

**Royal Oak Mines Inc.
Yellowknife Division - Giant Mine**

**Strategy for Permanent Storage
of
Arsenic Trioxide
in Underground Mine Workings**

**Place in Special Vaults Excavated in Dry,
Permafrost Bedrock Envelope Within Lease
Boundaries.**

**Vaults to be Isolated by Bulkheads and Remain
Stable and Dry Within a Protective Permafrost
Envelope During Mine Operations and for the
Long Term.**

**Objective: To Prevent Contact Between the
Arsenic Trioxide and Surface or Groundwater
Regimes.**

**This strategy is currently used and has been in
effect continuously since start of underground
storage in 1950.**

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**Permanent Storage of
Arsenic Trioxide in the
Underground Workings**

**TERMS OF REFERENCE - ENVIRONMENTAL STUDIES
FOR NORTHWEST TERRITORIES WATER BOARD**

A. Physical Stability of Storage Chambers

- **Rock Competency**
- **Potential flow paths**
- **Integrity of bulkheads**
- **Details of forced ventilation**
- **Geometry of chambers and environs**
- **Standards for future chambers**
- **Written monitoring program**
- **Final Study Report**

B. Options for Permanent Abandonment

- **Ventilation with Winter Air**
- **Additional Bulkheads**
- **Grout Curtains**
- **Artificial ice plugs**

C. Analysis of Permafrost Regime

- **Pattern of permafrost occurrence locally**
- **Install thermistors**
- **Monitor rock and arsenic temperatures**
- **Permafrost occurrence around Chambers**
- **Final Study Report**

D. Hydrogeology of Chambers Areas

- **Data Collection Program**
- **Geochemistry of arsenic trioxide**
- **Geological structures**
- **Current groundwater flows**
- **Pattern of permafrost occurrence**
- **Prediction of future groundwater flows**
- **Surface waters (e.g. Baker Creek)**
- **Final Study Report**

E. Risk Assessment

- **Potential failure modes**
- **Hazards**
- **Exposure**
- **Consequences**
- **Risk Characterization**
- **Risk Management**
- **Final Study Report**

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**Permanent Storage of Arsenic Trioxide
in the Underground Workings
Environmental Studies for
Northwest Territories Water Board**

Summary of Activities in 1995

A. Physical Stability of Storage Chambers

- **Review available data base**
- **Bedrock Geology**
- **Geometry of chambers and environs**
- **Historical data on inspections**

Priorities:

- i) Reliable models of geology; chambers; pillars; related underground workings; and surface features such as open pits and water bodies.**
- ii) Understanding of construction, filling and post-construction performance of chambers.**

B. Options for Permanent Abandonment

These are considered to be best addressed when the first phase assessment of the designated scheme for permanent storage is completed.

C. Permafrost Regime

- **Pattern of local permafrost occurrence**
- **Six thermistor hole installations**
- **Review historical data, from mining operations**

Priorities:

- i) Finalize geological and geometric models of chambers and environs and review all available data so a program of additional temperature monitoring of bedrock and arsenic can be formulated to best effect.**
- ii) Specialist expertise in thermal and permafrost engineering.**
- iii) Carry out a first phase feasibility evaluation of the designated scheme using best available design parameters.**
- iv) Finalize a plan of action for field and analytical studies for our long term objectives and for immediate needs of the Water Board in 1997.**

D. Hydrogeological Studies

- **Geochemistry of arsenic trioxide**
- **Initial evaluation of Geological structures**
- **Surface waters**
- **Initial evaluation of original groundwater flow patterns**
- **Review historical data**

Priorities:

- i) Finalize geological and geometric models of chambers and environs and review all available data so that a program of additional field work can be formulated to best effect.**
- ii) Specialist expertise in hydrogeology and groundwater management.**
- iii) Carry out an initial evaluation of the effects of surface water bodies (particularly Baker Creek) and open pits.**
- iv) Carry out a first phase feasibility evaluation of the designated scheme using best available parameters.**
- v) Finalize a plan of action for field and analytical studies for our long term objectives and for immediate needs of the Water Board 1997.**

E. Risk Assessment

- **Understanding of geochemistry of arsenic trioxide.**
- **Potential risks from Baker Creek under flood, or seepage from or through open pits, unplugged boreholes, etc.**
- **Increased inspection and monitoring.**

Priorities:

- i) Management of risks identified to date.**
- ii) Completion of other aspects of the study so that risks can be better identified and assessed.**
- iii) Continued visual inspections and monitoring by instrumentation including the additional installations which have been committed to.**