# Giant Yellowknife Mines Limited

Feasibility Study for the

## WAROX Project

December 1988
53138

Fenco
Lavalin

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<u>TABLE OF CONTENTS</u>



Design Building

- Suggest
- TURNKEY → Construction Stage
- overlap.

- Tests during next 2 months. Negotiate
- Process to control or get best price.
- 3.2 Building.

① Compaction
② Hot Bay House.
③ Gold Recovery 87%
④ Building.

## 1.0 EXECUTIVE SUMMARY

Fenco was retained by Giant Yellowknife Mines Limited (GYML) to provide an independent review of the work done to date on the WAROX project and to prepare a capital cost estimate for the project with a ± 25% degree of accuracy.

This feasibility study contains our review of all aspects of the project; underground reclaim, processing plant, transfer facilities, capital and operating costs and marketing.

Fenco personnel visited GYML facilities in Yellowknife to discuss the project with team members, to obtain copies of existing data and reports and to inspect the proposed site and underground crude dust storage chambers. Additional visits were made by Fenco to the Research and Productivity Council (RPC) and Ferro-Tech test facilities to observe on-going testwork.

Testwork and data were reviewed. Then flowsheets, equipment lists, preliminary plant layouts and capital and operating costs were developed for the three main areas of the project - underground reclaim, process plant and transfer facilities.

GYML has an underground stockpile of 217,900 tons of crude $As_2O_3$ and is currently producing arsenic dust at the rate of 12 tons/day.

The physical properties of the dust stored in the underground chambers varies considerably. Fenco agrees with GYML in that the reclamation methods must be flexible. The capital cost estimate includes two reclaim systems, pneumatic and mechanical.

It is proposed to produce high grade $As_2O_3$ by treating crude material in a fluidbed reactor operating at temperatures which cause $As_2O_3$ to vapourize. Gas from the reactor will be first cleaned and then cooled to condense a purified $As_2O_3$.

Testwork at RPC has proven that a high purity product, 99.7% $As_2O_3$ with a low antimony concentration, can be made from current baghouse dust. Fenco has concluded that similar recoveries can be obtained in an operating plant. GYML has named the $As_2O_3$ product WAROX.

Tests using mixtures of reclaim and current baghouse dust resulted in a high antimony concentration in the product. Recent testwork on low grade $As_2O_3$ from underground storage has indicated that it is possible to reduce antimony levels in the product using sintered metal bags in the hot baghouse.

The process plant flowsheet was developed from RPC test data with a few minor changes. Equipment has been included for drying and blending the crude feed dust. RPC was not able to generate a coarse particle size in the condenser. Although alternative condenser designs were considered, it was apparent that available designs cannot guarantee a coarse grain product.

It is important that the product be non-dusting and free flowing. This requires an agglomeration step in the process to increase the particle size of the 4 to 5 micron $As_2O_3$ product. Testwork conducted on the compaction and granulation of the purified arsenic dust has not been successful, to date. Further work is required in this area. Other agglomeration processes are currently being evaluated.

The road to rail transfer facilities proposed for Enterprise were reviewed and a capital cost estimate prepared. The preliminary GYML design was used for the facilities.

The capital cost for the total project has been estimated at $9,460,000.00 ± 25 percent.

The direct operating cost for the three areas of the project totals 17 cents per pound of WAROX based on a production rate of 7000 short tons per annum. This increases to 23 cents per pound, if the production rate is 4500 short tons per annum.

The market report prepared by Zeraldo suggests that GYML could successfully secure a base case sales volume of 4500 short tons of WAROX per annum during 1990-94 at a delivered price of 27 cents US per pound. It should not be assumed, however, that this amount could be sold during the first year of production. Fenco believe that a phased increase of production and sales would be more realistic.

Marketing is critical to the success of the WAROX project. GYML should include an allowance for a significant pre-production marketing effort.

## 2.0 RECOMMENDATIONS

The following recommendations are made to highlight areas of the flowsheet which are uncertain or which upon improvement could result in a significant capital or operating cost savings.

- The efficiency of antimony removal using sintered metal hot dust filters should be assessed at RPC. Product specifications with respect to antimony should be based on that which can be produced under continuous operating conditions using reclaimed (2.46% Sb) feed or that which could be projected from a blend of feed. Antimony marketing specifications are not sufficiently defined to indicate that a product with 0.5% Sb could not be sold, providing other impurities and handling properties are acceptable.

- A two-stage hot sintered metal bagfilter should be evaluated through tests at RPC. The ESP would not be required using this approach.

- A granular, non-dusting product is highly desirable and the agglomeration method should be reviewed. The process flowsheet herein includes water addition, compaction, granulation and screening. However, process parameters have not been established to date. An alternative water addition, mixing and drying process is currently being evaluated in preliminary tests at RPC and should be continued if results are encouraging.

- GYML should initiate a marketing program which would involve working closely with potential clients to develop optimum product specifications.

- The transportation costs for shipping the product in drums should be established. Also, since most of the potential customers can receive product in bulk, consideration should be given to deferring capital expenditure on drum packing and shipping equipment.

- The flowsheets and capital cost estimates contained in this report should be updated to include process improvements resulting from current testwork.

## 3.0 INTRODUCTION

Giant Yellowknife Mines Limited, Yelllowknife Division (GYML) proposes to construct a plant to purify crude arsenic trioxide dust to produce a high grade product, +99% $As_2O_3$. The material is to be marketed under the trade name 'WAROX'.

The process plant will be designed to produce 7,000 dry tons per year of WAROX from stored crude underground dust or current baghouse dust. In addition to producing WAROX, the plant will recover gold contained in the crude underground feed dust.

The project includes the construction of the following three main elements:

- Underground reclaimation facilities for the recovery of stored crude $As_2O_3$ dust.
- Process facilities for the purification of the $As_2O_3$ dust and recovery of gold residues.
- Road to rail transfer facility, to be located at Enterprise, N.W.T.

Fenco Engineers Inc. (FENCO) was selected by GYML to review the pilot plant testwork conducted by the Research and Productivity Council (RPC) and the preliminary designs for the reclaim, processing and transfer facilities developed by the GYML WAROX Project team.

Fenco was also requested to prepare a capital cost estimate, ±25% accuracy, for the project, and to review the market study prepared by Zeraldo Minerals.

During the course of this study Fenco personnel visited GYML facilities in Yellowknife to review existing reports and discuss the project with GYML team members. In addition, visits were made by Fenco to RPC and Ferro-Tech to observe testwork.

In this report, Fenco presents their review and budget capital cost estimate for the WAROX project. The design criteria, plant description, capital and operating costs and drawings are contained herein.

# 4.0 RECLAMATION

## 4.1 Summary

This Section of the report presents a review of the proposed methods for the reclamation of arsenic trioxide dust from the underground stopes.

The design parameters and plant description are contained in this Section of the report. The detailed cost estimate may be found in Section 7.0, Capital Costs.

The estimated capital cost of the reclamation facilities outlined herein is $860,000.00.

## 4.2 Scope of Work

The scope of work agreed for this section of the study was to review the reclamation methods proposed by GYML and comment on their feasibility.

Fenco was to prepare a capital cost estimate for the purchase and installation of the reclamation equipment.

The costs associated with underground development and ventilation required to obtain access to the storage chambers is not included. These costs will be estimated by GYML.

## 4.3 Design Parameters

### 4.3.1 Arsenic Storage Chambers

The underground storage chambers full of arsenic dust have been divided by GYML into five areas:

| Area | Stope Numbers |
|---|---|
| Area 1: | B2-30, B2-33, B2-34, B2-35, B2-36 |
| Area 2: | B2-12, B2-13, B2-14 |
| Area 3: | B-2-08 |
| Area 4: | C2-12, C9, C10 |
| Area 5: | B-11, B-12 |

Dust will be reclaimed from Area 1 first, specifically chambers B2-33 and B2-34. These storage chambers are located directly beneath the proposed location of the processing facility.

GYML has calculated that the five chambers in Area 1 contain 64,157 tons of arsenic dust. This represents approximately 5 years of feed supply, based on an annual production rate of 7,000 tons of WAROX.

### 4.3.2 Physical Dust Characteristics

Sampling of the dust in the Area 1 chambers was carried out by Geocon in October 1981. The following data is extracted from their report:

| Stope No. | B2-30 | B2-33 | B2-34 | B2-35 | B2-36 |
|---|---|---|---|---|---|
| Max. Bulk Density, pcf | 77.3 | 82.3 | 85.3 | 84.2 | 74.6 |
| Min. Bulk Density, pcf | 48.3 | 50.7 | 53.3 | 53.3 | 41.6 |
| Specific Gravity | 3.17 | 3.15 | 3.23 | 2.59 | 3.79 |
| % Moisture | 6.4 | 2 to 6 | 1 | <2 | <1 |
| Borehole No. | 5 | 6 | 7 | 8 | 9 |
| Distance of Dust below surface, ft. | 225 | 145 | 125 | 123 | 144 |

The Geocon report also indicated that the dust was 'wet' 36 feet below the dust surface in stope B2-33 and 15 feet below the dust surface in stope B2-30.

GYML attempted to vacuum a sample from stope B2-36 in July 1988 but were unsuccessful 'due to high moisture content'.

GYML Warox Update Report, Oct. 1988, indicated a dust moisture content ranging from 1% to 14%.

The following material characteristics were used in this feasibility study:

| | | | |
|---|---|---|---|
| Moisture Content: | | 1% | loose surface dust |
| | | 15% | compacted dust |
| Bulk Density, | loose: | 50 pcf | |
| | packed: | 80 pcf | |

4.3.3 Reclaim Rate

| | |
|---|---|
| Operation: | 5 days/week |
| | 8 hours/day |
| Daily Recovery Rate: | 56 tons (wet) |
| Hourly Recovery Rate: | 7.5 tons (wet) |

4.4 Plant Description

The following is a description of the proposed methods for dust reclamation from the underground storage chambers and should be read in conjunction with the drawing listed below:

| | |
|---|---|
| Drawing No. AO-53138-FS-01 | Process Flow Diagram, Underground Reclaim Systems |

This drawing is attached in Appendix I of this report.

4.4.1 General

The reclamation of underground material involves the recovery of baghouse dust and/or Cottrell dust that has been stored underground in sealed chambers progressively since 1951. The arsenic trioxide dust has settled overtime and additional 'fresh' dust added until the chambers are now nearly full.

The Area 1 chambers, stopes B2-30 to 36, contain over five (5) years feed supply for the processing facility. Thus only recovery from these stopes has been considered in this report. It is Fenco's opinion that the techniques developed for material reclaim from the Area 1 stopes will be adaptable to the other areas. The Area 1 stopes contain dust having the highest gold content and are also located directly beneath the proposed processing facility thereby reducing the surface conveying requirements.

The reports and data reviewed by Fenco, and referenced in Appendix II, indicate that the physical properties of the dust in the Area 1 chambers varies considerably. This range of properties requires that the reclamation method(s) be flexible.

GYML has proposed three alternative reclaim methods:

- Vacuum reclaim with pneumatic conveying to surface storage
- Mechanical reclaim, including clamshell bucket and conveyor to surface
- Slurrying of dust, pumping to surface and dewatering.

The first two methods will be discussed in this report. The slurry reclaim method was ruled out because of environmental concerns.

### 4.4.2 Vacuum Reclaim

Test data indicates that the dust stored in the upper portion of the chambers has a low moisture content and is not compacted. It is proposed that the vacuum reclaim method be used to remove this material. The vacuum reclaim equipment will be located underground, in a chamber above and at one end of the stope being worked. Refer to Figures 4-4-1 and 4-4-2.

The vacuum and aeration hoses will be drawn off the hose reel into the arsenic dust by the winches located at the far end of the stope. These winches will also be used to direct the vacuum nozzle across the width of the stope. Material vacuumed up will be transferred to a filter receiver unit located in the underground equipment chamber.

The filter receiver unit will separate the dust from the airstream. It will then pass through a rotary valve into a F-K pump. The F-K pump will be used to pneumatically convey the dust to the 200 ton surface storage bin.

Aeration air will be required at the vacuum nozzle to aerate the dust. This air will be provided by a blower located in the equipment chamber and an air hose running parallel to the vacuum hose.

The vacuum equipment will be operated from a pressurized control booth located underground, adjacent to the equipment chamber. Operations in the storage chamber will be observed on a TV monitor.

### 4.4.3 Mechanical Reclaim

The mechanical reclaim method will be used to remove compacted material with high moisture content that cannot be removed by vacuuming.

The mechanical reclaim system will consist of four (4) main components:

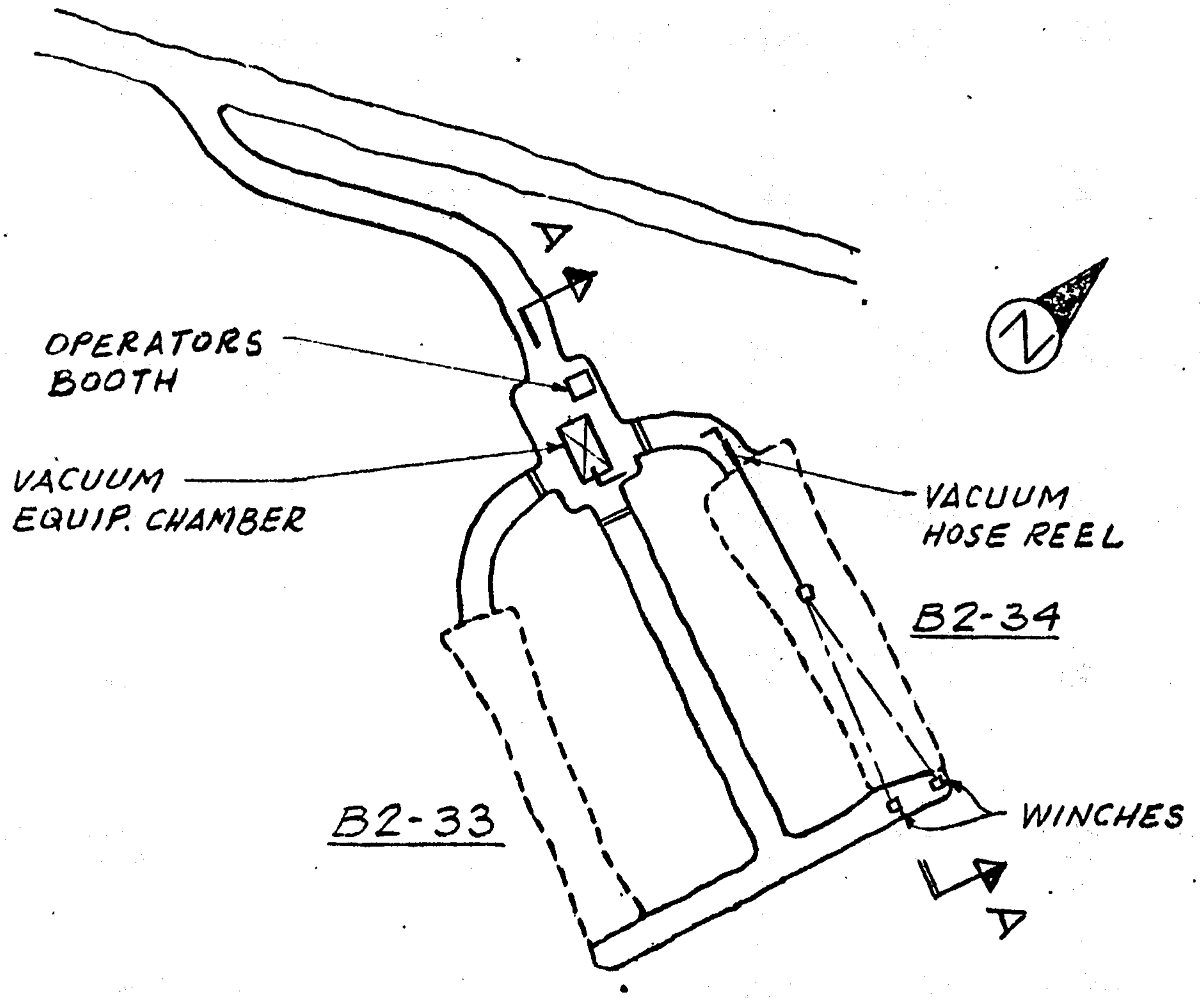
- Electro-hydraulic clamshell bucket.
- 5 ton overhead crane.
- Dump hopper with live bottom.
- Drag conveyor for moving material to the surface.

Once the access drift to the storage chamber has been completed and the dry loose dust vacuumed out, the overhead crane will be installed. The crane will run the full length of the stope and be used to carry the one cubic yard electro-hydraulic clamshell bucket. An electro-hydraulic bucket has been selected as it will provide greater digging power and also simplify the crane hoist. When maintenance is required the bucket may be easily removed from the crane hook and brought to the surface for repair. A complete spare unit has been allowed for in the estimate.

Material collected by the clamshell bucket will be transferred to the dump hopper located in the drift at one end of the chamber. Here the material will be dumped into the hopper, refer to Figure 4-4-3.

The dump hopper will be fitted with a grizzly and live bottom screw feeder which will feed the material into a drag conveyor. The tubular drag conveyor will transfer the material to the surface. Once on the surface the wet arsenic dust will be conveyed directly to an indirect paddle dryer to be located beneath the feed storage bin. The dryer will be used to reduce the material moisture content to the 1 to 2% range before it is conveyed by tubular conveyor to the 200 ton storage bin.

The mechanical reclaim equipment will be operated from a pressurized control booth located underground in the drift adjacent to the material dump hopper. Operation of the crane and clamshell bucket in the storage chamber will be observed by TV monitor.




NOTE :
FOR SECTION 'A-A' SEE FIG. 4-4-2.

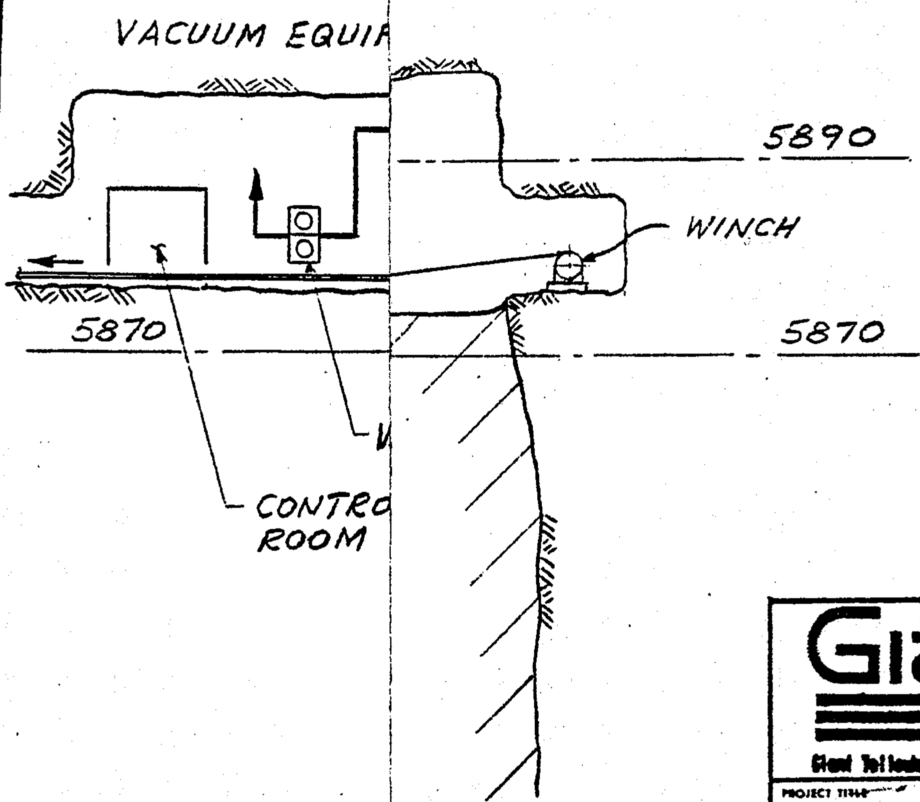
Giant
Giant Yellowknife Mines Limited

PROJECT TITLE
WAROX PROJECT

DRAWING TITLE
UNDERGROUND DEVELOPMENT

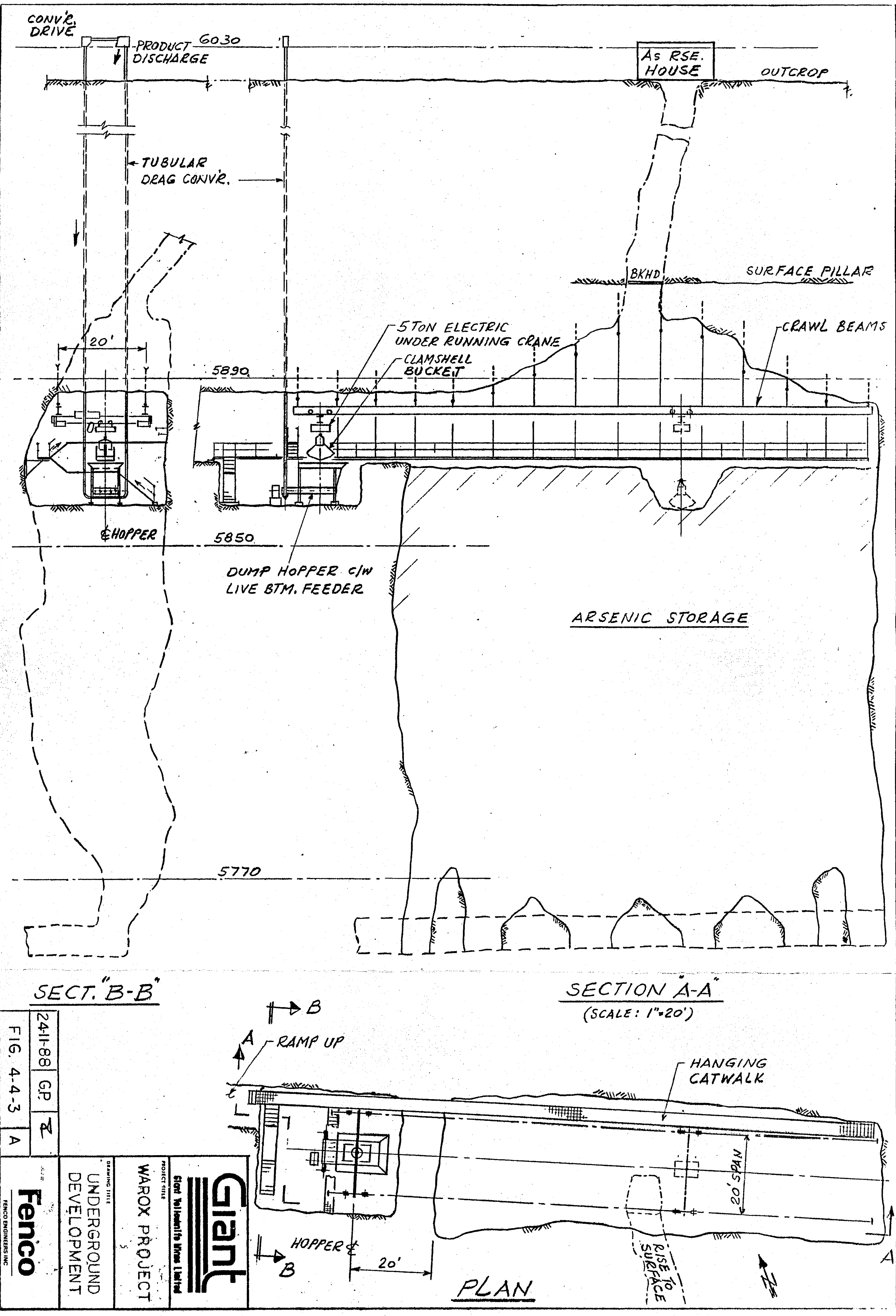
Fenco
FENCO ENGINEERS INC.

| SCALE 1"-60' | 24-11-88 | G.P. | |
|---|---|---|---|
| DRAWING NUMBER | FIG. 4-4-1 | REV A | |




| | |
|---|---|
| Giant — Giant Yellowknife Mines Limited | |
| PROJECT TITLE | WAROX PROJECT |
| DRAWING TITLE | UNDERGROUND DEVELOPMENT |
| Fenco — FENCO ENGINEERS INC. | |
| SCALE 1"=20' | 24-11-88 / GP. |
| DRAWING NUMBER | FIG. 4-4-2 |
| REV | A |

FENCO FORM NO. 602
METRIC CODE A1




24-11-88 | G.P.

FIG. 4-4-3 | A

Giant Yellowknife Mines Limited

PROJECT TITLE: WAROX PROJECT

DRAWING TITLE: UNDERGROUND DEVELOPMENT

Fenco

FENCO ENGINEERS INC