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Mr. Gordon Wray, Chairman
Northwest Territories Water Board,
P.O. Box 1500,
Yellowknife, NT X1A 2R3

January 25th, 1995

Dear Mr. Wray,

Re: Storage of Arsenic Trioxide Underground at the Giant Mine - Water License N1L2-0043

Please find enclosed, two copies of the annual report on the study of scientific data relating to the permanent storage of arsenic trioxide in the underground mine workings at the Giant Mine.

This years activities were primarily that of researching historic data. In addition, a series of drill holes have been completed, and installed with thermistors, to collect data on the rock temperature.

In 1995 data collection continues and analysis of the stability of the chambers and the bulkheads begins. An updated schedule of events and completion dates for this project is also included.

This study is being conducted in accordance with Part G: Item 6 of the Giant Mine Water Use License.

If additional information is required please contact the undersigned at your earliest convenience

Regards,

Royal Oak Mines Inc.

Larry Connell

Larry Connell
Manager of Environmental Services

cc: K. Weston
D. Anthony
M. Hoffman
R. Allan

Royal Oak Mines Inc.
NWT Division
Giant Mine

Assessment of Scientific Data Relating to Permanent Storage of Arsenic Trioxide in the Underground Workings at the Giant Mine

1994 Annual Report
Water Use License # N1L2-0043

Prepared: January 23rd, 1995

1994 Annual Report

Assessment of Scientific Data Relating to
Permanent Storage of Arsenic Trioxide
in the Underground Workings
at the Giant Mine

Introduction:

This annual report describes the activities in 1994 towards the 5 year study to collect and assess scientific data relating to the permanent storage of arsenic trioxide in the underground mine workings at the Giant Mine.

The study is multi-disciplinary, involving geologists, mining and civil engineers, hydrologists and chemists. The study will consist of both the collection and assessment of existing data as well as new data to specifically address areas of concern.

The areas of investigation are as follows:

A) Assessment of the Physical Stability of the Storage Chambers.
This includes the following:

An analysis of the rock type and competency surrounding each chamber.
An analysis of the competency of the concrete bulkheads isolating each of the storage chambers.
An analysis of the forced ventilation in the vicinity of these storage chambers.
Preparation of plan and section views through each storage chamber indicating access drifts, raises, bulkheads etc. that have an impact on the conditions in and around these storage chambers.
Preparation of a written engineering standard for the development of future arsenic storage chambers.
Development of a written monitoring program for both active and inactive storage chambers.

B) Analysis of the Technical Options for Permanent Abandonment

The intent of this portion of the study is to further develop the engineering feasibility of options to close out the storage chambers in a permanently frozen state. The technical review will include the potential impact on the groundwater regime in the area of each stope.

C) Analysis of the Permafrost Regime in the area of the Storage Chambers.

This portion of the study will lead to a more complete understanding of how zones of discontinuous permafrost behave, in the area of the storage chambers. The goal would be to provide a mapping of rock temperatures in both the horizontal and vertical dimensions.

D) Analysis of the Hydrogeology in the area of the Arsenic Storage Chambers.
Data will be generated/collected that would lead to an understanding of the risks associated with large volumes of water coming into contact with stored arsenic trioxide.

E) Risk Assessment Related to Underground Arsenic Storage.
A qualitative risk assessment is to be conducted in order to assist in managing possible risks that have both a high degree of hazard and a high probability of occurrence.

Discussion:

The following itemizes the work completed in 1994 in a format that compares to the items listed in the Introduction. This way it is possible to identify directly the progress on individual topics.

A) Assessment of the Physical Stability of the Storage Chambers:

Data files have been prepared for each of the storage chambers. Work concentrated on assembling available data on each chamber through a thorough search of data on and off site. This included plans, sections, design criteria and as-built drawings where possible.

As part of the requirement for studying the permafrost regime, 6 drill holes were drilled in the mine area surrounding the storage chambers. The core was geotechnically logged and has been saved for future reference. This data will help with future stability and hydrogeological analyses where data has been found to be insufficient.

The majority of the chambers are currently not accessible, the old drifts and raises being cut-off or bypassed over years of mining. Only the active storage chamber is routinely monitored by mine personnel. The majority of the arsenic storage areas are located in the 'B' shaft area. This area includes both the main downcast ventilation system (B shaft) and the main exhaust (B ramp). The mine air is not allowed to drop below freezing and as such the local underground rock temperatures are nominally +1 to +2 degrees Celsius.

Written engineering standards are being prepared for future storage chambers at this time. The bulkhead design is being prepared by mine staff and will be reviewed by a consulting structural engineer (Ferguson, Simek and Clark in Yellowknife) as well as the Mines Inspection Branch. Construction standards are also being drawn up. The chamber design of the next storage area (#14) has been completed and will form the basis of designs in the future. The construction of #14 storage chamber will be complete in the first quarter of 1995. Following the commissioning of this chamber a report will be prepared outlining standards to be used in future.

B) Analysis of the Technical Options for Permanent Abandonment:

No formalized work has been completed on this portion of the study.

C) Analysis of the Permafrost Regime in the area of the Storage Chambers:

Historical data on the permafrost regime is extremely limited. As such it was determined that a program to install thermistors in the area of the storage chambers was required.

In total six holes were drilled in June of 1994. Five of the holes are in the vicinity of active/inactive storage areas and one hole was drilled between the "C" and "A" shafts, in an area not influenced by active mining conditions.

In each of the holes a string of thermistors were installed. Each of the strings reads temperatures starting 20' below surface and then at 55' intervals down to the bottom of the hole. A summary of the data from 1994 has been attached as Appendix 1, and a location map has been attached as Appendix 2. The holes were drilled to 350' below surface which is below the lowest point of any of the storage chambers. Hole A-4 was only drilled to 240' due to the proximity of underground workings.

The instrumentation was read once a week in 1994, and has proved to be very consistent week to week. As such the readings for 1994 have been presented as monthly averages, and readings in 1995 will be taken only once a month.

Mine air is heated in winter, and as such is not allowed to fall below +2 degrees Celcius at any time of the year. The area where the storage chambers exist is also the area where the mine ventilation air enters the mine. It is also the area where the major portion of the mine air exhausts from the mine. Exhaust air generally is not less than +10 degrees Celcius. The ventilation conditions and the effect this heat source has on the rock temperatures will require further data collection and review.

D) Analysis of the Hydrogeology in the area of the Arsenic Storage Chambers:

The core from the diamond drilling completed in 1994 has been saved for further analysis under this portion of the study. No formalized work has otherwise been completed.

E) Risk Assessment Related to Underground Arsenic Storage:

Due to the lack of basic data at this stage of the project, there has not been any formalized work completed on this particular portion of the study.

Work Schedule by Study Area:

The following outlines the projected schedule of work up to completion of this project.

A) Assessment of the Physical Stability of the Storage Chambers:

1995 - Complete the compilation of data for each individual storage area, including preparation of plans and cross-sections.
Provide engineering assessments of rock competency and the competency of concrete bulkheads related to each storage chamber.

1996 - Complete the preparation of written engineering standards for the development of future storage chambers.
Formalize a monitoring program for active and inactive storage chambers.

1997 - Preparation of a final study report complete with stability assessments and drawings, and including engineering standards and monitoring programs.

B) Analysis of the Technical Options for Permanent Abandonment:

1995 - Develop a list of options to be investigated and additional data required in order to develop the technical feasibility of the options. Results from 1995 research for Study A will form a basis for this work.

1996 - Update results and data collection for a presentation of the feasibility of the options. Each of the options will be presented for discussion and consideration.

1997 - Further updating of results, together with a final study report outlining conclusions and recommendations for permanent abandonment of the arsenic storage chambers.

C) Analysis of the Permafrost Regime in the Areas of the Storage Chambers:

1995 - Continue monitoring rock temperatures from thermistor installations in 1994.
Include the data in the annual progress report.
Provide a preliminary report concerning the state of the permafrost regime, by 2 and 3 dimensional analyses. Modify the monitoring program as required for better coverage and consistency.

1996 - Continue monitoring rock temperatures from thermistor installations in 1994.
Include the data in the annual progress report.
Update the analyses of the permafrost regime.

1997 - Continue monitoring rock temperatures and update the analyses of the permafrost regime. Prepare and submit the final study report.

D) Analysis of the Hydrogeology in the Area of the Arsenic Storage Chambers:

1995 - Design and implement a data collection program with input from a hydrologist and mine geologists. Prepare a report regarding predictions of possible groundwater flows and the implications of mine flooding.

1996 - Continue data collection and assessment of same.

1997 - Prepare a final study report.

E) Underground Arsenic Storage - Risk Assessment

1995 - Establish the technique to be used in preparing the risk assessment. Complete the Hazard, Exposure, and Consequence portion of the risk assessment. Initiate programs to collect data and missing information as required.

1996 - Update the risk characterization portion of the risk assessment if required.

1997 - Update the risk assessment to include all data collected by other portions of the study. Complete a risk management plan based on the risk assessment.

Richard Allan, P.Eng.
Technical Services Manager - NWT Division

Appendix 1

Royal Oak Mines Inc. - NWT Division
Giant Mine

Arsenic Storage Study - Thermistor Data - Monthly Average (weekly readings) in Degree Celcius

Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-1	Collar	0	6023.43	--	--	--	--	--	--	--
	Pin 1	20	6003.43	0.0	0.0	0.0	-0.1	0.1	0.6	0.5
11198.57 N	Pin 2	75	5948.43	0.5	0.4	0.4	0.3	0.3	0.3	0.3
6262.97 E	Pin 3	130	5893.43	0.5	0.4	0.4	0.4	0.4	0.4	0.4
	Pin 4	185	5838.43	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Pin 5	240	5783.43	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Pin 6	295	5728.43	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	Pin 7	350	5673.43	0.8	0.9	0.9	0.8	0.8	0.8	0.8

Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-2	Collar	0	6047.96	--	--	--	--	--	--	--
	Pin 1	20	6027.96	0.1	1.4	3.4	5.1	5.5	4.9	4.0
10930.74 N	Pin 2	75	5972.96	2.0	1.9	1.9	1.8	1.0	1.7	1.7
6298.76 E	Pin 3	130	5917.96	1.4	1.4	1.4	1.4	1.4	1.3	1.3
	Pin 4	185	5862.96	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Pin 5	240	5807.96	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Pin 6	295	5752.96	0.9	0.9	0.9	0.8	0.9	0.8	0.8
	Pin 7	350	5697.96	0.9	0.9	0.9	0.8	0.8	0.8	0.8

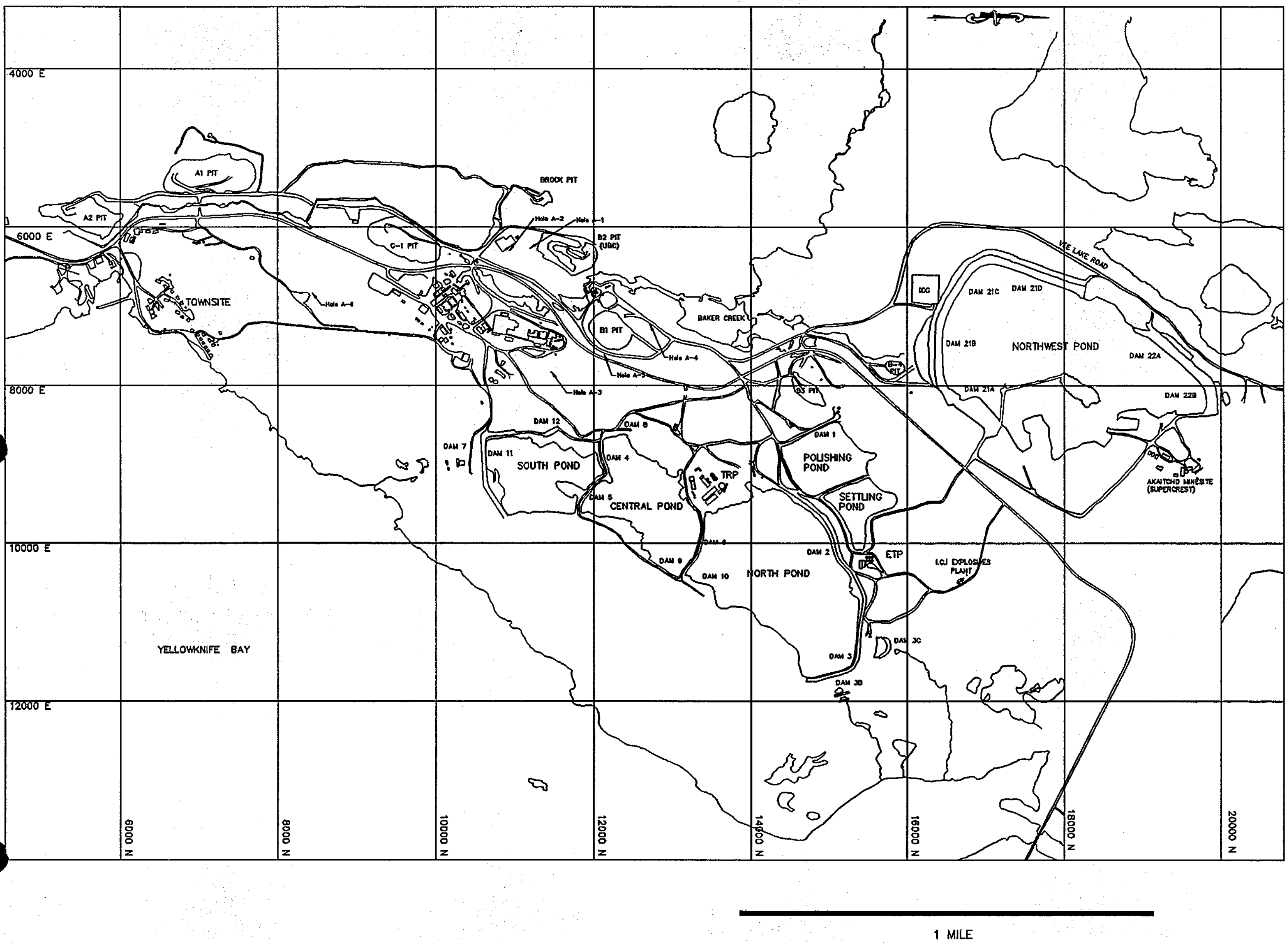
Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-3	Collar	0	6040.09	--	--	--	--	--	--	--
	Pin 1	20	6020.09	0.4	1.5	2.9	4.1	4.1	3.6	2.8
11462.13 N	Pin 2	75	5965.09	1.3	1.2	1.9	1.2	1.2	1.2	1.2
7831.88 E	Pin 3	130	5910.09	1.0	1.0	1.4	1.0	1.0	1.0	1.0
	Pin 4	185	5855.09	0.9	0.9	1.1	0.9	0.9	0.8	0.8
	Pin 5	240	5800.09	0.8	0.8	0.9	0.8	0.8	0.8	0.8
	Pin 6	295	5745.09	0.9	0.9	0.9	0.9	0.9	0.8	0.8
	Pin 7	350	5690.09	1.0	1.0	0.9	1.0	1.0	1.0	1.0

Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-4	Collar	0	6028.51	--	--	--	--	--	--	--
	Pin 1	15	6013.51	1.8	4.5	7.2	7.6	6.1	3.9	2.6
12719.98 N	Pin 2	90	5938.51	2.1	1.9	1.8	1.7	1.7	1.6	1.6
7234.30 E	Pin 3	165	5863.51	2.7	2.7	2.8	2.8	2.8	2.8	2.8
	Pin 4	240	5788.51	3.8	3.8	3.8	3.9	3.9	3.9	3.9

Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-5	Collar	0	6023.42	--	--	--	--	--	--	--
	Pin 1	20	6003.42	--	--	3.5	4.2	4.0	3.5	
12133.84 N	Pin 2	75	5948.42	--	--	0.4	0.3	0.3	0.3	
7614.36 E	Pin 3	130	5893.42	--	--	0.4	0.4	0.4	0.3	
	Pin 4	185	5838.42	--	--	0.6	0.5	0.5	0.5	
	Pin 5	240	5783.42	--	--	0.8	0.8	0.8	0.8	
	Pin 6	295	5728.42	--	--	1.1	1.1	1.1	1.1	
	Pin 7	350	5673.42	--	--	1.4	1.4	1.4	1.4	

Hole #	Location	Depth	Elevation	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A-6	Collar	0	6062.41	--	--	--	--	--	--	--
	Pin 1	15	6047.41	0.9	2.4	4.5	5.8	5.3	4.1	3.1
8442.86 N	Pin 2	70	5992.41	1.5	1.5	1.4	1.4	1.3	1.3	1.3
6837.13 E	Pin 3	125	5937.41	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	Pin 4	180	5882.41	1.0	1.0	1.0	0.9	0.9	0.9	0.9
	Pin 5	235	5827.41	1.0	1.0	1.0	0.9	0.9	0.9	0.9
	Pin 6	290	5772.41	1.1	1.1	1.1	1.1	1.1	1.0	1.0
	Pin 7	345	5717.41	1.2	1.1	1.2	1.1	1.1	1.1	1.1
	Pin 8	400	5662.41	1.3	1.1	1.3	1.3	1.3	1.3	1.3

Appendix 2



NOTES:
BASE MAP: 1987 AERIAL

Royal Oak
Mines Inc.

GIANT MINE
SURFACE PLAN

Thermistor Location

BY: PIERCEY / ALLAN	SCALE AS SHOWN
CHK'D	DATE SEPT. 1994

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