6. GENERAL QA/QC PROGRAM

Quality assurance (QA) encompasses a wide range of management and technical practices designed to ensure an end product of known quality commensurate with the intended use of the product. Quality control (QC) is an internal aspect of QA. It includes the techniques used to measure and assess data quality and remedial actions to be taken when data quality objectives are not realized. Mines and their consultants must ensure that reliable method of sample tracking, logging and data recording is practiced and documented to establish continuity between the sample collected and the results reported. Standard operating procedures and laboratory activities should also be available, as required. Environment Canada (2002) provides detailed guidance regarding QA/QC procedures for all EEM study components. It is our intent to follow this guidance as much as possible and, where deviations are required, document the changes and evaluate potential implications for data quality and interpretative value.

The purpose of this section is to briefly outline field and laboratory approaches proposed for the Polaris Mine EEM program, which contribute to QA.

6.1. Field Data Collection

The primary QA method in the field involves the completion of data sheets to provide a record and hard copy of relevant observations. Descriptions of key information that will be recorded on the data sheets are provided in Sections 3 to 5.

The main concerns for sample collection in the field center around the proper use of equipment and prevention of cross-contamination. Consistency in sample collection, proper calibration methods, and collection of appropriate QA samples will be an integral part of the field investigations.

6.2. Shipping and Transport

Along with proper sample packing and shipping methods, we will use comprehensive chain-of-custody procedures to ensure that sample integrity is maintained until arrival to the laboratories. Arrangement for sample shipment will be confirmed with the laboratories prior to field work and these will be advised of the shipping information (e.g., carrier, date sent and waybill number) so they can track the samples during shipment in case there are any delays.

Chain-of-custody documentation will be used for all samples shipped from or received by the laboratories.

6.3. Laboratory Procedures

Ms. Val Macdonald, Biologica Environmental Services (Biologica), Victoria BC, will undertake invertebrate taxonomy for the Polaris Mine EEM program. Biologica has a thorough knowledge of EEM requirements and guidance provided in Environment Canada (2002) for marine benthos will be followed.

Tissue as well as water and sediment chemistry analyses will be performed by ALS Environment, Vancouver BC. Details of their quality management program are included in Appendix E.

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APPENDICES

APPENDIX A

Polaris EEM Exposure Area for Biological Sampling. Email correspondence from Environment Canada to Azimuth Consulting Group Inc. (dated May 24, 2003).

Randy Baker

From: "Blenkinsopp,Sandra [Edm]" <Sandra.Blenkinsopp@EC.gc.ca>
To: "Bruce. Donald (E-mail)" <bruce.donald@teckcominco.com>
Cc: "Randy Baker (E-mail)" <rbaker@azimuthgroup.ca>
Sent: Saturday, May 24, 2003 3:04 PM
Subject: Polaris EEM - Exposure Area for Biological Sampling

Hi Bruce

Just a brief note:
* The exposure area for biological sampling should be Garrow Bay, not Garrow Creek.
* The sublethal toxicity tests that are performed on effluent should therefore be the marine tests.

I'm out of the office until Friday but will try to pick up voice mail and email daily.

S

****
Sandra Blenkinsopp, Ph.D.
Senior Environmental Effects Monitoring Coordinator
Prairie & Northern Region
Environment Canada
Rm 200, 4999 98th Ave.
Edmonton, AB T6B 2X3
Phone: (780) 951-8750
Fax: (780) 495-2758
****

APPENDIX B

EEM Study Design Meeting Polaris Mine (Teck Cominco Ltd.) and TAP – Meeting Minutes. April 8, 2003. Edmonton, AB.

DRAFT MEETING MINUTES

ENVIRONMENTAL EFFECTS MONITORING
STUDY DESIGN MEETING
POLARIS MINE (TECK COMINCO) & TAP
Tuesday, April 8, 2003
1:00 p.m to 5:00 pm.

Bev Burns Boardroom, Environment Canada, Edmonton

Attendees:

Bruce Donald	Teck Cominco, Cranbrook
Randy Baker	Azimuth Consulting Group Inc.
Dionne Filiatrault	Nunavut Water Board
Chris Baron	DFO, Winnipeg
Meighan Wilson	Indian and Northern Affairs, Yellowknife
Peter Blackall	Environment Canada, Edmonton
Anne Wilson	Environment Canada, Yellowknife
Sandra Blenkinsopp	Environment Canada, Edmonton
Jenny Ferone	Environment Canada, Edmonton

Regrets:

Patrick Allard	Azimuth Consulting Group, Inc.

1. Introductions
   - Attendees introduced themselves.
2. Agenda –no additional items were added.
3. Overview of the Polaris Mine site (Bruce Donald, Teck Cominco)
   - Described site and decommissioning plans (see appended background section).
   - After fall 2004, the site will be closed except for monitoring.
4. Main EEM Requirements as they pertain to Polaris (Randy Baker, Azimuth Consulting)
   - Showed key features of Garrow Lake and Garrow Creek, and provided findings from previous studies in Garrow Bay: lake and stream flow

regime, stream invertebrate densities, sediment and clam metal concentrations.

- Showed underwater video taken during sediment and clam sampling during May (under ~2 m ice) from three locations in Garrow Bay. Video indicated lots of life on seabed (clams, snail fish, red algae, urchins, etc). Depth and distance offshore unconfirmed, but estimated to be > 8 m depth and at least 250 m offshore

- Presented MMER and EEM requirements for Water Quality and Effluent Characterization as they pertain to Polaris.

    - TAP indicated that some of the MMER requirements that the mine wished to clarify were not part of the EEM program, and that the mine should contact Glenn Groskopf of Environment Canada (Regional Contact for the general MMER).

5. Preliminary discussion on 4 key issues regarding Polaris and EEM.

    - Key Questions (in italics) submitted by Randy Baker before the meeting were discussed:

        - ***Clarify whether Garrow Creek or Garrow Bay is the ultimate receiving environment*** - *Garrow Creek, containing brackish (8 ppt) decant water in an ephemeral stream channel, or Garrow Bay, a marine environment. Garrow Creek is an ephemeral channel with little to no life, although technically would be considered the receiving environment, as opposed to Garrow Bay, which would seem the more reasonable receiving environment.*

            - The TAP explained that the receiving environment for the study should represent the most ecologically relevant habitat below the final discharge point (FDP). The TAP decided to review the data from the creek and marine environments before making a decision as to where the EEM biological study should be. Randy Baker will send relevant reports to Sandra Blenkinsopp, who will distribute them to the TAP for their review.

        - ***Clarify Monitoring Requirements for Compliance and EEM monitoring***. *Discharge from the lake occurs over an eight to twelve week period from the lake to Garrow Creek and then Garrow Bay, so opportunities to collect water for chemistry and toxicity are limited. Given the "effluent" is brackish, do we use freshwater or marine*

species for toxicity testing? This depends on the receiving environment definition.

- The TAP explained that effluent characterization and water quality monitoring for EEM is to be conducted 4X/year with a minimum of a month between sample dates. If effluent is only discharged for 8 – 12 weeks/year, then the mine is required to collect the maximum number of samples possible during effluent discharge while maintaining the 1 month interval between sample dates. Sublethal testing is to be conducted 2x per year for the first three years and 1x per year following. The appropriate sublethal tests to be conducted will depend on the environment determined to be used for biological monitoring. (Sandra…Bruce corrected the discharge time frame during the meeting)

3. ***Determine scope of Site Characterization Studies for: plume delineation; fish survey; benthic survey.*** *The scope and location of these studies is directly related to answering question 1. We will be prepared to discuss what tools to use or how best to address these questions at the meeting.*

- The mine asked for clarification on the relationship between the concentration of effluent at 250 m from the final discharge point and the location of the exposure area. The TAP explained that the concentration of effluent at 250 m only determines whether or not a fish population survey is required for the EEM study, but does not determine where the EEM study should be conducted.

- The TAP asked if there was information on the effluent mixing characteristics in the Polaris receiving environment. The mine indicated effluent mixing hasn't been examined to date, but that a plume delineation of some sort could possibly be done during the open water season this year (late July to Sept). Options discussed included a dye study or using a tracer from the effluent (e.g. Zn). However, since a description of the effluent mixing characteristics is required for the Study Design, which will be due by mid June, 2003, before the open water season, methods to roughly estimate effluent mixing patterns (which could later be confirmed) were discussed. The possibility of modeling effluent mixing based on tidal regime and current patterns was discussed. The mine indicated that not much current and bathymetry data is available for the area, and any modeling done at this point would be rough estimates.

4. ***What will the monitoring requirements be for water quality and toxicity testing in 2005 when the site is abandoned?***

- The TAP indicated that until the mine has received Recognized Closed Mine Status under the MMER (36 months after providing notice to close), effluent and water quality monitoring for the MMER must continue.

6. General Discussion (All)

- The mine indicated that they believed the site is very unique and complicated due to its northern geography, and that they hoped the TAP could be flexible in what would be considered to meet EEM requirements. As examples, the mine suggested:
    - a SIMM survey (seabed image mapping system) involving a video recording of the seabed communities
    - a control impact study design for sediment and benthos, using Garrow Bay (at > 5 m depth) and a reference area in Tigumiavivk Harbour.

- The TAP explained that under the EEM program there is a list of approved alternatives to be used at sites where a traditional EEM design is not possible. These alternatives include 'caged bivalve studies', and 'mesocosm studies'. The TAP indicated that they are open to running ideas by the National EEM Office for comment, but that more site information is necessary before a decision can be made on whether an alternative approach is needed.

- The mine asked if past data from previous studies could be used to meet EEM requirements.
    - The TAP informed them that the data must be from a new study occurring within the regulated EEM timelines.

- The mine mentioned that there are separate DFO requirements for Teck Cominco that they would like to combine with EEM requirements if possible.

    - The TAP explained that data for other agencies/programs is acceptable for EEM as long as the timelines meet those of EEM and the endpoints are similar.

- Sandra Blenkinsopp mentioned that a Polaris site visit will likely be conducted this summer and asked when the best time for this visit would be, and who to contact. Bruce Donald said that he can be the initial contact and recommended that early to mid-August is probably the best time. The visit should preferentially correspond with site field activities that are tentatively scheduled from August 9 – 22.

- Meeting closed with decision that Randy would forward reports on Polaris to Sandra Blenkinsopp and that she would circulate them to the rest of the TAP. The TAP would respond to outstanding Polaris issues after reviewing the reports.

Polaris Background Presented at April 8th, 2003 TAP meeting:

Site Overview:

- Polaris is an underground lead/zinc mine, and the most northerly metal mine in the world.

- Mine started operations in 1981.

- During operation, the mine produced ~ 1 million tonnes of ore per year, ~ 250,000 to 300,000 tonnes of concentrate per year.

- The mine permanently ceased operations in September 2002, and is now actively undergoing decommission and reclamation. No concentrate remains on site.

- The decommissioning plan outlines activities until 2011 (when land and possibly water license end). The plan indicates that by fall of 2004, the site will be closed except for monitoring, and will consist of at least 2 visits most years, or each year, depending on the licence.

- Site is approximately 100 km from Resolute Bay, by air. Ship access from mid July to late September.

- Permafrost in the area is > 300 m, with an active layer approximately 1 to 1.5 m deep.

- The mean temperature in the area is –17 degrees C, with a range from –50 degrees C to 15 degrees C. Eight frost-free days per year.

- The source of freshwater to the mine is Frustration Lake.

Garrow Lake:

- The tailings impoundment area is Garrow Lake. The lake is a meromictic lake where the mixolimnion is ~12m deep, the halocline extends from 12 to 30 m and the bottom monomolimnion is 30 to 48 m.

- The winter ice cover on Garrow Lake is approximately 3 m deep, and some years the ice cover doesn't melt.

- Tailings are deposited in the bottom of the lake, ~5 million m^3 have been deposited in the lake to date.

- Breaks had occurred in the tailings line in '85 and '89, releasing into the upper layers of the lake. Increased Zn concentrations were noted.

- In 1990/91, a dam was built to extend the height of the lake by 2.5 m. The dam was designed to allow 5 years storage before water release. A water treatment plant was considered at one point but was later decided not necessary.

- The decommission plan is to lower the lake to the original level by removing ~ 1/3 of the material in the dam, and restoring an open flow to the creek. The creek will be about 15 m wide (naturally the creek was 10m wide and ~ 9 cm deep). The creek is about 700 m long below the dam and flows into Garrow Bay. After the dam is removed, the natural stream channel will return to its original 1400 m length.

- Studies of the lake have indicated that thermal and chemical stratification is very stable.

- The lake is sampled 3 times per year (mid winter, summer, spring), at 12 intervals throughout the column of the lake. These measurements include: Pb, Zn, salinity, conductivity, temperature, Hg, Cu, and cyanide. The mine has proposed to continue this until summer 2004, and then reduce to 1x/year.

- Since 1994, water has been discharged over the dam from the lake, i.e. during the summer the water accumulated from the previous year is siphoned out.

By fall 2003, the lake is expected to be down to original water level. Removal of the dam is planned for 2004.

APPENDIX C

Effluent and Water Quality Monitoring. Letter from Environment Canada to Teck Cominco Ltd (dated May 23, 2003)

Environment Canada / Environnement Canada

Prairie & Northern Region
Environmental Protection Branch
Twin Atria #2, Room 200
4999-98th Avenue
Edmonton, AB T6B 2X3

23 May 2003

Bruce Donald
Reclamation Manager
Teck Cominco Limited
Bag 2000
Kimberly, B.Columbia
V1A 3E1

Fax: (250) 427-8451

Dear Bruce Donald:

Subject: Effluent and Water Quality Monitoring

The purpose of this letter is to remind you that all mining companies subject to the Metal Mining Effluent Regulations (MMER) must commence with the effluent and water quality monitoring requirements set out in Schedule 5 by June 6, 2003.

I have enclosed a fact sheet on the MMER Environmental Effects Monitoring (EEM) Program. This fact sheet is intended to provide an overview of the EEM Requirements. Specific EEM requirements are outlined in the MMER and these regulations must be used in order to obtain compliance with the MMER.

Please note the following:

- Effluent characterization is to be conducted 4 times per calendar year and not less than one month apart, on aliquots of samples taken for compliance monitoring of deleterious substances.
- Sublethal toxicity testing is to be conducted on effluent from the final discharge point that potentially has the most adverse environmental impact. The testing must be conducted twice per calendar year for the first 3 years, then once per calendar year thereafter, on aliquots of effluent taken for effluent characterization.
- Water quality monitoring is to be conducted four times per calendar year and not less than one month apart, in both reference and exposure areas near each final discharge point. (These sampling stations will NOT likely be the same sampling stations used for biological monitoring.) Note that water

quality monitoring must also be conducted at the same time and in the same sampling areas used for biological monitoring studies.
- An effluent and water quality report must be submitted to the Authorization Officer yearly, by March 31st.

If effluent is not deposited before June 6, 2003, effluent samples cannot be collected and sublethal toxicity testing cannot be conducted. The Regional Environmental Effects Monitoring Coordinator should be notified in writing if the effluent characterization and sublethal toxicity testing cannot be conducted for this reason.

The Regulations specify that water quality monitoring is to be conducted, starting no later than June 6th, 2003, four times per year and not less than one month apart. The policy intent is that water quality monitoring be conducted when effluent is being deposited in order to provide information that best contributes to the EEM program. It is therefore recommended that water quality monitoring be conducted when effluent is deposited and the same day that the sample for effluent characterization is collected. If this is not possible, mines should contact the Regional Environmental Effects Monitoring Coordinator.

Please note that according to Environment Canada's toxicity test method protocols, the sublethal toxicity tests should be initiated within 3 days of sample Laura Johnsontest results from tests up to four days after collection may be considered valid, if the Regional Environmental Effects Monitoring Coordinator was notified and concurs with the sample delay.

If you have any questions or concerns about these requirements, please do not hesitate to contact me [Tel: (780) 951-8750, Fax: (780) 495-2758, Email: Sandra.Blenkinsopp@ec.gc.ca].

Sincerely,

S. Blenkinsopp

Sandra Blenkinsopp, Ph.D.
Senior Environmental Effects Monitoring Coordinator

cc Peter Blackall, Authorization Officer
Glenn Groskopf Jennifer Bernt
Laura Johnson

METAL MINING ENVIRONMENTAL EFFECTS MONITORING PROGRAM[1]

What is Environmental Effects Monitoring (EEM)?
EEM is a scientific monitoring approach that can be used to help determine the health of aquatic ecosystems potentially affected by human activity and the effectiveness of environmental protection measures.

EEM studies consist of iterative scientific evaluations of fish, fish habitat and fisheries resources. The program is set up in 2-6 year sequences of monitoring, interpretation and reporting phases, whereby the frequency and type of monitoring is dependent on the results from previous studies.

The EEM program for metal mining is based on a consensus agreement between stakeholders. The program requirements and associated guidance documents were developed through a multi-stakeholder consultation involving industry, government and community representatives.

All mines regulated under the Metal Mining Effluent Regulations (MMER), as part of the *Fisheries Act*, are required to conduct EEM as part of their authority to deposit effluent.

The MMER were registered June 6th, 2002 and were published in Canada Gazette II on June 19th, 2002 (SOR/DORS/2002-222).

EEM Objective:
The objective of the EEM program is to evaluate the effects of mine effluent on fish, fish habitat and the use of fisheries resources.

What are the Main EEM Requirements?
Section 7 of the MMER obligates the mine to: conduct EEM studies, submit reports within prescribed timelines and use standards of good scientific practice to conduct studies and interpret results. The "Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring" provides recommended scientific practices that can be used to meet the EEM requirements.

Section 23 of the MMER requires mines to submit their data to Environment Canada in a written and electronic format.

Section 32 of the MMER outlines the requirements for mines that wish to obtain recognized closed mine status.

Schedule 5 of the MMER presents the specific EEM requirements and is divided into 2 parts:

Part 1: Effluent and Water Quality Monitoring
Part 2: Biological Monitoring

Effluent and Water Quality Monitoring:
The objectives of effluent and water quality monitoring are to monitor changes and trends in the receiving environment and collect supporting information to help interpret biological monitoring data. This portion of EEM requires:

- Effluent characterization: conducted 4 times per calendar year on aliquots of samples taken for compliance monitoring of deleterious substances. Hardness and alkalinity must be measured, as well as the total concentrations of: Al, Cd, Fe, Hg, Mo, NH_3, NO^{-}_3.
- Sublethal toxicity testing: conducted twice per calendar year for the first three years, then once per year thereafter on aliquots of effluent taken for effluent characterization. Sublethal toxicity is tested using a fish, an invertebrate, a plant and an algal species. Mines can use historical sublethal toxicity data to reduce this frequency, if the mine has data to meet the requirements.
- Water quality monitoring: conducted four times per calendar year in both reference and exposure areas near each final discharge point *and* at the same time and in the same sampling areas as biological monitoring studies. The parameters measured for water quality monitoring are the same as those measured for effluent characterization plus: temperature, dissolved oxygen, deleterious substances and pH.

An effluent and water quality monitoring report must be submitted to Environment Canada yearly, by March 31st. This report outlines when and where samples were collected, the results of effluent characterization, sublethal toxicity testing and water quality monitoring, methodologies and method detection limits, and the QA/QC implemented.

[1] Note: this factsheet is intended to provide an overview of the EEM requirements. Specific EEM requirements are outlined in the MMER and these regulations must be used in order to obtain compliance with the MMER.

Biological Monitoring:
The objectives of biological monitoring are to determine whether or not there are effects on fish, fish habitat and the use of fisheries resources. This portion of the EEM requires:

- A fish survey (if the concentration of effluent is >1% within 250 m of a final discharge point)
- A fish tissue analysis (if the effluent characterization identifies a concentration of total mercury in the effluent equal to or greater than 0.10 µg/L)
- A benthic invertebrate community survey.

Study Design
Study designs describe how, when, where, and what biological monitoring studies will be conducted, and present the scientific rationale for the EEM studies.

The first study design must be submitted by December 6, 2003. However, if historical biological data exists at a mine, the mine may submit a report that contains the scientific results of the historical study by December 6, 2003. These latter mines would then submit their first EEM study design by December 6, 2004.

The second and subsequent study designs must be submitted at least 6 months prior to conducting field monitoring.

Data Assessment
Statistical analyses are conducted on specific endpoints to determine if there are significant differences between the exposure area and the reference area. A significant difference represents an "effect" in EEM. Fish endpoints are indicators of population growth, reproduction, condition and survival.

Benthic invertebrate endpoints include: abundance, richness, Simpson's Diversity Index, Bray Curtis Index. An effect in fish tissue is defined as measurements of total mercury that exceed 0.45 µg/g wet weight in exposure fish tissue, and that are statistically different from reference fish.

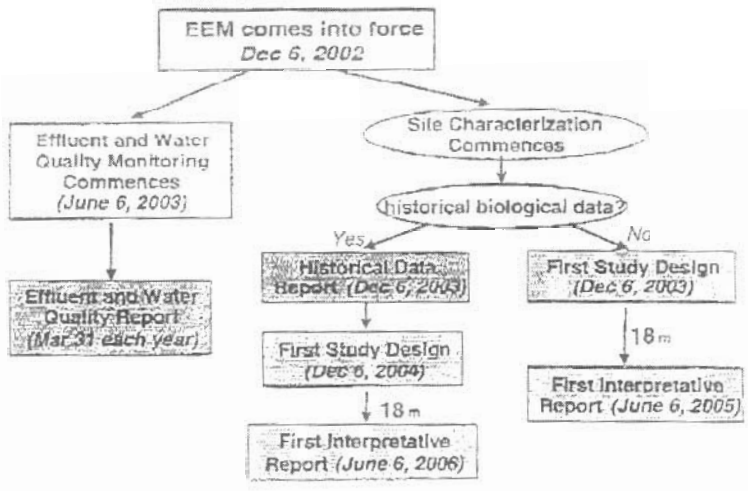
Interpretative Reports
Interpretative reports outline changes in the study designs, present the monitoring and data interpretation results, the QA/QC procedures undertaken and the schedule for the next EEM phase.

For mines that did not submit a historical data report, the first interpretative report must be submitted by June 6, 2005. For mines that did submit a historical data report by December 6, 2003, the first interpretative report must be submitted by June 6, 2006.

The submission of the second and subsequent interpretive reports will depend on the results of previous monitoring. Generally, the frequency will be every 36 months; however it may range from 24 months (if effects are seen in all 3 components) to 72 months (if no effects are seen in any component of 2 consecutive biological monitoring studies).

Recognized Closed Mines
A mine is required to conduct a complete biological monitoring study, including the submission of an interpretive report, within 36 months of the owner or operator of the mine providing written notice of its intent to close. Effluent and water quality monitoring is continued until the mine obtains recognized closed mine status.

*EEM First Monitoring Studies and Timelines**



* all dates are "not later than"

Contact information:
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Visit our website at:
www.ec.gc.ca/eem