GRUM DEPOSIT

PROGRAM FOR
CONTINUED EXPLORATION
AND
CONFIRMATION OF
ORE RESERVE OUTLINES

VANGORDA CREEK AREA Y.T.

N.T.S. 105 K-6

015061

JANUARY, 1975

KERR/AEX JOINT VENTURE

GRUM DEPOSIT

ENVIRONMENTAL ASPECTS OF

PROPOSED UNDERGROUND EXPLORATION

JANUARY, 1975

Montreal Engineering Company, Limited,

593 King Street,

Fredericton, N.B.

montreal engineering company, limited
a monenco company

593 KING STREET, FREDERICTON,
NEW BRUNSWICK

Tel: (506) 454-3309

30 January 1975

Mr. M.D. Rowswell
Executive Vice President
Kerr Addison Mines Limited
P.O. Box 91 - Commerce Court West
Toronto, Ontario

Dear Mr. Rowswell:

We are pleased to submit this report on the environmental procedures which should be considered with respect to the 1975 exploration decline at the Grum deposit.

The costs for the waste management measures recommended will vary widely depending on the characteristics of the drainage from the decline and the stored ore piles. Known characteristics of the ore would suggest that the drainage will be strongly acid and will require elaborate treatment facilities. The total cost in this case might be as high as $483,000. However, drainage characteristics at the Anvil mine from apparently similar ore are not strongly acid. The reason is unknown, but if a similarly weak drainage were obtained at the Grum workings, the costs of the waste management measures will be in the order of $164,000.

Our recommendation is to initially provide the basic facilities at the lesser cost but maintaining the flexibility to add to them if the characteristics of the drainage dictate.

We trust that this report meets your requirements, and will be pleased to further discuss it with you at any time.

Yours very truly,

Alan V. Bell, P. Eng.
Assistant Manager
Resources & Environmental Division

AVB/bs

CONTENTS

	PAGE
LETTER OF TRANSMITTAL	(i)
CONTENTS	(ii)
1. INTRODUCTION	1-1
2. EXPLORATION PROGRAM - PRINCIPAL ACTIVITIES, IMPLICATIONS AND CONTROLS	2-1
2.1 Waste Rock Disposal	2-1
2.2 Ore Storage Piles	2-2
2.3 Mine Water Treatment Facility	2-3
2.4 Fuel Storage	2-5
2.5 Power Plant and Maintenance Shop	2-5
2.6 Camp Facilities	2-6
2.7 Water Supply	2-7
2.8 Cost Breakdown	2-7
3. REGULATORY PROCEDURES	3-1
3.1 Federal Regulations	3-1
311 Water	3-1
312 Land Use	3-3
313 Mining	3-3
3.2 Territorial Regulations	3-4
321 The Public Health Ordinance	3-4
.1 Regulations Governing Private Sewage Disposal Systems	3-4
.2 Other	3-4
322 Forest Protection Ordinance	3-4
4. MONITORING	4-1
APPENDIX A EVALUATION OF THE ACID PRODUCING POTENTIAL OF ORE & WASTE ROCK	
APPENDIX B COPY OF APPLICATION FORM FOR WATER LICENCE	

1. INTRODUCTION

The objective of this presentation is to define and cost the measures which will be required with respect to the 1975 exploration program on the Grum Deposit in order to maintain the degree of environmental control acceptable to the regulatory agencies concerned and to be consistent with environmental requirements in future activities at the site.

Several important factors must be borne in mind from both the technical and regulatory standpoints:

1. A very favourable attitude towards the development has been created in the minds of the regulatory people in Whitehorse to date. This is due to the manner in which the Company has informed and involved officials of the various agencies in the early stages of planning. Every effort should be made to maintain this attitude by clearly integrating the 1975 exploration program into the longer term program of environmental and development studies and by ensuring that the environmental safeguards adopted generate confidence with the agencies concerned with respect to future activities by the Company.

2. The development area is close to the Anvil operation and also to the town of Faro. In many respects this is fortunate from the environmental standpoint as the impact of a similar development in a wilderness or undeveloped region would inevitably be of greater concern. However, the fact that the development is situated in the Vangorda Creek watershed which drains into the Pelly River at Faro close to the Town's point of water supply will focus considerable attention on the control of water borne contaminants. Also the fact that the Anvil development has been the centre of some concern with respect to water quality problems and waste disposal will inevitably result in a greater emphasis being given to the measures adopted at the Grum Deposit.

2. EXPLORATION PROGRAM - PRINCIPAL ACTIVITIES IMPLICATIONS AND CONTROLS

The 1975 Exploration Program essentially involves driving a 2639 ft. decline and associated lateral drifts, cross-cuts, and raises into the ore body of the Grum Deposit plus approximately 40,000 ft. of diamond drilling from the surface. The program will start in early March and will run for approximately 10 months. The following principal facilities and activities are involved:

1. Disposal area for approximately 30-45,000 tons of waste rock consisting of unmineralized argillite.
2. Storage area for ore mined from decline estimated as approximately 100,000 tons total. Of this approximately 50,000 tons will be "high grade" (14% Pb + Zn with 70% sulphide) and the balance "low grade".
3. Treatment facility for mine water and contaminated surface drainage.
4. Fuel storage.
5. Power plant and maintenance shop for mining and drilling equipment.
6. Trailer camp for approximately 80 people - sewage system
   - garbage disposal
7. Water supply of approximately 25 gpm.

The environmental implications and controls proposed for each of these are discussed in the following sections.

2.1 WASTE ROCK DISPOSAL

As far as is known at this stage the waste rock consists of argillite and contains no mineralization. It should therefore be possible to use this material for fill in the area of the portal, levelling the camp and shop areas, road building, etc. without concern for environmental implications. As a precaution, a "potential acid generation" test should be conducted on a sample of the argillite. This is recommended as the information is useful in positively establishing the implications of waste rock useage with the regulatory agencies should the question of the chemical stability arise. Details of the test are attached as Appendix A.

The amount of waste argillite is estimated to be in the order of 30-45,000 tons depending on the location of the waste/ore contact. The amount required for road building and site levelling is unknown but will probably use a majority of this. The balance should be used to create a level working area in the immediate vicinity of the portal. It is extremely important that only non-mineralized material be dumped there, however, as the drainage from the area will not be controlled as shown in the layout in Plate 1. The area could, however, be ditched in the future should a problem arise.

2.2 ORE STORAGE PILES

Provision has to be made to store approximately 100,000 tons of ore at the site. Approximately 50,000 tons of this will be "high grade" consisting of approximately 70 per cent total sulphides with 14 per cent combined lead and zinc. It can be anticipated from the waste management standpoint that this material once stockpiled will oxidize and result in an acid, metal bearing drainage. Provision must therefore be made to collect and treat the runoff from the ore storage pile. This is most easily and economically handled by ditching at the toe of the pile and leading the drainage into a holding pond as shown in Plate 1. In this way the pond can also be used to treat the mine drainage in the early months of the development and to provide some balancing of flows from the ore piles during periods of heavy rainfall or snowmelt.

The location of the ore pile and the collection pond have been situated on the basis of utilizing as much as possible of the relatively level ground to the SW of the portal. If this is not done the pond has to be located on steep slopes and requires more extensive earth work to achieve the required volume. Also it is otherwise difficult to avoid its location in the swamp area below the 4130 contour. A pond volume of approximately 95,000 cu. ft. is recommended although this is based more on treatment considerations than on storage requirements. The cost of constructing the pond and ditches will vary from $31,000 to $37,000 depending on soil conditions and whether borrowed material has to be used for the berms and dykes.

It is assumed that the ore will be stored in two piles roughly 40 ft. high by 600 ft. long to facilitate covering with plastic sheeting and subsequent sampling for metallurgical testing (See Plate 2).

The cost of locating these piles at an average of about 300 ft. to the south rather than in the immediate vicinity of the portal is estimated to be $10,000 based on an average incremental haulage cost over this additional distance of $0.10 per ton.

2.3 MINE WATER TREATMENT FACILITY

Specification of the type and capacity of the mine water treatment system is extremely difficult due to the undefined quality and volume of the mine water. The evidence is conflicting: one would anticipate that once the decline is into the ore body the drainage will be very acid and high in dissolved metals due to the high sulphide (particularly pyrrhotite) content of the ore. However, the ore characteristics of the neighbouring Anvil deposit appear to be essentially similar yet the mine drainage there has a pH in the order of 8.0-8.6. No explanation exists for this and in fact the Department of Indian Affairs and Northern Development has let a contract to B.C. Research to find a explanation for this apparent anomaly. A similar situation might exist at the Grum deposit if the lack of oxidation is due, for example, to a trace element blocking the bacterial leaching reaction. In view of this fact and the normal difficulty associated with designing mine water treatment facilities before the drainage characteristics are known, the basic approach recommended here is to maintain as great a degree of flexibility as possible without investing heavily in equipment that may not be required.

In the initial three months of operations the decline will be in the barren argillite and should therefore contain mainly suspended solids (rock flour) and some oil from drilling operations but few dissolved minerals. A simple lagoon should therefore provide adequate treatment for settling the solids and for skimming oil during the early stages of the decline. The proposed drainage collection pond (Plate 1) will be adequate for this purpose.

Once the workings are into the mineralized zone (approximately July 1975) it can be anticipated that the pH of the mine water will decrease and the metals content will increase to levels where chemical treatment will be required, although the situation at Anvil raises some doubt in this respect.

If a strong acid drainage could definitely be anticipated we would recommend construction of a mechanized High Density Sludge, lime neutralization treatment system using an inclined plate clarifier so that the entire operation could be enclosed. The cost of this for a 200 gpm* nominal capacity plant would be in the order of $400,000 and would require a building floor area of approximately 2700 sq. ft. (See Plate 3).

* all gallons used in this report are Canadian

In the circumstances, it is recommended that floor space be made available in the maintenance shop so that if required the complete system could ultimately be installed there. Locating it in the shop eliminates the necessity for a separate building and lessens the requirement for specialized operating personnel. All that need be provided initially, however, is the main reactor vessel (see Plate 3) and the lime storage and mixing facilities. The neutralized mine drainage can then be gravity fed into the treatment pond where it will buffer any surface drainage from the pile prior to discharge. This should prove satisfactory through 1975 if there is little tendency for acid production in the ore. However, if the ore is strongly acid producing; a) the drainage from the ore storage pile will be very acid and will require more than just buffering in the collection pond and b) the volume of treatment sludge will accumulate very rapidly and will fill the collector/treatment pond. In this event it will be necessary to use the pond only to collect untreated drainage and to then pump from the pond to the expanded treatment plant in the maintenance shop.

An early indication of the treatment requirements can be gained by runnning potential acid generation tests on the various grades of ore to be encountered as soon as possible. Delivery time for most items of treatment equipment is about 4 months so it is necessary to maintain this order of lead time if embarassment of having a problem drainage and no adequate means to treat it is to be avoided. The proposed system does, however, provide the basic components required prior to the time when the decline will be into even low grade ore. The cost of providing the minimum requirements based on the initial use of bagged lime can be broken down as follows:

Treatment Equipment Capital Cost		$24,000
Treatment Equipment Installation		5,000
30% Contingency		9,000
Provision of Floor Space 2700 sq. ft. @ $20/ft^2		54,000
	TOTAL	$92,000

The incremental cost of upgrading this system for a strongly acid drainage would be as follows: (Ref. Plate 3)

Equipment Costs	$170,000
Installation	25,000
Pump and Line From Pond	39,000
30% Contingency	70,000
Total Increment	$304,000
Maximum Complete Treatment Cost for Strong Drainage	$396,000

If the strong drainage system is required, up to 67 tons/day of 30% solids treatment sludge will require disposal based on the drainage characteristics given in Plate 3. The disposal alternatives are as follows:

- disposal in a dry heading underground
- haulage to the Faro land-fill site
- burial or lagoon storage on site
- haulage to Anvil tailings area

It is recommended that evaluation of these alternatives be left until such time as their need is established.

2.4 FUEL STORAGE

The Territorial Land Use Regulations state that fuel oil storage in amounts exceeding 5,000 gals. or in any amount for periods exceeding 6 months is subject to approval. Although these Regulations do not apply to the proposed development, information regarding fuel storage is required by the Controller of Water Rights in considering the water use request. Obtaining approval should not pose a problem if the use of steel tanks is proposed particularly if they are located in an area from which accidental spills can be controlled. This will be the case if the storage tanks are located in the general proximity of the maintenance shops (Plate 1) and should not incur any additional cost with respect to location elsewhere.

2.5 POWER PLANT AND MAINTENANCE SHOP

Apart from placing this in an area from which any spills of oil or fuel can be controlled, no special considerations are necessary. Floor drains should contain

oil catchement sumps and be connected into the treatment collection pond. As mentioned in Section 2.3 space should be provided in the shop building (or annexed to it) for the treatment plant. A total of 2700 sq. ft. is required. An incremental cost allowance of $54,000 has already been included in Section 2.3.

2.6 CAMP FACILITIES

10-12 trailer units will probably be involved in the camp facility including the kitchen, an administrative unit and the mine dry. Key considerations made here with respect to the camp are sewage treatment and garbage disposal.

Based on a maximum resident population of 80 persons and a per capita flow of 65 gpd (including waste water from the Dry), the treatment facilities should have a capacity of about 5,200 gpd.

Several alternative treatment facilities are available:

- septic tank system
- lagoon system
- package, extended aeration units

The package units are the easiest to install and for the capacity required cost in the order of $45,000 in place.

Septic tanks are also viable methods of treatment under northern conditions but the installation of the necessary soak-away system is expensive for a system that may be used for only several months. This alternative is therefore not recommended.

A lagoon system is simple, acceptable to the regulatory authorities, and requires virtually no maintenance. A retention of 6 months is usually assumed for lagoons in northern climates meaning that the pond is relatively large even for small treatment flows. In this case a lagoon 120 ft. x 100 ft. x 12 ft. deep would be required.

The cost of constructing such a pond including the collector system could vary from $31,500 to $42,000 depending on whether the excavated material is suitable for constructing the side dykes (see Plate 4). The higher figure would apply if borrowed material for the dykes and an impervious lining were required. In practice it might be feasible to use a smaller retention pond thus incurring some saving on this item.

Some problems with odours might be experienced in early summer as the system converts from anaerobic to aerobic but it is recommended that a lagoon be used unless the contractor has a package treatment unit of adequate capacity available (which apparently might be the case).

The commonly accepted practices for the disposal of camp solid wastes include either burning or burial. However, in this situation, it is recommended that the Town of Faro dump be used since it is only 5 miles distant. Based on 3 lbs/capita/day haulage would be in the order of 3/4 ton/week and can be handled using plastic bags or steel drums.

2.7 WATER SUPPLY

The volume of water required during this exploration phase is very small: approximately 20 gpm for the camp itself and probably no more than 5 gpm for drilling. The latter can almost certainly be supplied by recycling mine water once the decline is in progress. The camp supply can be trucked from Vangorda Creek or taken from either a groundwater well or from Doal Lake. The latter probably represents the simplest alternative. The supply should be chlorinated by using a small package chlorinator which apparently the contractor has available.

2.8 COST BREAKDOWN

Ore Storage Piles		
Incremental Cost of Locating 300 ft. average distance from immediate vicinity of portal		$10,000
Drainage Collection Pond and Ditches		
Pond excavation and berm formation	$20,000	
Incremental cost if borrowed dyke material required	3,000	
Drainage ditch/dyke system	4,000	
Cost range including 30% contingency		$31-35,000
Mine Water Treatment - Initial Installation		
Equipment costs (delivered at site)	24,000	
Equipment installation	5,000	
30% contingency	9,000	
Allowance for building space @ $20/ft^2	54,000	
		$92,000

Mine Water Treatment - Incremental Cost for Strong, Acid Drainge

Equipment Costs	$170,000	
Installation	25,000	
Pumps and Line from pond installed	39,000	
30% contingency	70,000	
Possible incremental costs		$304,000

Sewage Treatmemt Costs

Lagoon construction if excavated material used for berms, incl. outfall	$19,000	
Collector system from camp, allow	5,000	
30% contingency	7,000	
	$31,000	
Additional cost of borrowed material required	11,000	
Possible cost range		$31-42,000

TOTAL CAPITAL COST FOR ENVIRONMENTAL CONTROLS

a) Weak or alkaline drainage, good excavation conditions	$164,000
b) Strong acid drainage, poor construction conditions	483,000

OPERATING COSTS

Operating costs if the mine drainage is weak or alkaline will be very small. However, for a strong acid mine drainage in the order of 200 gpm costs could be in the order of $2.50 per 1000 gals or $720 per day. This is very much influenced by the cost of lime which has been assumed to be $50 per ton deliverd to site.

3 REGULATORY PROCEDURES

This Part deals with the regulations of the Federal and the Yukon Territorial Governments which must be satisfied in order to begin the proposed exploratory program.

3.1 FEDERAL REGULATIONS

311 Water

Under the Northern Inland Water Regulations, the project area lies within water management area No. 2 which encompasses all of the river basins tributary to the Yukon River. Use of the waters of this area are under the administrative jurisdiction of the Department of Indian Affairs and Northern Development (DIAND).

Long term use of substantial quantities of water is normally authorized by a water licence issued by the Controller of Water Rights. However, Section 11 of the Regulations permits the Controller to authorize the temporary use of water when the quantity does not exceed 50,000 gallons per day. Although the period of such use is not specific, the Controller may require that the authorization be formalized by a water licence if the use is continued over a long period of time.

Application for authorization to use water without a licence takes the same form as in the formal procedure. Schedule II contained in the Regulations is required to briefly summarize the proposal. In addition, the Controller requires supplementary information which includes, but may not be limited to, the following:

(a) Map of claims involved and their numbers

(b) Method of obtaining water

(c) List of substances which might be added to natural waters

(d) Method of mine waste water treatment and location of effluent discharge

(e) Type and location of work camp, number of men, and place of origin of the workers

(f) Method of sewage treatment and disposal

(g) Methods of fuel handling, types and amounts of fuels to be stored, and type of container

(h) Locations of stockpiles of ore and waste rock

(i) Proposed method of solid waste disposal.

The form of Schedule II is presented in Appendix B. The required supplementary information can be assembled from this report and other materials in the files of the Kerr/AEX Joint Venture.

A minimum of approximately three weeks time should be allowed for approval of the water use request after application.

Effluent requirements for waste discharges are normally defined in a water licence. Whether specific requirements will be defined in the case of a temporary authorization is not known but if required will almost certainly be of similar form to those of other mining developments in the Yukon. A sample of such effluent requirements is as follows:

- No waste discharge shall exhibit constituents or characteristics exceeding the following limits.

Suspended solids	not greater than 15 mg/l
pH	not less than 6.5 pH units
Colour	not greater than 20 pt-Co units
Turbidity	not greater than 15 Jackson Turbidity units

- No waste discharge shall contain floating solids
- No visible or floating oils or greases shall be present in any waste discharge
- No waste discharge shall be toxic to fish
- The concentrations of elements which shall not be exceeded in any waste discharge are listed below:

			Concentration mg/l
Ammonia	(as N)	total	1.00
Antimony	(Sb)	extractable	0.10
Arsenic	(As)	dissolved	0.05
Barium	(Ba)	extractable	1.00
Cadmium	(Cd)	extractable	0.02
Copper	(Cu)	extractable	0.2
Cyanide	(as CN)	total	0.05
Lead	(Pb)	extractable	0.20
Mercury	(Hg)	extractable	0.005
Molybdenum	(Mo)	extractable	0.50
Nickel	(Ni)	extractable	0.5
Selenium	(Se)	extractable	0.05
Silver	(Ag)	extractable	0.10
Zinc	(Zn)	extractable	0.5

The measures proposed should achieve the above requirements if they are in fact applied.

312 Land Use

The Territorial Land Use Regulations, also administered by DIAND, are not operative in regard to the proposed exploratory program. The project area does not lie within a designated land management zone. Moreover, it is our understanding from the Land Claims Administrator that the surface rights of Kerr Addison/AEX mineral claims are now covered by a lease from the Federal Government. Under these circumstances, no further permits with respect to land use within the confines of the claims are required.

The Territorial Timber Regulations, however, require a permit where trees are to be removed for the purpose of land clearing. This permit is obtained from the Resource Management Officer of the Yukon Lands and Forest Service at Faro upon authorization from DIAND.

313 Mining

There are several approvals and permits which must be obtained with respect to the proposed exploratory mining operation.

Where underground mining work is involved, approval of the proposed plans must be obtained from the Mining Inspector of DIAND. Plans for the work should be submitted to the Mining Inspector, Room 234 Federal Building, Whitehorse, at least two weeks in advance of the anticipated start of underground work.

Other matters which are directed to the attention of the Mining Inspector are:

(a) Each individual blaster employed in the proposed operation is required to have a Blasting Permit.

(b) If the use of diesel equipment underground is contemplated, the exhaust emissions of the engines must meet the required mine safety standards. An application accompanied by the specifications of the engine should be submitted for approval as far as possible in advance of the beginning of construction.

Storage of explosives at the mining site will require an Explosives Magazine Licence which may be obtained by application to the Explosives Division of the Department of Energy, Mines and Resources, 555 Booth Street, Ottawa.

3.2 TERRITORIAL REGULATIONS

321 The Public Health Ordinance

Under the Public Health Ordinance of the Yukon Territory, there are several Regulations which apply to developments of the type proposed. These are discussed briefly below.

.1 Regulations Governing Private Sewage Disposal Systems

These regulations provide detailed specifications and require a permit from the Territorial Health Officer for sewage disposal systems where the volume of flow is less than 2,000 imperial gallons per day. For flows above this limit, as are expected from the proposed camp, the regulations do not apply; jurisdiction is shifted to DIAND and the plans for sewage disposal would be subject to approval under the application for water use submitted to the Controller of Water Rights.

.2 Other

Regulations Respecting Public Health , and Regulations Respecting the Sanitation of Camps in the Yukon Territory are administered by a Territorial Government Health Officer. While the health and sanitation aspects of camps are governed by these regulations and are subject to inspection by the Health Officer, no permits or prior approvals are required by the legislation.

322 Forest Protection Ordinance

In the event that clearing of land for construction purposes is carried out at the site, a permit would be required to burn the clearing debris during the designated fire season from April 1 to September 30. Field contact with the Resource Management Officer of the Yukon Lands and Forests Department at Faro, who can issue the permit, is all that is required.

4 MONITORING

As mentioned in the Introduction, it is important that the 1975 exploration and development activities at the site be integrated into the longer term program of environmental studies. This program is presently being drawn up by Montreal Engineering Company, Limited and will be submitted to Kerr Addison Mines Limited at the end of February. The program will be designed to take into account the 1975 exploratory program and details are therefore not included here. In general terms however it will be necessary to ensure that sufficient water quality data are accumulated for Vangorda Creek so as to define background conditions and the impact of the exploration activities on the stream. Regular effluent monitoring will also be recommended.

APPENDIX A

EVALUATION OF THE ACID PRODUCING POTENTIAL OF ORE & WASTE ROCK

EVALUATION OF THE ACID PRODUCING POTENTIAL OF ORE AND WASTE ROCK

The following test procedures for evaluating the acid producing potential of ore and waste rock were developed by BC Research under contract to the Department of the Environment with a view to providing a method that could be used to establish the degree to which problems associated with acid generation (arising from the oxidation of sulphidic material) might occur at prospective developments.

1. INITIAL TEST

1.1 SAMPLE

The sample selected must be taken in such a manner that it is truly representative of the type of mineralization being examined. A composite made up of split drill core or of randomly selected grab samples should be satisfactory. The number of samples to be examined will depend on the variability of the mineralization and must be left to the discretion of the geologist taking the samples. The bulk sample is crushed to a size which can be conveniently handled, (i.e. -2 inch) and then thoroughly mixed and approximately a 2 lb portion split out, using the usual coning and quartering technique. This sample is than pulverized to pass a 100 mesh screen and used for assay, the titration test, and the confirmation test if necessary.

1.2 ASSAY

The pulverized sample is assayed in duplicate for total sulphur. The use of a Leco furnace is recommended, although a chemical oxidation technique followed by barium sulphate precipitation is satisfactory. The total sulphur assay value is expressed as pounds of sulphuric acid per ton of sample, assuming a 1:1 conversion factor, which is the acid-producing potential of the sample.

1.3 TITRATION TEST

Duplicate 10 gram portions of the pulverized sample are suspended in 100 ml of distilled or deionized water and stirred for approximately fifteen minutes. The natural pH of the sample is then recorded and the sample titrated to pH 3.5 with 1.0 normal sulphuric acid and left stirring. If an automatic titrator is used the test is continued until less than 0.1 ml of acid is added over a 4 hour period. If manual

titration is used, the addition of acid is repeated every half-hour (approximately) until the pH change over a 4 hour period is 0.1 pH unit or less. The total volume of acid added is recorded and converted to lbs per ton of sample. This is the acid-consuming ability of the sample, i.e.

$$\text{acid-consuming ability (lb/ton)} = \frac{\text{ml of 1.0 } NH_2SO_4 \times 0.049 \times 2000}{\text{wt of sample in g}}$$

or

for a 10 g sample

$$= \text{ml of 1.0 } NH_2SO_4 \times 9.8$$

1.4 INTERPRETATION

If the acid consumption value (in lbs of acid per ton of sample) exceeds the acid-producing potential (lbs per ton) then the sample will not be a source of acid mine drainage and no additional work is necessary. If the acid consumption is less than the acid-producing potential, the possibility of acid mine water production exists and the confirmation test should be conducted.

2. CONFIRMATION TEST

This test examines the amenability of the sulphides in the test sample to oxidation through the action of *T. ferrooxidans*, which is the only organism presently known to be capable of oxidizing insoluble metallic sulphides. The organism also has the ability to oxidize ferrous iron. Experience has shown that not all sulphide minerals are amenable to microbiological attack, nor do they all oxidize completely and so the acid-producing potential indicated by the assay may overestimate the danger.

2.1 SAMPLE

The remaining portion of the pulverized sample is ball milled (wet) for 2-3 hours to produce a -400 mesh sample which is dried overnight at 105°C.

2.2 SHAKE-FLASK LEACHING TEST

Duplicate 30 gram portions (or a smaller amount if the sulphide content exceeds 2%) are placed in 250 ml Erlenmeyer flasks with 70 ml of a nutrient medium containing 3 g/l $(NH_4)_2SO_4$; 0.10 g/l KCl; 0.50 g/l K_2HPO_4; 0.50 g/l $MgSO_4.7H_2O$;

0.1 g/l $Ca(NO_3)_2$. Add sufficient sulphuric acid (use either 12 or 36 Normal) to bring the pH to 2.5. Shake the flask for approximately four hours and the pH should be between 2.5 and 2.8. If necessary add additional acid until the pH remains in that range, and then inoculate the flask with 5 ml of an active culture of Thiobacillus ferrooxidans. Record the weight of the flask and contents. Plug the flask with a loose cotton plug and incubate at 35°C on a gyratory shaker.

The experimental leaching flask is returned to its original weight before sampling by adding distilled or deionized water. Monitor the pH and concentration of a dissolved metal, e.g. iron or copper, for the first three days to ensure that the pH remains below 2.8. Thereafter, monitor every second day until microbiological activity has ceased, i.e. the pH no longer drops or the dissolved metal concentration remains constant.

When microbiological activity has ceased, add half the weight of feed used originally (i.e. 15 grams), shake 24 hours and record the pH. If it is greater than pH 3.5, terminate the test. If it is pH 3.5 or less, again add half the weight of feed (i.e. 15 grams) and shake for 24 hours. If the pH is less than 3.5 or greater than pH 4, the experiment is terminated. If the pH is between 3.5 and 4.0, the sample is shaken an additional 48 hours and the final pH value recorded.

2.3 INTERPRETATION

The object of this test is to determine if the sulphide oxidizing bacteria can generate enough sulphuric acid from the sulphides present in the sample to satisfy its acid demand. If they can, microbiological action will continue on a self-sustaining basis and acid mine water will result. In this test, the acid demand is satisfied initially by adding sulphuric acid. This permits the bacteria to generate the maximum amount of sulphuric acid from the sample concerned. Once microbiological action has ceased, half the original sample weight is added. If there has not been sufficient acid production, the pH will approach the natural pH of the sample (i.e. be above pH 3.5) and the sample is reported as not being a potential source of acid mine water. If the pH remains at 3.5 or below, the remainder of the sample is added and the sample is shaken for up to 72 hours before measuring the final pH. If the pH is still in the leaching range, i.e. pH 3.5 or below, there is a strong possibility that natural leaching will occur and acid mine drainage will be produced. If the pH is above 3.5, there is no possibility of acid mine drainage occurring.

If the sample produces excess acidity, there is the possibility of metal recovery by microbiological leaching. A measure of this potential can be obtained by estimating the percentage of the contained metal which has been solubilized during the leaching test. Under such circumstances, it may be desirable to promote microbiological action as a means of recovering valuable metals from a waste material. In such a system, suitable precautions must be taken to prevent the metal and acid rich leach waters from entering the natural drainage system of the surroundings.

APPENDIX B

COPY OF APPLICATION FORM FOR WATER LICENCE

SCHEDULE II

Department of Indian Affairs and Northern Development
Water, Forests and Land Division

APPLICATION FOR LICENCE, AMENDMENT OF
LICENCE OR RENEWAL OF LICENCE

No. _____

1. Name and Mailing Address

2. Address of Head Office in Canada if incorporated

3. Location of Undertaking - describe and attach map, naming river, creek lake, spring or groundwater reservoir

4. Nature of Undertaking - describe and attach plans

5. Purpose of Undertaking
   (1) To obtain water
   (2) To divert water
   (3) To store water
   (4) To alter the flow of water
   (5) To return a flow of water
   (6) Other (specify)

6. Water Use Classification
   (1) Agriculture
   (2) Conservation
   (3) Industrial
   (4) Municipal
   (5) Power
   (6) River Improvement
   (7) Storage

7. Quantity of Water Involved - (cubic feet per second, gallons per day, acre feet per year)

8. Quality of Returned Water
   (1) Unaltered
   (2) Altered (specify)

9. Other Properties Affected by this Undertaking - describe location and list owners

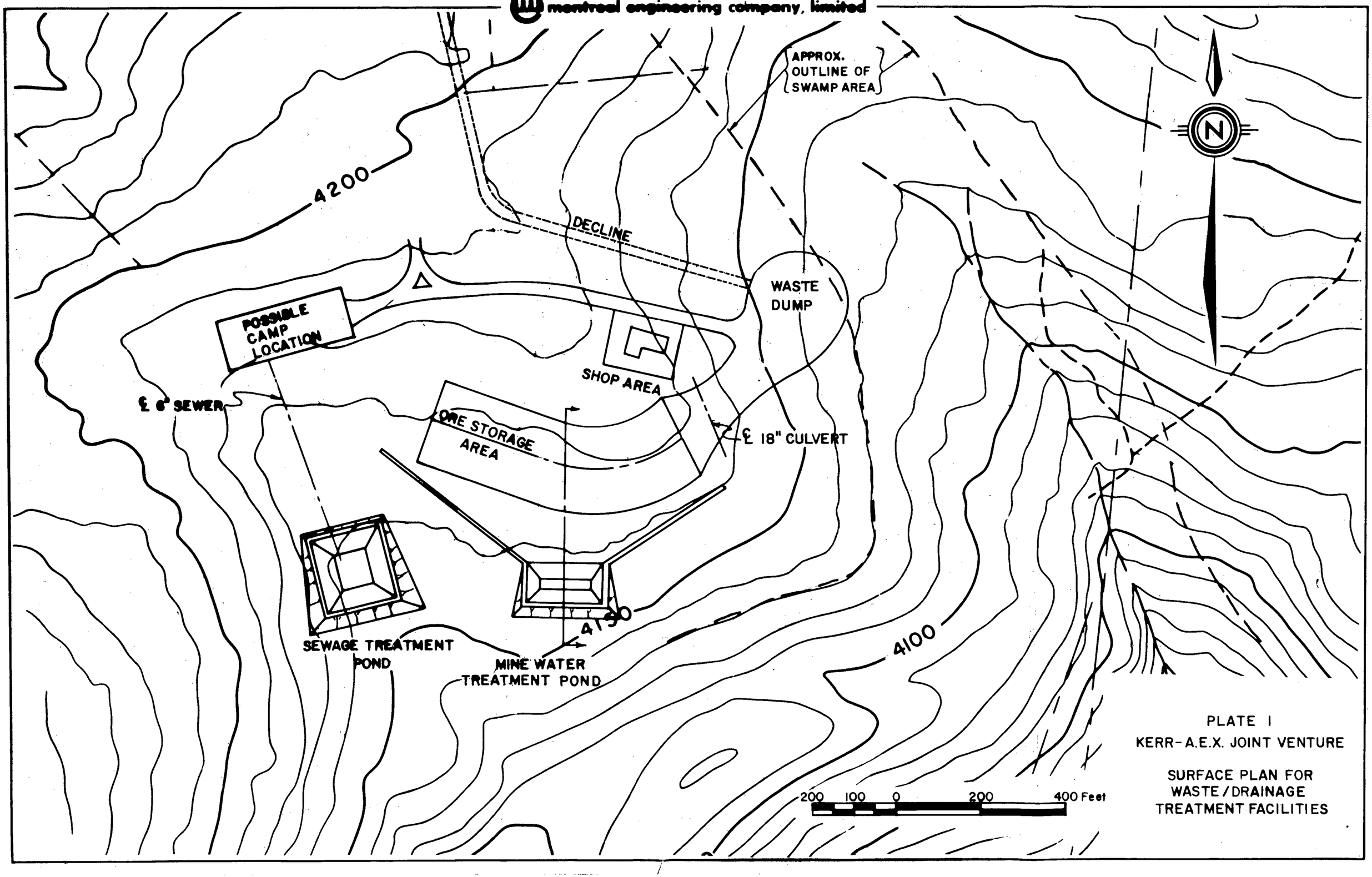
10. Contractor and Sub-Contractors Names and Addresses — Functions

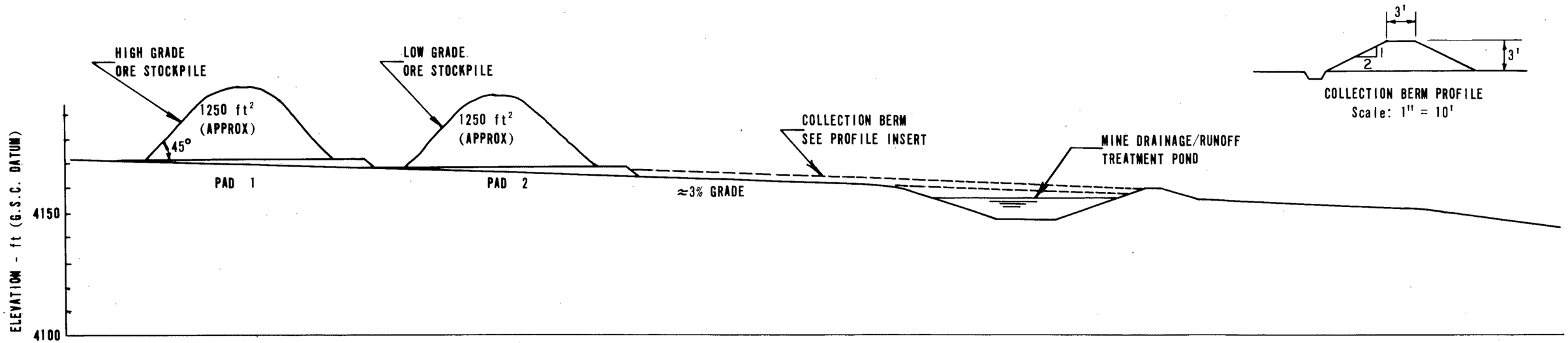
11. Time Schedule Proposed
    Start
    Completion

12. Fees

Application	Water Use	Total
$_____	$_____	$_____

....
Signature Title Date


montreal engineering company, limited
APPROX. OUTLINE OF SWAMP AREA
N
4200
DECLINE
WASTE DUMP
POSSIBLE CAMP LOCATION
SHOP AREA
℄ 6" SEWER
ORE STORAGE AREA
℄ 18" CULVERT
4190
4100
SEWAGE TREATMENT POND
MINE WATER TREATMENT POND
200 100 0 200 400 Feet
PLATE I
KERR-A.E.X. JOINT VENTURE
SURFACE PLAN FOR WASTE / DRAINAGE TREATMENT FACILITIES



PROFILE
Scale: 1" = 40'

COLLECTION BERM PROFILE
Scale: 1" = 10'

WASTE PADS:

1. X-sectional Area = $P_1 + P_2$
   = (½ x 100' x 4') + (½ x 100' x 5')
   = 450 ft²

2. Volume = 450 ft² x 600 ft length
   = 270,000 ft³

3. Tonnage Required = 270,000 ft³ @ 18 ft³/ton
   = 15,000 tons of Waste or Borrow required for pad construction

ORE STORAGE:

1. Ore storage required for (a) 50,000 tons high grade ore
   (b) 50,000 tons low grade ore

2. Bulk densities to be
   (a) high grade ore (broken) 12 ft³/ton
   (b) low grade ore (broken) 15 ft³/ton
   (c) waste (argillite) (broken) 18 ft³/ton

3. Pile profile as above - pile to be covered with heavy mil plastic.

CALCULATION:

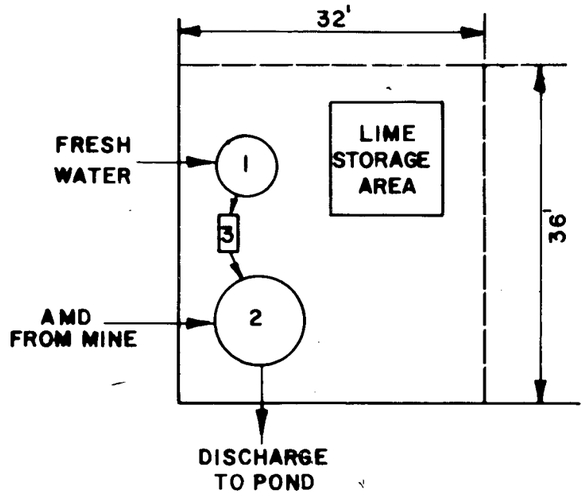
1. Length of high grade pile $= \frac{50{,}000 \text{ x } 12 \text{ tons ft}^3}{1250 \text{ ton ft}^2} = 480$ ft.

2. Length of low grade pile $= \frac{50{,}000 \text{ x } 15 \text{ tons ft}^3}{1250 \text{ ton ft}^2} = 600$ ft.

3. Use 600 ft. as length of ore storage area.

PLATE 2

KERR-A.E.X. JOINT VENTURE
ORE STOCKPILE & TREATMENT
POND PROFILE



DESIGN BASIS

FLOW: 200 gpm (imperial)

DRAINAGE CHARACTERISTICS: Weak acid mine drainage

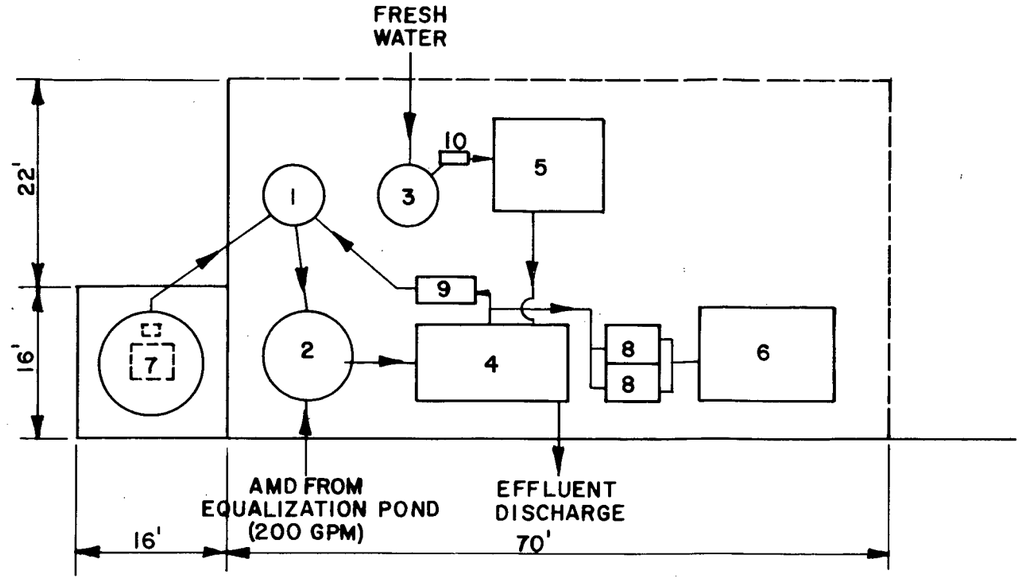
RETENTION TIME IN NEUTRALIZATION TANK: 20 Mins.

LIST OF MAJOR EQUIPMENT

1.	Lime slurry tank, mixer for lime slurry	1000 gals. capacity 3.0 h.p.	6' dia. x 8' height
2.	Neutralization tank, mixer for neutralization tank	5000 gals. capacity 7.0 h.p.	10' dia. x 12' height
3.	Lime slurry feed pump	15 gpm	

PH flow recorder/controller

SCHEME I - INITIAL BASIC TREATMENT SYSTEM



DESIGN BASIS

FLOW: 200 gpm (imperial)

DRAINAGE CHARACTERISTICS:

pH	=	2.7
Acidity	=	2400 mg/l
Sulphates	=	10 mg/l
Cu	=	10 mg/l
Zn	=	1200 mg/l
Pb	=	5 mg/l
Fe (total)	=	1500 mg/l
Suspended solids	=	150 mg/l

RETENTION TIME IN NEUTRALIZATION TANK: 20 mins.

LIME CONSUMPTION: 73lb/1000 gal treated

SLUDGE PRODUCTION: 140 lb (dry wt.)/1000 gal.
or 470 lb (at 30 wt.% solids)/1000 gal.

LIST OF MAJOR EQUIPMENT:

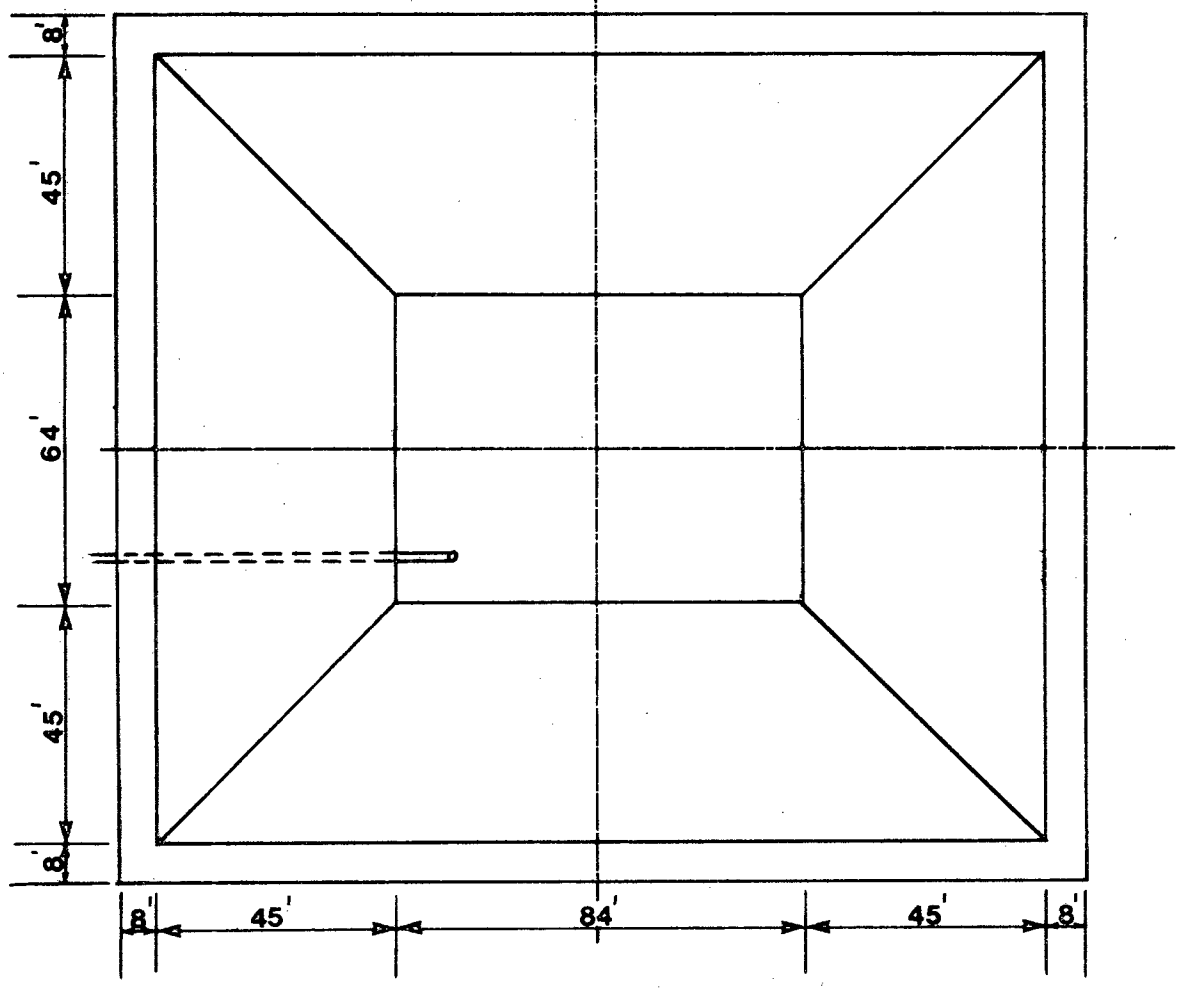
1.	Lime/sludge reactor mixer for 1.	1000 gal. capacity (6'x8') 3.0 h.p.
2.	Drainage reactor mixer for 2	5000 gal. capacity (10'x12') 7.0 h.p.
3.	Freshwater storage tank	1000 gal. (6'x8')
4.	Tilted plate clarifier	(7'x14'x16' height)
5.	Polymer mix and feed equipment	30 lb/day
6.	Vacuum filter unit	115 ft^2
7.	Lime silo incl. dust collector pH recorder/controller	60T capacity
8.	Sludge pumps (2 No.)	20 gpm
9.	Sludge recycle pump	55 gpm
10.	Water pump	15 gpm

SCHEME II - STRONG ACID DRAINAGE TREATMENT SYSTEM

PLATE 3

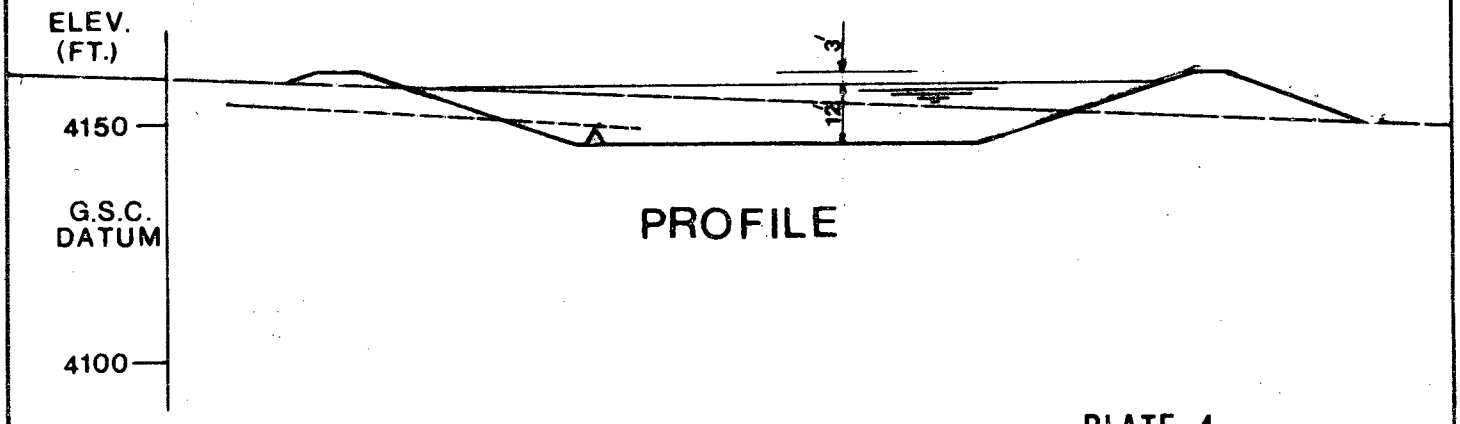
KERR-A.E.X. JOINT VENTURE
MINE WATER TREATMENT SYSTEM

montreal engineering company, limited



PLAN

SCALE 1" - 40'

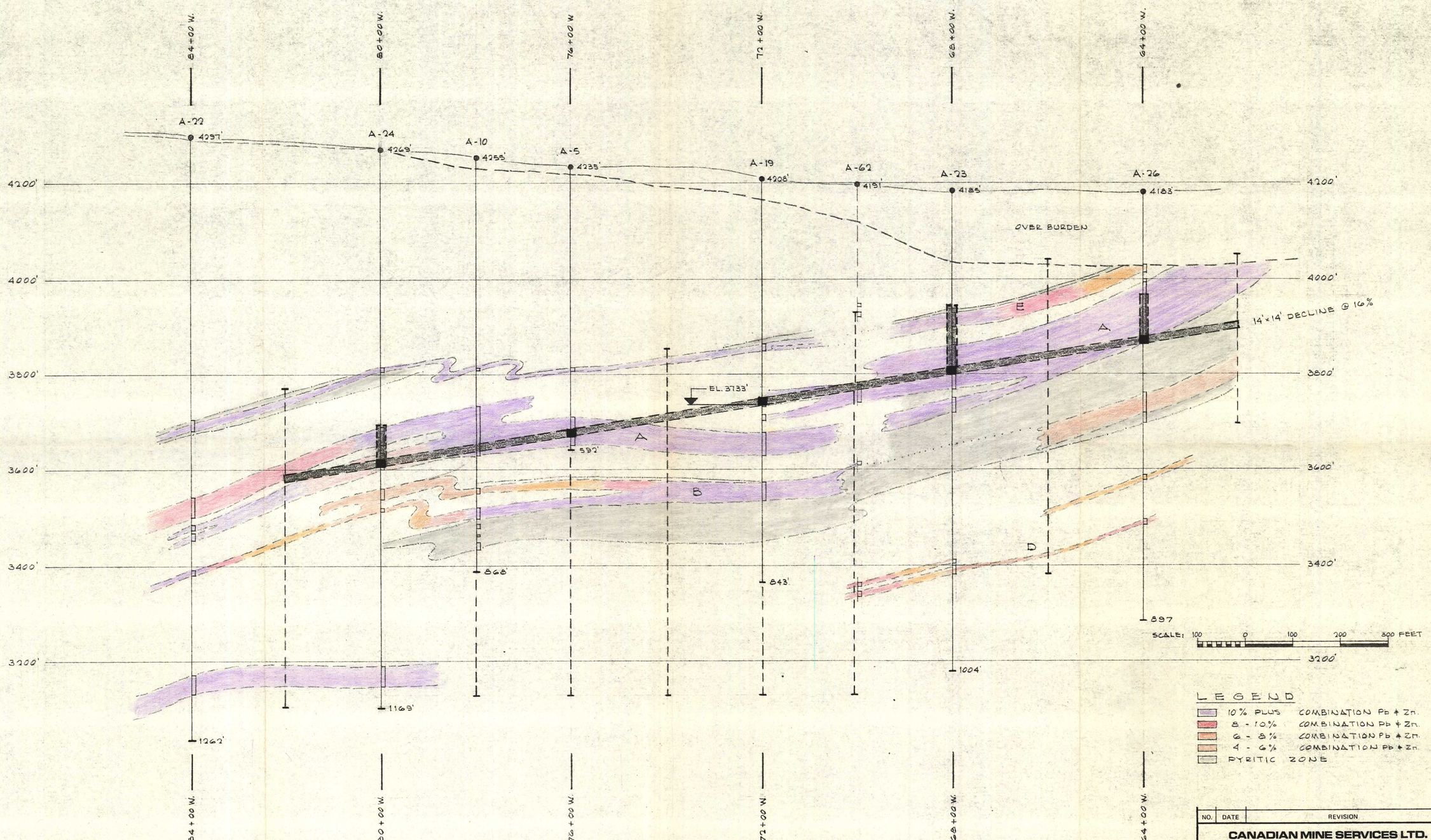


PROFILE

PLATE 4

SEWAGE TREATMENT LAGOON

KERR - A.E.X. JOINT VENTURE



LEGEND

10% PLUS	COMBINATION Pb & Zn.
8 - 10%	COMBINATION Pb & Zn.
6 - 8%	COMBINATION Pb & Zn.
4 - 6%	COMBINATION Pb & Zn.
PYRITIC ZONE	

NO.	DATE	REVISION	BY

CANADIAN MINE SERVICES LTD.
VANCOUVER, B.C. CANADA

KERR-ADDISON MINES LTD.
GRUM DEPOSIT, Y.T.
LONGITUDINAL SECTION 2+00 N

inches 0 1 2
0 1 2 3 4 5
centimetres

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YUKON GEOLOGICAL SURVEY

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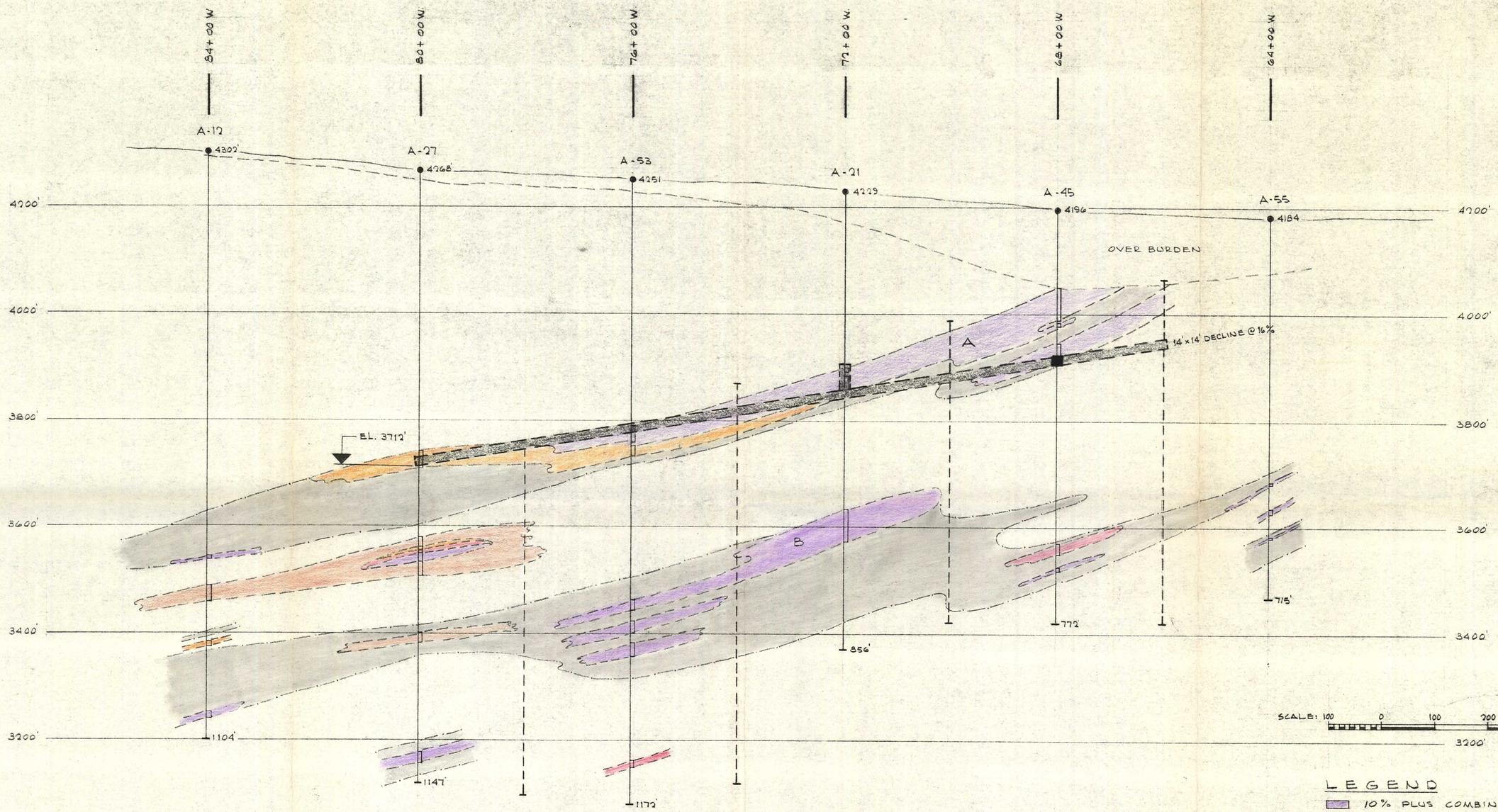

LEGEND

- 10% PLUS COMBINATION Pb & Zn.
- 8 - 10% COMBINATION Pb & Zn
- 6 - 8% COMBINATION Pb & Zn
- 4 - 6% COMBINATION Pb & Zn.
- PYRITIC ZONE

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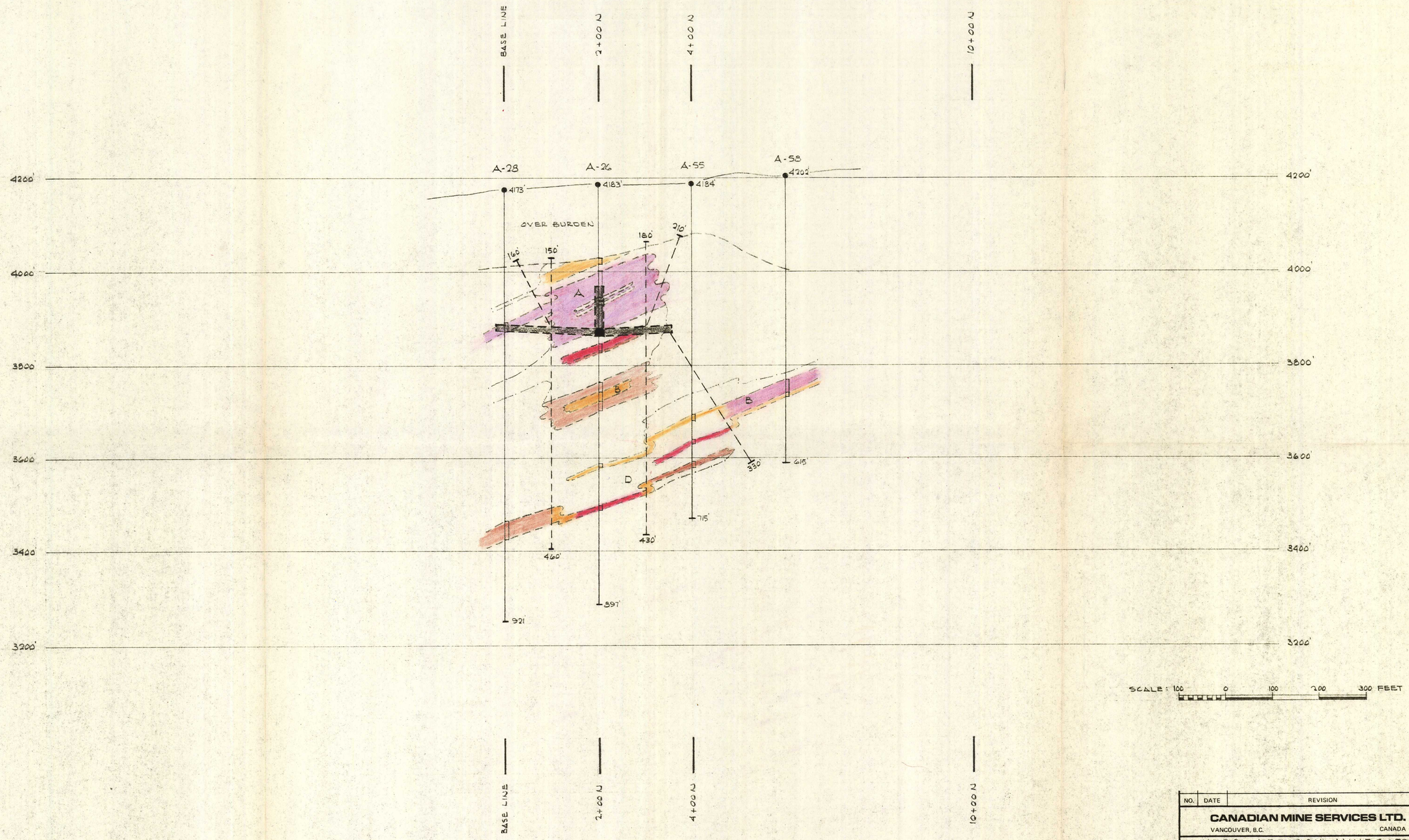

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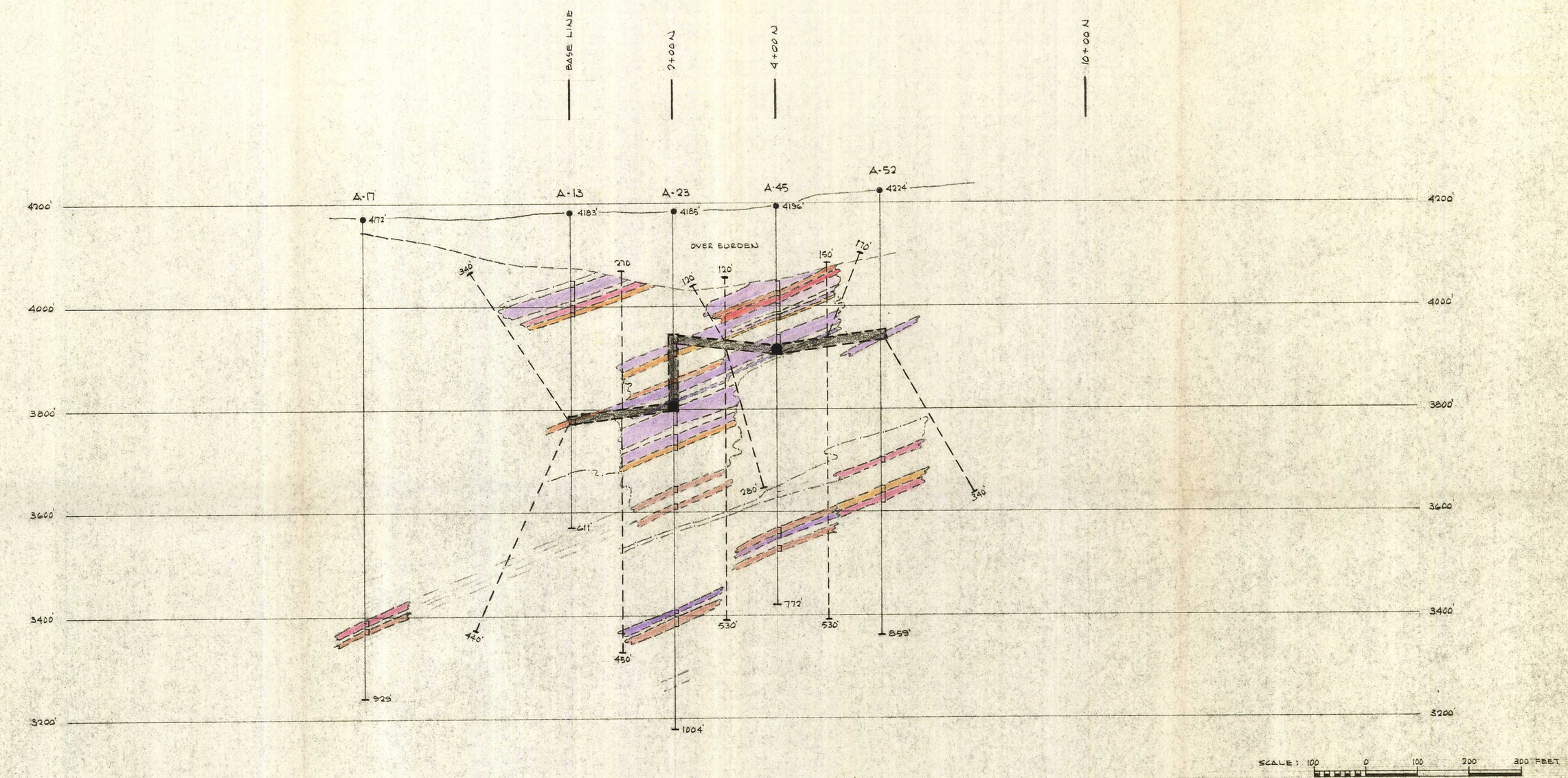

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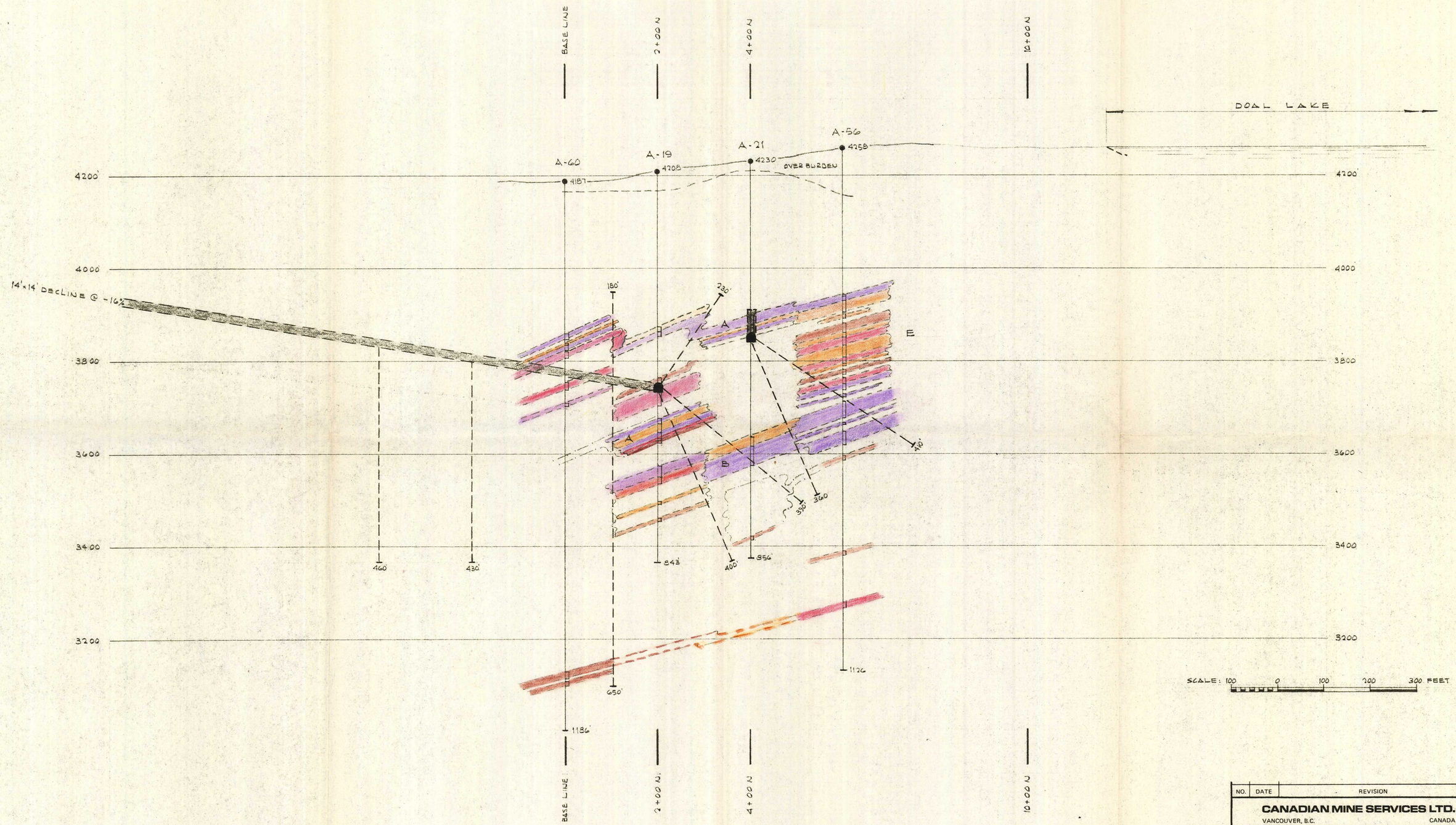

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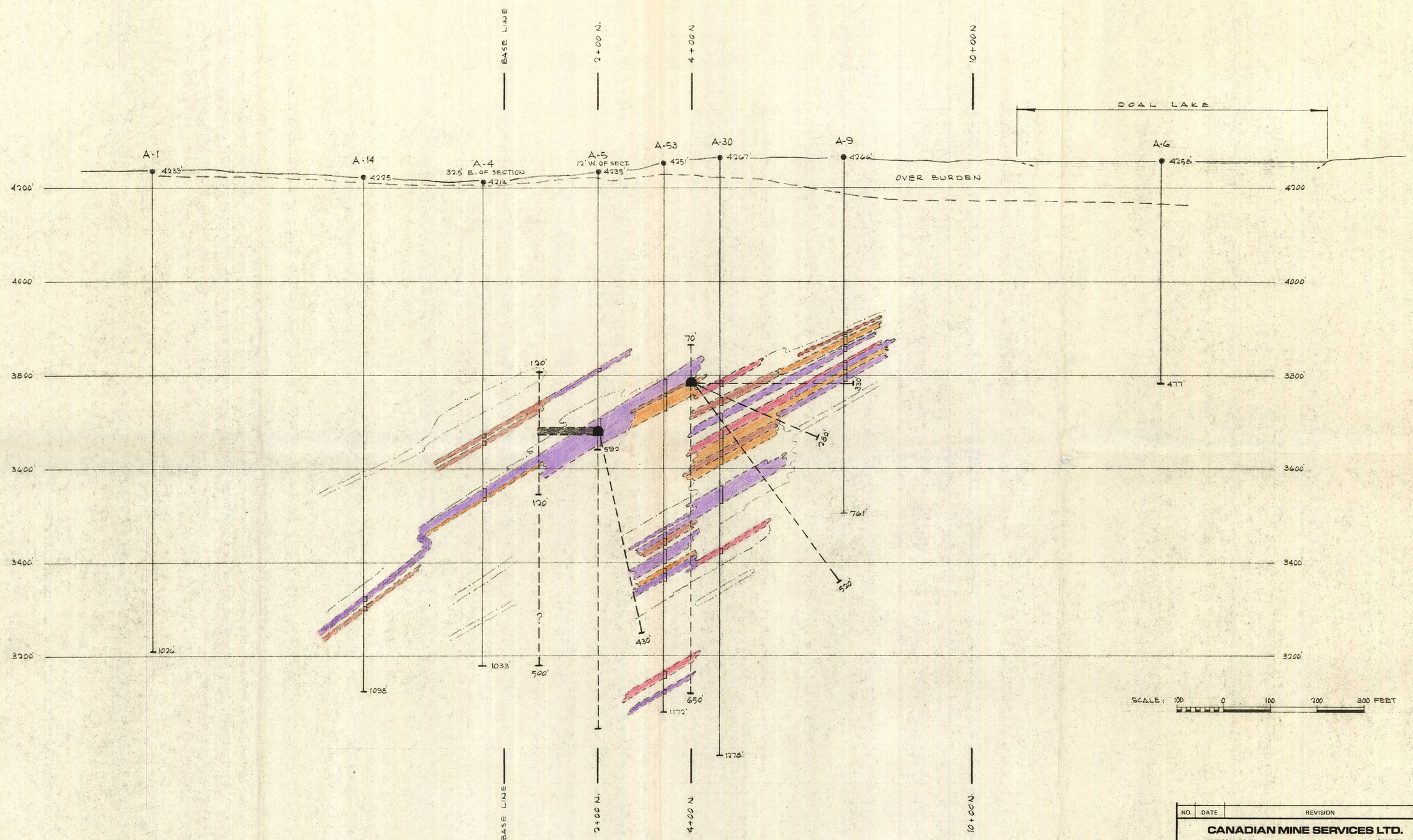

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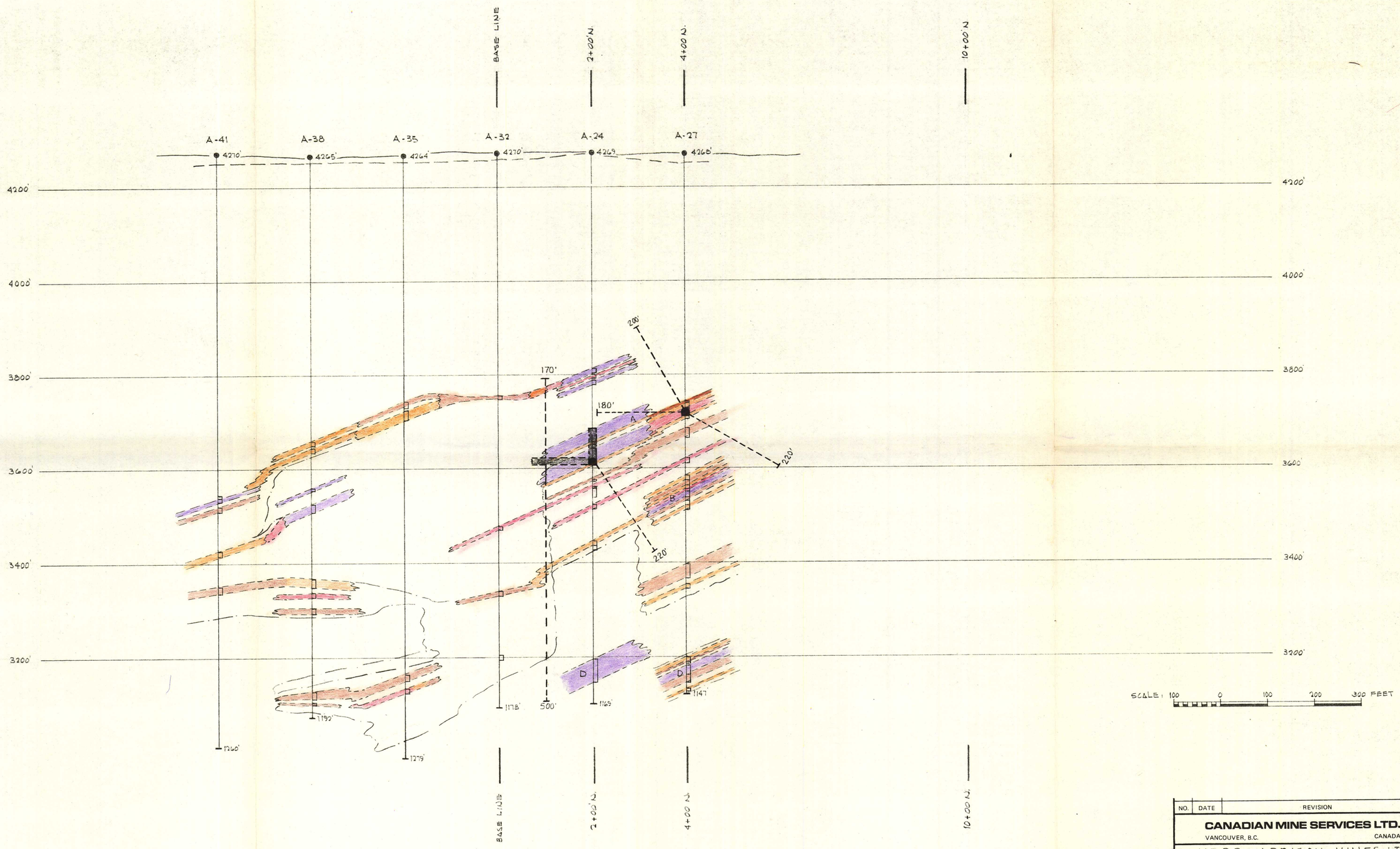

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