

BHPB gets high marks for the effort invested in collecting field data and conducting laboratory studies to understand waste rock behaviour at Ekati. Understanding the current geochemical processes clearly will assist in clarifying predictions about long-term waste rock drainage chemistry and developing management prescriptions for operation and closure.

BHPB is also to be commended for pursuing further work at our behest in getting a better handle on both the natural acidity of tundra waters and on the mineralogic characteristics of *kimberlites*. This work has added to our understanding of geochemical processes on site. It is noted that the *kimberlites* have relatively high concentrations of some rare earth elements, and a few metals such as molybdenum. There are several high dissolved molybdenum concentrations in waste rock seepage. The environmental significance of these is not discussed, and we look forward to more evaluation as to potential effects when more data are gathered in the near future.

Restricting the comparison of seepage quality results to Class “A” Water Licence limits is, however, an undue limitation on understanding the implications of observed low quality drainage for the receiving environment. Evaluating the drainage in terms of the CCME Guidelines for the Protection of Aquatic Life would be more informative about potential



Water seeping out of the waste rock storage area. AGENCY

environmental effects of waste rock seepage, and more conservative from a management perspective.

Despite the extensive monitoring work to date, we are not yet convinced that waste rock management will be environmentally protective of the downstream environment in the long-term. Several issues remain.

BHPB has recognized that the *geochemistry* of kimberlitic material, particularly within the contact zone with tundra soils, is relatively complex. Explanations have been developed for the various processes that result in site water quality, and further monitoring over the next few years will help verify these. There appears to be little doubt that oxidation of *sulphides* within the waste *kimberlite* piles is occurring, although sufficient *neutralizing material* exists, for the present at least, to prevent the formation of acidic drainage.

While the 2002 Waste Rock Seepage Survey concludes that *sulphide* oxidation is not presently producing acid drainage, the Fox Waste Rock



Waste Rock Management

Management Plan produced last year notes that “Fox coarse *kimberlite* rejects might be expected to release elevated concentrations of major elements under non-acidic conditions”, and that it is “reasonable to assume for the purpose of waste rock storage area management planning that waste *kimberlite* will generate acid.”

While lab tests of static and kinetic characteristics of *kimberlite geochemistry* are encouraging, one lesson from Ekati experience is that field results can be quite different than lab results. Acid-base accounting predicts *kimberlite* not to be acid-generating, for example, but coarse *kimberlite* tailings do generate acidic leachate.

And despite the company's assurance that *kimberlites* exhibit “similar” geochemical behaviour, enough differences exist among the pipes to be potentially problematic. Lab testing of Fox *kimberlite*, for example, revealed difficulties with filtering cloudy leachates, and it was speculated that “the build-up of major elements and nickel in the leachates is due to physical rather than chemical weathering processes.” This characteristic has not been reported for other *kimberlites*, but it is consistent with earlier lab tests, which revealed much higher percentages of ultra-fine clay particles in the Fox *kimberlite*, and exceedingly lengthy settling and consolidation rates compared to Panda tailings.

Continued prevention of acidic drainage may well depend upon continuing availability of carbonates and other neutralizing minerals to buffer acid generation, and we're not yet convinced the kinetics of these reactions is well enough understood yet to competently predict that neutralizing capacity will outlast *sulphide* supply. This may turn out to be a non-issue.

Some of these uncertainties pose risks for successful closure. BHPB minimizes the significance of poor quality drainage flowing out of the coarse *kimberlite* areas by noting that it ends up in the Long Lake Containment Facility. While this is true during mine operations, at closure in 20 years or so this facility will be reclaimed and will become part of the receiving environment. Deleterious drainage arising from waste rock in the Long Lake drainage area then becomes an issue. The current waste rock management and closure plans have not accounted for this possibility.

Additionally, the much greater management dependency now upon freezing, both within the core of the waste rock dumps and within perimeter toe berms, is worrisome, particularly with respect to the *kimberlite* deposition areas which appear not to be freezing at depth. Dependency upon frozen dump cores, while intuitively appealing, is not yet a proven technology for northern ecosystems.

While the granite dumps appear to demonstrate internal freezing at super-cooled temperatures, this has yet to be demonstrated for areas that contain a

significant volume of *kimberlite*. This material is much finer-grained than the granite, and may not allow for convection effects of the latter material. The coarse *kimberlite* rejects pile shows that freezing of the core of that pile has yet to occur and, if this is reflective of how the waste *kimberlite* material will behave, then frozen cores in the future are not necessarily assured.

We do not agree with the company that climate change is not an issue for long-term security of the waste rock piles. If current warming trends continue, the dumps could become unfrozen at some distant time. The ability to keep oxygen and moisture out of the dumps would then depend critically on the effective impermeability of the capping material. It has not been demonstrated that BHPB's approach to waste rock management in this regard is conservative, and a more precautionary approach would suggest that waste rock dumps ought to be constructed so that they are safe-fail under temperate (i.e. non-frozen) conditions. After all, the true test of sustainability in mining lies with the ultimate success of closure. ■

Recommendation:

7. BHPB should assess the long term, i.e. post closure implications of poor quality seepage from the coarse *kimberlite* storage area.



Coarse *kimberlite* reject storage area within the waste rock pile. AGENCY

Waste Management and Reclamation Activities



Waste Management and Reclamation Activities

The progressive reclamation of a large project, although never before undertaken in the north, is a concept well supported by northerners. During progressive reclamation, as mine activities are completed and infrastructure no longer required, roads are reclaimed, buildings and equipment removed, areas revegetated and land-fills and dumps remediated as per approved plans. Through progressive reclamation, the amount of

remediation required once a mine closes is less than if no remediation had occurred during the life of the project. Progressive reclamation activities should also influence the amount of a security deposit the mine must set aside at any given point in the mine's lifecycle.

Regular waste management activities also influence reclamation activities. The amount and type of wastes disposed on-site during the construction and operations of the mine need to be considered in the final reclamation plans.

Sampling natural vegetation. JERI HERMANN/BHP BILLITON DIAMONDS INC.



Reclamation Activities

In 2002, BHPB focused on three primary reclamation activities: reclamation of sites and infrastructure no longer required, revegetation studies and establishment of reclamation criteria.

BHPB has identified the following areas as having undergone reclamation, for a total of 70.9 hectares (out of a total of 1400 ha of disturbed lands) in 2002:

- Ekati Airstrip – perimeter, Culvert Camp, Fred's Channel – contoured and seeded with native plants.
- Panda Diversion Channel - placement of fish habitat structures and seeded with native grasses and shrubs.
- Fox Portal Road - road closed to traffic, natural vegetation colonizing.
- Old Camp – road seeded, removal of buildings, fuel tanks and equipment.
- Other smaller areas contoured and seeded.

BHPB has conducted studies on vegetation growth in processed *kimberlite* and elsewhere for over eight years. It has used many different types of vegetation native to the arctic such as arctic grasses, shrubs and willows, many types of substrate including lake sediments, sewage sludge and pulp and paper waste and many different techniques.

Findings to date have shown:

- Transplanted seedlings have a higher success rate than seeds grown directly in the soil.
- Adding lake sediment to the growth substrate decreases the viability of seedlings.



Isolated group of small trees
along the Misery road.

AGENCY

Waste Management and Reclamation Activities

- Adding peat, sewage sludge and pulp and paper waste increases the viability of seedlings.
- The use of rock pile islands in the processed *kimberlite* promotes immediate local growth due to protection of seedlings from the wind.
- Four metals (nickel, magnesium, aluminum, and molybdenum) were present in elevated concentrations in plant tissues compared to normal ranges in plants.

One of the purposes of the vegetation studies in 2002 was to determine if plants growing in processed *kimberlite* posed a concern to local and migratory grazers such as caribou and hare and their predators. Although the results show that metals taken up in the vegetation do not affect the success of revegetation of processed *kimberlite*, they also show that 12 metals were of concern, four showing elevated concentrations in plants. No reports were available on the impact to animals grazing on the plants either through sampling or risk modeling.

BHPB completed the field phase of studies designed to better understand the physical behaviour of *tailings* once deposited in the *tailings* facility. Our assessment of the studies noted that only some of the original study objectives as defined in the Class "A" Water Licence had been achieved in the field study.

One objective not addressed was to determine whether progressive restoration of *tailings* slurries will be possible, and over what time frames. The concern is related to the uncertainty about both how easy it would be to remove clarified water from settling slurries in the cell low-point, and whether the subsequent consolidation and freezing of slurry solids would allow heavy equipment to be supported in

order to deposit waste rock on the surface in accordance with the Abandonment & Restoration Plan. Evidence introduced at the 1996 hearings suggested that inordinate lengths of time may be required before freezing is adequate to support construction of the cover. Whether this objective needs to be met may depend on whether the Abandonment and Restoration Plan is revised to include a different means of dealing with reclamation of the processed *kimberlite* containment facility

Not yet determined by BHPB is how much, if any, of the processed *kimberlite* may eventually be deposited in the mined-out pits. Infilling of pits is not yet a part of the approved plans for closing the mine, but the company is seriously contemplating this alternative.

The concept may have significant benefits. First, it would provide much greater flexibility for managing the Long Lake Containment Facility by relaxing storage limitations, particularly, if new developments are brought on line as a result of continuing exploration on the property.

Second, infilling of pits so that only a thin surface layer of water remains (similar to natural lakes in the area) after closure will likely increase the chances for re-establishing viable aquatic ecosystems—something that all parties would prefer to see happen. Pits filled only with water will likely result in deep pools that will be stratified, with a thick oxygen-poor layer below a relatively shallow layer of oxygenated water. The deeper layer will act as sink for nutrients and other biological detritus that ordinarily would be available to support a growing aquatic community in the shallower zones. Instead, this material will fall into the deep layer, maintaining the surface layer in an organically impoverished state

from which it may never attain ecological viability. In other words, pits that are not filled with rock to create a shallow water layer are unlikely to be of much use to aquatic life.

From a sustainability perspective, however, filling the pits with processed *kimberlite* obviously depends upon the environmental stability of the *tailings* material. Its residual toxicity upon placement underwater is still a matter of investigation at Ekati, and we look forward to reviewing the results.

Since we are optimistic about the concept of pit-infilling with waste *kimberlite* (or, for that matter, granite waste rock), an issue of concern to us is that BHPB's approach to using *kimberlite* deposition in mined-out pits appears to be one more of management convenience than a studied reflection of how to close the mine in the most environmentally sound way. A closure design emphasizing environmental sustainability would have involved mine development planning in a structured way, sequencing the pit and underground operations in a fashion that would have maximized accommodation of waste *kimberlite* (or waste granite) disposal. Scheduling of mining activities appears to have proceeded without consideration of the full range of possibilities for minimizing waste rock volumes on surface or maximizing opportunities for re-establishing viable aquatic communities.

In 2002, BHPB conducted a literature review of reclamation closure criteria, and committed to continue development of such criteria in consultation with other stakeholders.

In 2002 the scope of the Abandonment and Restoration Plan was revised to cover the



Waste Management and Reclamation Activities

requirements of both the *Environmental Agreement* and the main Water Licence and approved by the MVLWB. The Abandonment and Restoration Plan will be updated in 2003 to include activities related to the expansion into Sable, Pigeon and Beartooth Pits and other changes.

Waste Management Activities

The main areas of waste management at Ekati involve waste rock and processed *kimberlite*. These programs are covered under separate sections of our annual report.

BHPB has a Health, Safety, Environment and Community Policy which has a target of reducing and preventing pollution. To meet this goal, an Energy Smart Program was initiated to reduce the amount of energy used on-site and the Environment Award Program was established to recognize individuals for their contributions to environmental programs. The Agency congratulates the Energy Smart Program for reducing diesel consumption by more than 900 000 litres and being recognized as a success story by the Canadian Industry Program for Energy Conservation. Particular credit is given to the formation of an Environment committee, administered and attended by staff on a voluntary basis. The committee provides employees and contractors with a venue for discussing environmental issues.

BHPB has an extensive waste management program which includes material management, spill contingency and recycling programs. We are pleased to note the large amount of materials shipped off-site and the extensive hazardous waste management practices and facilities at Ekati. The Agency

encourages BHPB to continue to increase the amount of materials it recycles or ships out, thereby decreasing the amount of waste left on-site once the mine has closed.

The *Environmental Agreement* requires BHPB to produce, review and revise a Waste Management Plan. In November 2002, we made two requests to BHPB related to the proposed Waste Management Plan:

- That the plan be updated to include land farm operations and management.
- That explanations be provided for removing juice boxes, pop cans, waste paper, air filters and metals from the recycling program.

We are waiting for a response to our request or a revised Waste Management Plan.

The Agency has heard concerns from community members about the type and amount of waste

Revegetation plot on the Long Lake Containment Facility



JER HERNANDEZ/BHP BILLTON DIAMONDS INC.

materials presently being landfilled at Ekati. We note that DIAND, in its review of the Operating Environmental Management Plan and the Waste Management Plan, recommended that an inventory be kept of wastes produced and entering landfills. It was noted on site visits by the Inspector in September and Agency staff in February that tracking of landfill-destined materials was still not occurring.

Agency Assessment of Reclamation and Waste Management Activities

BHPB is to be commended on its extensive efforts and research to develop effective reclamation tools that can be used to reduce residual impacts of the mine.

We are pleased that BHPB and regulators carefully considered our recommendations from our last annual report, and revised the amount of the security deposits such that it does not include the assumption that progressive reclamation has proceeded as anticipated. We continue to support the adjustment of the security deposit amount once it is confirmed that reclamation activities have successfully occurred.

The development of reclamation completion criteria is an objective we would like to see achieved at the earliest possible time. These criteria will need to outline performance requirements, indicators and benchmarks to meet reclamation goals under the Abandonment and Restoration Plan and the reclamation guidelines for NWT. While we commend BHPB on initiating research on reclamation closure criteria, we strongly support the company's commitment to consult with other regulators, particularly DIAND (as the primary inspection and enforcement agency for reclamation activities) on the



Waste Management and Reclamation Activities

continued evolution of the criteria. We suggest that a workshop among the key parties, including the Aboriginal Peoples who will have to co-exist with what is left behind when the mine closes, may be helpful to advance work on the reclamation completion criteria.

Recommendation:

8. *BHPB should continue to explore the uptake by grazing animals of metals in plants being considered for revegetation of processed **kimberlite**.*
9. *BHPB should improve its reporting of the type and amount of materials stored in waste landfills.*
10. *BHPB should conduct an analysis of its spill records to determine the reasons and trends for spills as a means of improving its operating and management practices.*

We are still not satisfied that BHPB's approach to emerging *tailings* and water issues is as thorough or conservative as it ought to be, particularly since the commitment to "sustainable development" is such a prominent theme in the company's Health, Safety, Environment and Community Policy.

The decanting, for instance, of Fox turbid water into cell D instead of cell C was not an example of a precautionary or conservative approach to managing environmental risk. An environmental assessment of these alternatives could have been carried out, and used to support the option selected.

A revised Abandonment and Restoration Plan will be produced in 2003. Greater attention needs to be placed on closure issues related to the Long Lake facility, including the use of *tailings* as infill material for the pits. It would be good evidence of the commitment to sustainable development to see that mining operations were more fully integrated with closure activities, particularly as regards the supply and transport of waste material to be used in reclamation.

Unless the company is about to revise its closure plan so that revegetating the *tailings* without a rock cover will be the approach adopted, more work needs to be completed to determine whether the approved reclamation of covering the *tailings* area with a waste rock cap is feasible, given the potentially long times following closure before the *tailings* are sufficiently frozen or solid to support the operation.

Designing for closure will also need to consider the post-closure implications of deleterious drainage that may flow from waste rock storage areas within the Long Lake watershed.

We suggest that the revised Abandonment and Restoration Plan also include:

- conceptual plans for restoration of the Panda Diversion Channel;
- conceptual plans for the flooding of Koala and Panda Pits; and
- a clear link to the Waste Management Plan.

With respect to waste management activities we suggest that BHPB:

- consider a tracking system in a revised Waste Management Plan for wastes entering and contained within landfills at Ekati;
- include operations and management of the land farm in its Waste Management Plan; and
- link the Waste Management Plan to the Abandonment and Restoration Plan.

We note that the number of reported spills occurring on-site is increasing but this may be indicative of better reporting, not more spills. As we go to press, the Agency has learned that BHPB has reviewed spill records from the main site to determine the cause of spills. BHPB suggested the increase in spills is a function of increased awareness of contractors and staff in the proper protocols for reporting spills. To understand the situation better BHPB should do an analysis of the number of spills, reasons for the spills and spill trends at both the main and Misery sites. The Agency respectfully suggests that such an analysis would be a beneficial project under BHPB's Operating Excellence program, and contribute to better environmental management practices. ■

Financial Statements

March 31, 2003



Independent Environmental Monitoring Agency

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Management's Report

The management of the Independent Environmental Monitoring Agency is responsible for the integrity of the accompanying financial statements. The financial statements have been prepared by management in accordance with the accounting principles disclosed in the attached notes. The preparation of the financial statements necessarily includes some amounts that are based on the best estimates and judgements of management.

To assist meeting its responsibility, management maintains accounting, budget and other internal controls. These controls provide reasonable assurance that transactions are appropriately authorized and accurately recorded, that assets are properly accounted for and safeguarded, in order that the integrity of the financial records is maintained.

The financial statements have been audited by the independent firm of MacKay LLP, Chartered Accountants. Their report to the directors of Independent Environmental Monitoring Agency, stating the scope of their examination and opinion on the financial statements, follows.

Secretary-Treasurer

May 14, 2003



Financial Statements

Auditors' Report

To the Directors of Independent Environmental Monitoring Agency

We have audited the statement of financial position of the Independent Environmental Monitoring Agency as at March 31, 2003 and the statement of general operating fund and fund balance and the statement of cash flows for the year then ended. These financial statements are the responsibility of the Agency's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with Canadian generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these financial statements present fairly, in all material respects, the financial position of the Agency as at March 31, 2003, and the results of its operations and cash flows for the year then ended in accordance with Canadian generally accepted accounting principles.

Chartered Accountants
Yellowknife, Northwest Territories
May 14, 2003



Financial Statements

Statement of General Operating Fund and Fund Balance

For the year ended March 31

	2003	2002
Revenue		
BHP Billiton Diamonds Inc.	\$ 511,350	\$ 501,400
Contributed services (Note 2)	26,791	23,837
Interest income	3,377	8,794
	541,518	534,031
Expenses		
Accounting and auditing fees	7,018	6,279
Advertising	2,491	310
Amortization	5,214	5,118
Board support		
- per diem fees	177,819	158,282
- travel, meals and accommodation	80,389	90,044
Community consultation	69,009	13,628
Contributed services		
- copying	873	267
- equipment lease	2,618	770
- office lease	23,300	22,800
Insurance	606	2,055
Office supplies	9,254	9,379
Outside consultants	1,080	14,803
Postage and freight	1,835	1,055
Printing, design and communication	39,536	37,557
Recruitment	2,725	-
Relocation	1,556	8,604
Telephone and fax	8,295	6,094
Wages and benefits	131,999	134,320
	565,617	511,365
(Deficiency) excess of revenue over expenses, before the following	(24,099)	22,666
Loss on disposition of capital assets	2,149	-
(Deficiency) excess of revenue over expenses	(26,248)	22,666
Fund balance, beginning of year	67,685	49,655
Transfer from (to) investment in capital assets fund	591	(4,636)
Fund balance, end of the year	\$ 42,028	\$ 67,685



Financial Statements

Statement of Financial Position

As at March 31

Assets

Current

Cash	\$ 569,436	\$ 586,053
Accounts receivable	-	2,519
Prepaid expenses	1,155	1,155
	570,591	589,727
Capital assets (Note 3)	18,113	18,704
	\$ 588,704	\$ 608,431

Liabilities

Current

Accounts payable and accrued liabilities	\$ 9,963	\$ 10,692
Deferred revenue (Note 4)	518,600	511,350
	528,563	522,042

Net Assets

Investment in capital assets fund (Note 5)	18,113	18,704
General operating fund	42,028	67,685
	60,141	86,389
	\$ 588,704	\$ 608,431

Approved on behalf of the Directors


Director


Director



Financial Statements

Statement of Cash Flows

For the year ended March 31

	2003	2002
Cash provided by (used in)		
Operating activities		
(Deficiency) excess of revenue over expenses	\$ (26,248)	\$ 22,666
Items not affecting cash		
Amortization	5,214	5,118
Loss on disposition of capital assets	2,149	-
Changes in non-cash operating working capital		
Accounts receivable	2,519	(1,889)
Prepaid expenses	-	(960)
Accounts payable and accrued liabilities	(729)	(7,287)
Deferred revenue	7,250	511,350
Repayable contribution	-	(33,900)
	(9,845)	495,098
Investing activity		
Purchase of capital assets	(6,772)	(9,755)
Change in cash position	(16,617)	485,343
Cash position, beginning of the year	586,053	100,710
Cash position, end of the year	\$ 569,436	\$ 586,053

Notes to the Financial Statements

March 31, 2003

1. Accounting Policies

The Independent Environmental Monitoring Agency ("the Agency") is a non-profit organization incorporated under the Societies Act of the Northwest Territories. It is exempt from income tax under Section 149(1) of the *Income Tax Act*.

The mission of the Agency is to oversee environmental management of BHP Billiton Diamonds Inc. at the Ekati mine site in the Northwest Territories.

The following is a summary of the significant accounting policies used by management in the preparation of these financial statements.



Financial Statements

Notes to the Financial Statements *(continued)*

March 31, 2003

(a) Financial instruments

All significant financial assets, financial liabilities and equity instruments of the Agency are either recognized or disclosed in the financial statements together with available information for a reasonable assessment of future cash flows, interest rate risk and credit risk.

(b) Capital assets

Equipment purchases are recorded on the balance sheet at historical cost less accumulated amortization. Amortization is calculated by the declining balance method at the annual rates set out in Note 3. In the year of acquisition, amortization is taken at one-half the annual rates.

(c) Economic dependence

The Agency receives all of its contribution funding from BHP Billiton Diamonds Inc. Management is of the opinion that operations would be significantly affected if the funding was substantially curtailed or ceased.

(d) Fund accounting

The Agency follows the deferral method of accounting for contributions.

The general operating fund accounts for current operations, programs and general operations, and the Agency's capital assets.

(e) Recognition of revenue

The Agency recognizes unrestricted contributions when they are received or receivable if the amount receivable can be reasonably estimated and its collection is reasonably assured.

Revenue is recorded in the year specified in the funding agreement with BHP Billiton Diamonds Inc.

(f) Use of estimates

The preparation of this financial information in conformity with Canadian generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial information and the amounts of revenues and expenditures during the period. Actual results could differ from those estimates.

2. Contributed Services

BHP Billiton Diamonds Inc. has directly paid for the office rent and equipment lease for the Agency. The monthly rent is \$2,050 (\$1,900 for the months of April to December 2002) and the equipment lease and photocopying expenses are \$2,618 and \$873 respectively. The Agency recognizes the contributed services at the fair value of the services provided.



Financial Statements

Notes to the Financial Statements *(continued)*

March 31, 2003

3. Capital Assets

				2003	2002
	Rate	Cost	Accumulated Amortization	Net Book Value	Net Book Value
Computers	30%	\$ 14,760	\$ 6,246	\$ 8,514	\$ 8,297
Computer software	100%	907	907	-	453
Office equipment	20%	16,338	6,739	9,599	9,954
		\$ 32,005	\$ 13,892	\$ 18,113	\$ 18,704

4. Deferred Revenue

Deferred revenue consists of the funds contributed by BHP Billiton Diamonds Inc. for the March 31, 2004 year end. This amount will be taken into revenue in 2004, as services and goods are acquired.

5. Investment in Capital Assets

	2003	2002
Balance, beginning of year	\$ 18,704	\$ 14,068
Purchase of capital assets	6,772	9,754
Disposition of capital assets	(2,149)	-
Amortization	(5,214)	(5,118)
Balance, end of year	\$ 18,113	\$ 18,704



Summary of 2003-2005 Workplan and Core Budget

Summary of 2003-2005 Workplan and Core Budget

For the next two years the Agency's work plan has been modified to reflect the recommendations made by our members at the 2002 annual general meeting. In addition to the Agency's regular activities, the Agency intends to devote more effort to:

- Facilitating the integration of community knowledge and traditional knowledge in monitoring and management programs at the Ekati mine
- Encouraging and participating where appropriate in discussions for the development of monitoring activities in a more regional context to better assess *cumulative effects*
- Review plans and designs of infrastructures relative to the newly approved mine expansion (Sable, Beartooth, and Pigeon pipes)
- Monitor the effects of dust on water, vegetation and animals
- Discussion on reclamation and re-vegetation issues
- Implementation of refined monitoring programs for 2003-2007 with regard to aquatic effects, wildlife effects, and Panda diversion channel
- Increasing availability of web-based resources

It is important to note the Agency's activities continue to increase with modifications and expansions to the project.

Core-Budget 2003 – 2004 and 2004 – 2005

- Budget figures are all in \$1000's (thousands of dollars).
- Budget (not including honoraria) has been increased by 3.0 % (predicted rate of inflation) for the 2004-2005 year compared to the 2003-2004 year.

	1st quarter	2nd quarter	3rd quarter	4th quarter	2003-2004	2004-2005
A. Operations						
1. Insurance	0.55	0.55	0.55	0.55	2.2	2.3
2. Telephone, fax, email	2.1	2.1	2.1	2.1	8.4	8.7
3. Office supplies, software	1.7	1.7	1.7	1.7	6.8	7.0
4. Postage, courier, freight	0.6	0.6	0.6	0.6	2.4	2.5
5. Bookkeeping	0.6	0.6	0.6	0.6	2.4	2.5
6. Auditing, accounting	0.0	0.0	0.0	4.7	4.7	4.9
Subtotal					26.9	27.9
B. Board Support						
1. Travel	17.1	8.9	17.1	8.9	52.0	53.6
2. Accommodation	5.6	2.8	5.6	2.8	16.8	17.2
3. Meals	2.2	1.2	2.2	1.2	6.8	7.0
4. Honoraria (Note 1)	46.2	33.6	46.2	33.6	159.6	159.6
Subtotal					235.2	237.4
C. Communication / Consultation						
1. Communication (Note 2)	32.0	1.5	1.5	1.5	36.5	37.6
2. Community Consultation (Note 3)	10.5	10.5	10.5	10.5	42.0	43.0
Subtotal					78.5	80.6
D. Staffing						
1. Manager	21.0	21.0	21.0	21.0	84.0	88.0
2. Environmental Analyst	13.25	13.25	13.25	13.25	53.0	55.0
3. Benefits & Payroll taxes	6.25	6.25	6.25	6.25	25.0	25.8
4. Outside experts	4.0	4.0	4.0	4.0	16.0	16.5
Subtotal					178.0	171.3
Total					518.6	531.2

1. Based on 6 meetings/yr (3 days each) and 1.5 days/month/director for office work and participation in workshops. Meetings are planned in April, June, August, October (with Annual General Meeting), December, and February (with workshops) and 14 days for the Chair for community consultation.
2. Annual report (\$32k), 3 newsletters and web site (\$4.5k)
3. Costs for holding meetings in communities, and attendance/ presentations at Aboriginal assemblies. The Agency has an open invitation to meet with communities to discuss issues related to the mandate of the Agency

**Aerating**

Use of mechanical pumps that add air to a body of water.

Ammonia

The most toxic form of nitrogen, most commonly associated with blasting at Ekati.

Ammonium-nitrate

A fertilizer that is also used as an explosive at Ekati in combination with fuel oil.

Barren kimberlite

Kimberlite that does not contain enough diamonds to be economically processed through the mill.

Benthic macroinvertebrates

Invertebrate organisms (i.e. those without a backbone – insects, worms, mollusks, etc.) large enough to be seen that live on the bottom of rivers, lakes and ponds.

Biotite schist

Schist is a type of metamorphic rock (mudstone and sandstone) that has been subjected to tremendous heat and pressure to change it into a layered, crystalline rock. Biotite is a type of mica that is abundant enough in the Lac de Gras schists to have the rock called a biotite schist. Because the schist also has higher levels of sulphides in it, it has the potential to react with air and water and produce acid.

By-catch

Accidental mortality to other species that occurs during removal of fish from water bodies.

CCME

Canadian Council for Ministers of the Environment.

CIMP and CEAMF

Cumulative Impact Monitoring Program, Cumulative Effects Assessment Management Framework.

Cumulative Effects

The environmental changes that occur from a project or activity combined with effects from other human activities.

Emissions

The process of sending out or releasing contaminants into the air.

Environmental Agreement

Created as a legally binding instrument to provide monitoring and input into management practices not covered by other authorizations.

Eutrophic

Rich in nutrients and therefore supporting a dense plant population, which kills animals by depriving them of oxygen.

Eutrophication

The addition of excessive amounts of nutrients (usually nitrates and phosphates) to water bodies, which causes rapid growth of plants and leads to lower oxygen levels and potentially fish kills.

Fishout

Removal of fish from water bodies in preparation for mining activities.

Flocculants and Coagulants

Chemicals used to make solids stick together and fall out of water quicker as bigger pieces.

Geochemistry

The chemistry of the earth and its rocks and minerals.

Groundwater

Water that flows beneath the surface of the tundra.

Kimberlite

A rare, potentially diamond bearing iron and magnesium rich rock from deep in the earth's mantle. Kimberlites are generally found as vertical pipe-like structures.

Limnology

The study of lakes and other fresh waters.

Mine water

Water found within the pit containing wastes from mining practices.

Mineralogy

The scientific study of minerals.

Neutralizing Material

Minerals in a rock that neutralize acid.

Nitrate

A nutrient, like a fertilizer, derived from nitrogen.

Phosphorous

A plant nutrient that can cause rapid bacteria and algae growth when present in high amounts, leading to eutrophic conditions.

Phytoplankton / Periphyton

Microscopic plants, such as algae, found in freshwater and ocean environments.

Pit Water

Runoff, groundwater and water mixture that is leftover after the mill removes the valuable rocks (i.e. diamonds).

Processed Kimberlite Effluent (tailings)

The waste material and water mixture that is leftover after the mill removes the valuable minerals (i.e. diamonds).

Sulphide

A mineral containing iron and sulphur that has the potential to react with water and oxygen to produce acid.

Tailings

The waste material and water mixture that is leftover after the mill removes the valuable rocks (i.e. diamonds) from the ore. Also referred to as processed kimberlite.

Toxicity

The ability to cause harmful or deadly effects to plants and animals.

Turbidity

A measure of the clarity of water. The more turbid the water the less clear it is.

Young of the Year

Fish less than one year old.

Zooplankton

The small, almost microscopic animals that live suspended in freshwater (and ocean) environments. Zooplankton feed on phytoplankton.



2002-2003

TECHNICAL ANNUAL REPORT

Independent Environmental Monitoring Agency

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