



Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT TO
THE MAYOR AND COUNCIL
TOWN OF COBALT
ON

PRELIMINARY ENGINEERING ASSESSMENT
AND SUGGESTED REMEDIAL MEASURES
"P-S" STOPE INTERSECTION CROWN PILLAR,
HWY #11B
COBALT, ONTARIO
WO: 2002-11005

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August 1987

871-1289

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1. INTRODUCTION

Golder Associates has been retained by the Ministry of Northern Development and Mines and the Town of Cobalt to investigate the June 22, 1987 collapse of a section of the overburden beneath Highway 11B (Plates 1 and 2).

The terms of reference as agreed at a meeting held with the Town of Cobalt and Ministry officials on July 13, 1987 are:

- o to investigate and develop remedial plans for rebuilding the road in the vicinity of the collapsed section of the highway right-of-way, and
- o to evaluate subsurface conditions along the remainder of the Highway 11B corridor through the Town.

This report forms the first of a series of reports on the Highway 11B connecting link. It presents the interim results of Phase I - Investigation in the area of the recent "cave-in" on Highway 11B about 100 m west of Galena Street (Figure 1). Subsequent reports will be presented on the Phase II investigations - from the Townsite Circle to Nickle Street, and on the Phase III investigation - the remainder of the highway northwards through the Town.

All available mining data sources have been utilized together with geophysical methods - radar, seismic and magnetics - to aid in establishing locations for air-track, diamond drill and/or auger hole boring aimed at defining overburden and bedrock conditions in and around the critical crown pillar area of the stope intersections. The results collected and assessed up to August 10, 1987 are summarized in this report.

The compilation drawings presented in this report are considered to provide enough information for the development of alternative remedial schemes. The data shown on these drawings has been presented to the Ministry of Transportation and Communications (MTC) in order that the Ministry's early input to the choice of acceptable remedies could be obtained, thus expediting repair of the Highway.

2. BACKGROUND INFORMATION

A brief summary of the mining history for workings beneath the Town of Cobalt is given in Golder Associates report 851-1172* while the layout of the Town with respect to the mining properties is shown on Figure 2 of this report.

The broad scale geology of the Cobalt camp, comprising narrow vein mineralization and virtually barren host rocks contrasts markedly with the relatively simple configuration of relatively wide, disseminated mineralization seen in many other mining camps. The complex geometry of the excavations - drifts and cross cuts, stopes and multiple anastomosing veins also differs from the essentially tabular orebody shapes seen elsewhere in the gold and base metal mines of Northern Ontario and Quebec.

In the area in which the highway collapsed numerous very high grade silver veins occur which were heavily exploited by the mining companies during the early phase of mining (1903 to 1920). These same veins were further exploited by less exemplary mining methods during the period 1920 to 1939 when the mines were operated by independent lessors.*

An illustration of the traditional method of stoping used for extracting the silver in Cobalt is presented in Figure 3. Mining was progressed upwards from workings within the rock mass up until stoping was stopped when a minimum crown pillar thickness had been reached. Several examples of relatively catastrophic crown pillar collapses

* Refer to pages 10 to 18 of Golder Associates' Report #851-1172 entitled "Evaluation of bedrock conditions along proposed Watermain Alignments, Town of Cobalt, Ontario" dated October, 1985.

occurred during the period of the lessors where mining had been carried right up to the bedrock/overburden interface. Some of these events are described in the 1985 Golder Associates Report, the most notable occurring under the railway and into the bed of Cobalt Lake.

Figure 4 illustrates the spaghetti-like complexity of the drifts and stopes which are known to exist in the area of the "cave-in" and the adjacent sections of the Highway 11B corridor. The records shown on this drawing were copied from old level plans compiled by the old mining companies and it is understood that they are correct and up-to-date only to about 1920. No detailed records of subsequent stoping or development carried out by the lessors or others are documented. Only a few notes and sketches exist showing information on the subsequent underground workings. They mainly consist of pencil annotated prints, dated 1946, which were compiled as an aid to the then active mining company when attempts were made to rehabilitate some of the old mines beneath the Town.

The information shown by these annotations has been plotted onto Figure 4 together with the areas of known stoping (shown in stipple). Some indication of the geometry of the major stopes (as mined by the old Mining Companies) is given on Figures 5 and 6. These two drawings have been prepared from reductions of the 1916 longitudinal mine sections, updated to show all information including the pencil annotations existing on the original prints.

Details of precise crown pillar geometry are not given on these or on other stope sections for the workings in this area of the Town. In several locations, it has been found that no rock cap exists over such stopes ("hole-throughs").

The locations of these "hole-throughs" where known in the area around the present overburden "cave-in" are shown on Figure 4. Figure 7 shows details of one of these locations where previous stope capping was undertaken by Angico Eagle Mines Ltd. after collapse of part of the shoulder of Highway 11B in about 1970.

3. INVESTIGATION RESULTS

Within three days of the collapse of the overburden and pavement of the Highway on June 22, a programme of drilling and geophysical investigation was initiated, working outwards from the "cave-in". To date (August 10th) investigations have been completed of most of the area within an approximately 100 foot (30 m) radius of the "cave-in".

The investigations have included:

- o 167 air-track holes (5,848 ft)
- o 10 diamond drillholes (630 ft)
- o 14 overburden holes (382 ft)
- o 114 radar traverse lines (22,440 ft)
- o 8 seismic spreads (512 ft) and
- o 2500 magnetic grid point measurements

Detailed records for all of this investigation work will be presented in a subsequent factual report. In this document only summary drawings and cross-sections are presented.

In Figure 8, subsurface holes, put down in the vicinity of the "cave-in" area, are shown as:

- o open circles, where a bedrock thickness of greater than 20 ft. was encountered beneath the overburden
- o squares, where "break-through" to a stope occurred but where a thin rock cap still exists (typically less than 10 ft. thick), and

- o triangles, where an open void or loosely back-filled stope was encountered with no rock crown pillar and only overburden or timbers bridging over the stope crown.

Figures 9 to 12 present cross-sections drawn through the various boreholes to illustrate the geometry of the stope crowns and the overburden/bedrock conditions in the immediate vicinity of the "cave-in".

On Figure 8 the areas of known "hole-throughs" (i.e. no rock present in the crown pillar) and of thin crown pillar conditions, have been shaded with dark grey and light grey screens, respectively; the latter has also been coloured in orange on the drawing. The extent of the rock cap around the existing "cave-ins", as shown on Figure 8 is based on interpretation of crown pillar geometry derived from the old 1916 stope sections for the S and P veins (Figures 5 and 6), on data from the ongoing drilling and on information provided by mapping carried out by surveyors from Agnico Eagle Mines Ltd. The condition of the rock mass in the vicinity of the P-S stope intersection as revealed by radar traversing, is illustrated on Figure 13 which indicates that the remaining crown pillar over the orange shaded area on Figure 8 is only of the order of 3 ft. to 5 ft. (1 m to 1.5 m) thick on the sides of the open holes (see plates 1 and 2).

The plan (Figure 8) and the sections (Figures 9 to 12 inclusive) are up-to-date as of August 10, 1987; drilling is still on-going following directions identified either by the geophysics or by review of the mine records. Most of the potential hazard locations identified to August 10, 1987 had already been investigated by that date, by means of airtrack drilling, by diamond coring and/or by overburden augering and bedrock coring; however several areas were still outstanding as indicated in Figure 8.

Unfortunately, the utilization of geophysical techniques to target drilling is not without complications. Many of the anomalies that show up on the radar, for example, are difficult to interpret because of disturbed overburden ground conditions and overhead power lines; in many cases the anomalies do not represent underground workings; rather they reflect variations in the overburden or reflect random fill containing obstructions. In consequence, only by careful validation using drilling techniques is it possible to establish the precise cause for each of the geophysical anomalies. Figure 14, for instance, shows the locations of all significant radar anomalies and major zones of reflectivity, as currently being used for positioning the drilling. It should be noted that not all of the anomalies shown on this drawing are associated with underground workings. However, some clearly indicate subsurface workings, as for example that shown on Figure 15.

This drawing shows the type of response typical of that now known to reflect an uncharted stope. This stope also occurs under the highway and slightly to the northeast of the area of the original June 22nd "cave-in" (see Figure 8). It should be noted that it does not appear on any of the old mining records (Figure 4), and was therefore probably developed by the lessors in the 1930's. As indicated on Figures 11 and 12, (sections II, JJ, KK and LL) no rock crown pillar was found over much of the central section of the stope. Some timber was however found at the bedrock/overburden interface suggesting that mining had probably been taken right up to a frozen overburden interface and that over the intervening years only the timber supported the overburden.

4. CONCEPTS FOR REMEDIAL MEASURES

The type of relatively unsheared, narrow vein mineralization set within competent barren rock walls, that characterize the Cobalt mining area, and the results of the recent rock core drilling carried out as part of this investigation, indicate that, in general, the rock forming the crown pillars is competent. As far as can be determined, overburden "cave-ins" subsequent to mining in the area have resulted from decay of timbers used to cap stopes when "hole-throughs" through the rock occurred during stoping.

Various concepts can be developed for remedial measures for the Phase I area; each assuming some degree of competence of the rock in the crown pillar area. Appropriate alternative measures have been discussed with the Ministry of Transportation and Communication (MTC); each of these involve different degrees of possible risk while yet safeguarding against collapse of the road.

The simplest form of treatment is to replace the timbers which have been used in the past with reinforced concrete beams. This assumes that all the rock remaining in the crown pillars is competent to support the overburden loads and the highway surcharge. Available evidence suggests that the rock is competent; however, there would be some risk of failure of the rock supporting the concrete beams where the stope dimensions are greater than the voids in the crown pillar.

Risk of rock failure can be minimized by sounding the crown pillar prior to construction, and the possibility of collapse of the highway can be prevented by providing a secondary line of support in the form of geogrid reinforcement incorporated within the backfill above the concrete beams. In the event of rock failure, the geogrid

would span the opening, preventing a "cave-in", although some settlement of the road would be anticipated.

Additional investigation of the rock would be carried out during preparation for construction. The procedure would be:

- o Expose bedrock over suspect area
- o Map the thickness and quality of the bedrock using radar
- o Sound bedrock by dropping a steel ball on a regular pattern over the area of the crown pillar
- o Repeat radar mapping and visual examination for defects

This simple minimum span solution has the advantage that the prevailing drainage would not be altered.

The alternative to the minimum span solution is to conservatively select the minimum thickness of crown pillar for which collapse would be improbable and to provide a structure to span over the remainder of the crown pillar. Based on the geometry of the stopes and crown pillars investigated so far, this thickness has been established as 10 ft (3 m) and the area involved is coloured orange on Figure 8.

At the meeting with the MTC on August 11, 1987, the Ministry indicated that safety was paramount and, for the remedial measures in Phase I, the option of spanning all sections of crown pillar less than 10 ft (3 m) thick was preferred. However, it was agreed that the radar mapping and sounding of the bedrock as described above would be carried out prior to capping the stopes so that further confirmation of the integrity of the crown pillar could be obtained with a view to optimizing design spans for any repairs in other parts of the town.

5.0 STRUCTURAL CAPPING

Two alternative schemes have been prepared jointly by Golder Associates and Morrison Hershfield Ltd. for structurally capping all stopes in the phase I area where the crown pillar is less than 10 ft. (3 m) thick. The first scheme (Approach "A") involves use of a mass concrete cemented fill, while the second scheme (Approach "B") incorporates a conventional reinforced concrete slab. Final selection of the approach to be used at any given location will depend on the depth of overburden present as well as costs.

Approach "A" (Figure 16) would be applicable to any location where the depth of overburden is in excess of 1/4 of the span plus a given depth for frost protection. Since protection against cyclic freeze-thaw action only is required, adequate granular cover for this degree of frost protection would be 1 m.

The primary load carrying mechanism for this approach is arch action within the mass concrete. To develop arching action, restraint against lateral thrust must be insured. This would be provided by a continuous thrust block constructed around the perimeter of the area to be spanned. Standard 30 MPa concrete and epoxy coated dowels would be used to construct the thrust block. The 25 mm diameter dowels would be grouted into 50 mm diameter holes drilled to an appropriate depth into competent rock on the shoulders away from the stope crown pillar. The remainder of the resistance to lateral thrust would be provided by rock-concrete interface friction and by interlock.

The concrete mass in which arch action would develop would be placed as a low strength cemented fill with a minimum compressive strength of 7 MPa. The use of pit run materials as aggregate for this mass concrete

approach is currently being investigated. Water-cement ratios would be kept as low as practical to minimize shrinkage cracking. Stay-in-place formwork would span all openings in the bedrock, supporting the mass concrete and compaction equipment until initial set has taken place.

As shown on Figure 16, provisions would be incorporated during the cemented fill placement to allow surface runoff to drain through the concreted mass into the stope below. In this manner, it is anticipated that little disruption will be caused to existing subterranean drainage patterns.

Where insufficient overburden depth exists to allow Approach "A" to be utilized, it is considered that use of a reinforced concrete slab would be appropriate. The typical slab construction approach developed by Morrison Hershfield Limited is shown as Approach "B" in Figure 17.

The reinforced slab would be constructed using 30 MPa concrete and epoxy coated reinforcing steel. Aggregate for the concrete would be high quality material from Ministry of Transportation and Communication approved sources. As shown on Figure 17, nominal temperature and shrinkage reinforcement is proposed normal to the principal reinforcement to control cracking. Furthermore because of the required long term performance required from the structure, concrete cover for the reinforcing steel would be increased above normal amounts to provide additional protection and durability. Waterproofing would be applied to the top and sides of the slab to provide additional protection; particularly against any salt-laden runoff from the highway. Drainage provisions would also be incorporated as for Approach "A".


It is envisaged that such a slab approach would be most appropriate for shallow overburden depths. This is clearly illustrated on Table 1 by the dramatic effect on slab thickness and steel requirements of increased overburden depths. The table, which follows the text of this report, gives proposed slab thickness (t) and reinforcing steel requirements for spans ranging from 10 ft. (3 m) to 30 ft. (10 m) and for three different ranges of the depth of overburden (h + t). For the typical width of most of the old stopes away from intersections (i.e. 10 ft. to 15 ft. [3 m to 5 m]) appropriate slab thicknesses would be of the order of 3 ft. (1 m).

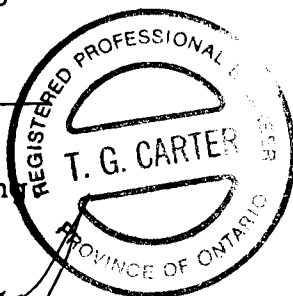
6. CONCLUSIONS


Based on the data being currently collected from the field investigations, (summary information up to August 10, 1987 being presented on the drawings included in this report) it is our opinion that viable engineering solutions can be designed and constructed to cap the existing "hole-through" locations and to cover areas of thin and/or otherwise uncertain crown pillar stability. We consider that the engineering solutions presented in this report for the immediate area of the "cave-in" are adequate to form the basis for formulating a construction tender for remediation of the highway through the Phase I area.

In this regard, we trust that the contents of this report are sufficient for your immediate purposes. With your approval, Contract Documents are currently being prepared to enable expeditious repair of the highway.

GOLDER ASSOCIATES


T.G. Carter, P.Eng.




J.R. Busbridge, P.Eng.

TGC/JRB/mmh

TYPICAL SLAB THICKNESS AND REINFORCING REQUIREMENTS

TABLE 1

DEPTH OF OVERBURDEN <1 metre			
SPAN (L) (m)	SLAB THICKNESS (t) (mm)	REINFORCEMENT	
		TOP	BOTTOM
3	600	20m @300	25m @300
4	700	20m @200	25m @250
5	800	25m @300	25m @225
6	800	25m @300	25m @175
7	800	25m @300	35m @275
8	800	25m @300	35m @225
9	900	25m @275	35m @220
10	1000	25m @250	35m @210

DEPTH OF OVERBURDEN $1.0 \text{ m} \leq (h + t) \leq 2.0$			
SPAN (L) (m)	SLAB THICKNESS (t) (mm)	REINFORCEMENT	
		TOP	BOTTOM
3	600	20m @300	25m @280
4	800	25m @300	25m @225
5	1000	25m @250	25m @175
6	1000	25m @250	35m @250
7	1000	25m @250	35m @190
8	1000	25m @250	35m @150
9	1000	25m @250	35m @100
10	1000	25m @250	45m @150

DEPTH OF OVERBURDEN $2.0 \text{ m} \leq (h + t) \leq 3.0$			
SPAN (L) (m)	SLAB THICKNESS (t) (mm)	REINFORCEMENT	
		TOP	BOTTOM
3	600	20m @300	25m @250
4	800	25m @300	25m @225
5	1200	25m @200	25m @200
6	1200	25m @200	35m @300
7	1200	25m @200	35m @240
8	1400	25m @175	35m @220
9	1600	30m @215	35m @150
10	1600	30m @215	35m @150

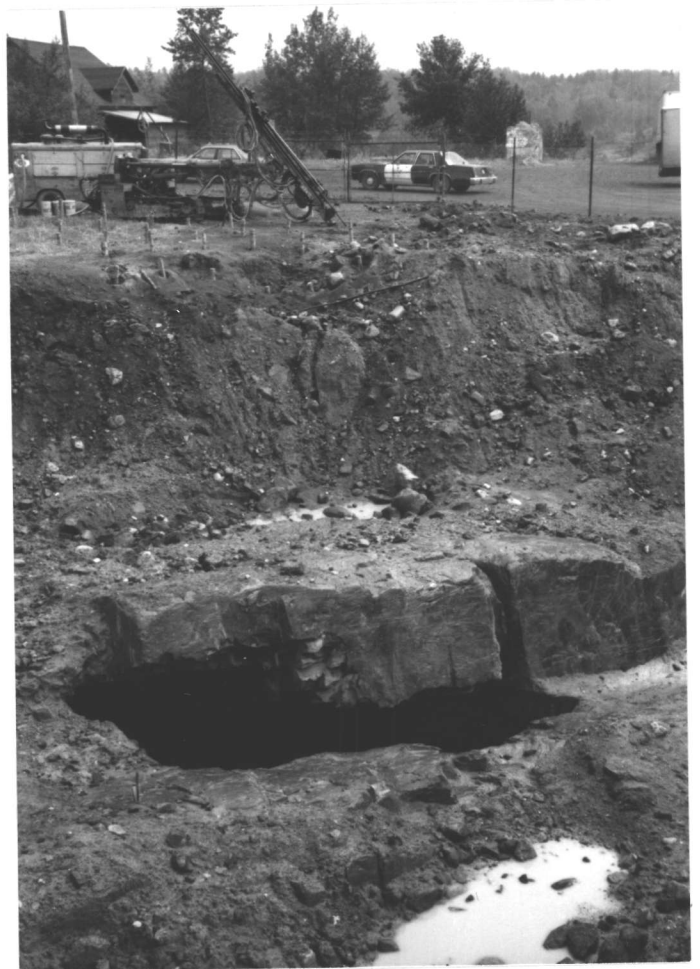
PLATE I

PHOTOGRAPHS OF EXISTING EXCAVATED AREA
SHOWING CROWN PILLAR CONDITIONS

(Details of overburden geometry and rock cap configuration)



View south-west looking along Highway 11B pavement shoulder - note "hole-through" position on S-vein stope lines up with edge of roadway.



View east showing 3-5 ft thick rock cap over S-Stope Crown and air-track holes where stope continues off highway right of way.

PLATE 2

PHOTOGRAPHS OF EXISTING EXCAVATED AREA
SHOWING CROWN PILLAR CONDITIONS

(Details of "hole-through" shapes and of crown pillar conditions)



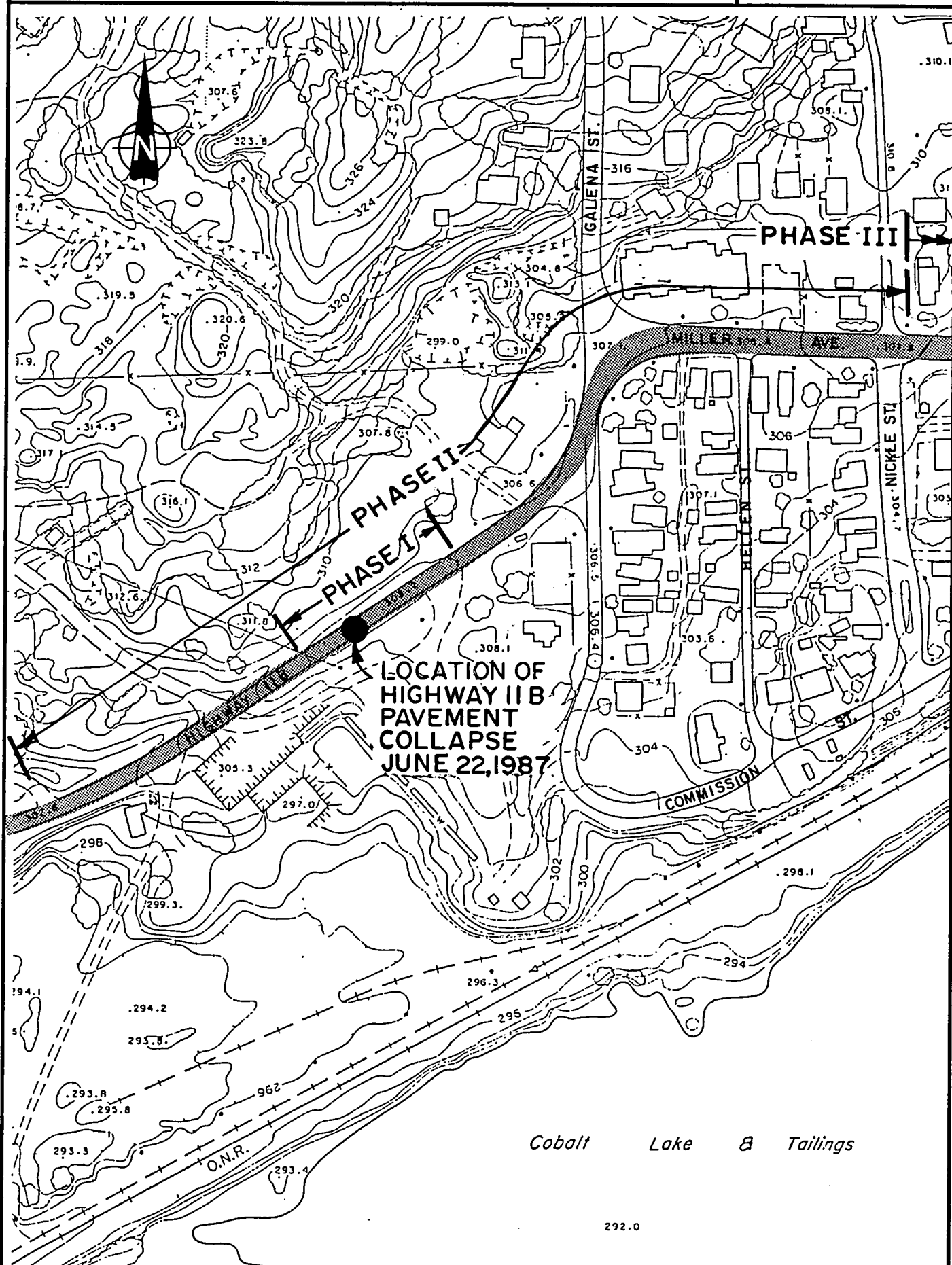
View north-east showing 1 ft.
thick rock cap on S-vein in
intersection area.



View south-east along strike of
P-vein stope showing both openings
into stope intersection.

SITE LOCATION PLAN (SOUTH WEST CORNER OF TOWN OF COBALT)

FIGURE 1



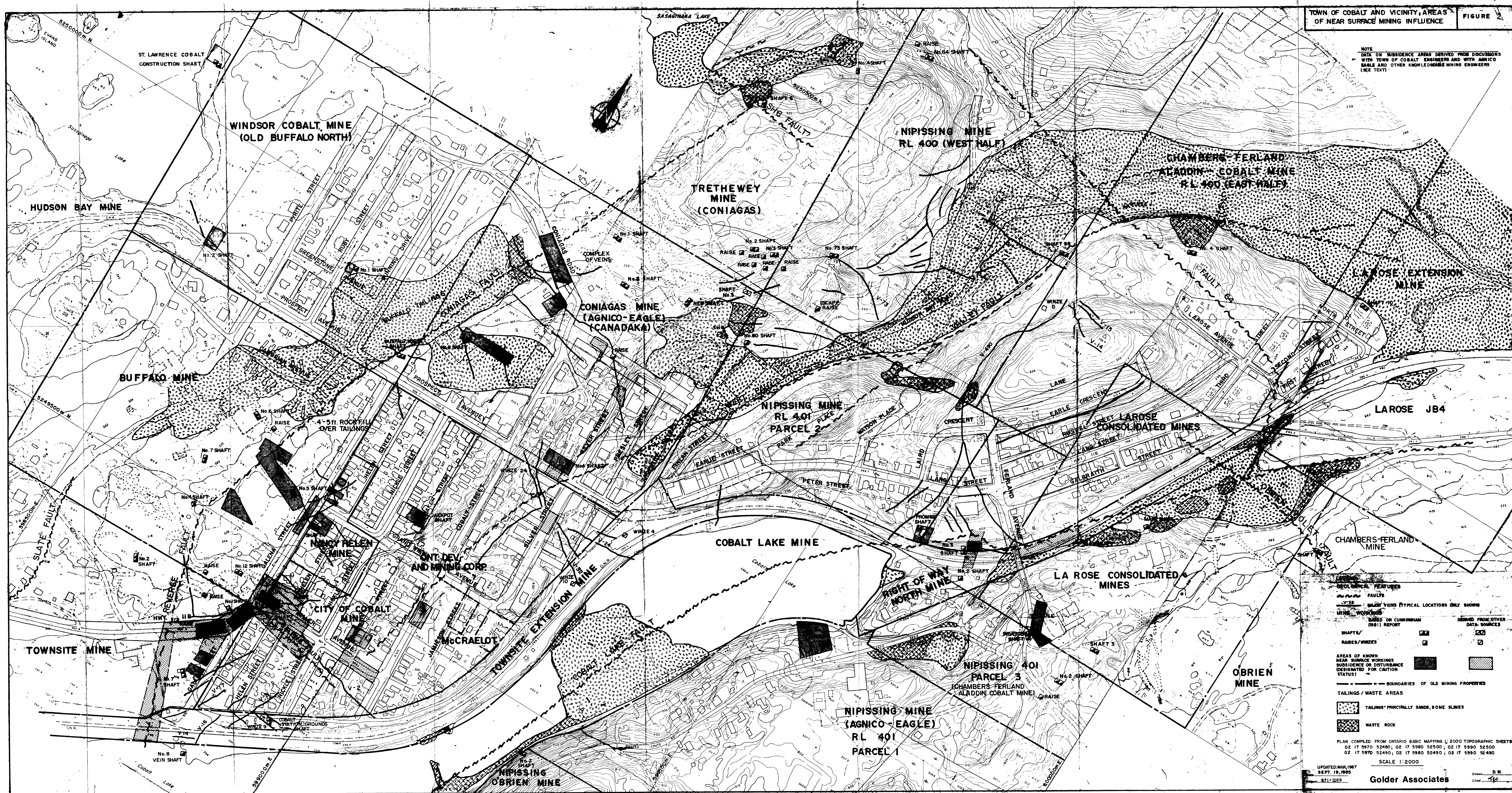
Date AUG. 13, 1987
Project 871-1289

SCALE 1:2,000

Golder Associates

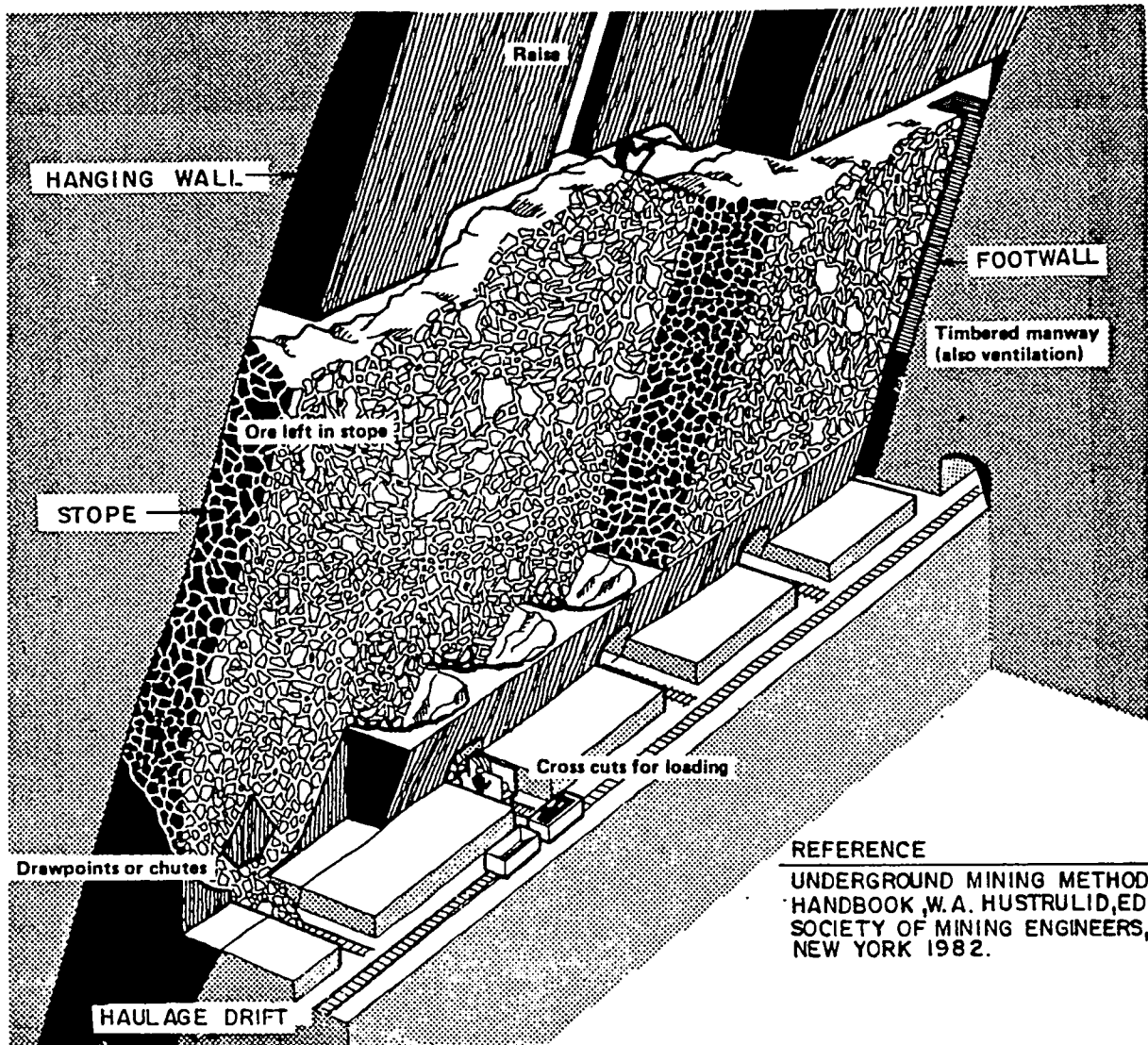
Drawn MHW
Chkd TGC

NOTE
DATA ON SUBSIDENCE AREAS DERIVED FROM DISCUSSIONS
WITH TOWN OF COBALT ENGINEERS AND WITH AGNICO
EAGLE AND OTHER KNOWLEDGEABLE MINING ENGINEERS
(SEE TEXT)



PLAN COMPILED FROM ONTARIO BASIC MAPPING 1:2000 TOPOGRAPHIC SHEETS
02 17 5970 52480; 02 17 5980 52500; 02 17 5990 52500
02 17 5970 52490; 02 17 5980 52490; 02 17 5990 52490

UPDATED: MAR, 1987
 SEPT. 19, 1985
 Project: 871-1289
 Goldier Associates



REFERENCE
UNDERGROUND MINING METHODS
HANDBOOK W.A. HUSTRULID, EDITOR
SOCIETY OF MINING ENGINEERS,
NEW YORK 1982.

SUMMARY OF MINING SEQUENCE

1. Haulage drift excavated along bottom of proposed stope. Drawpoints and cones developed from cross-cut to undercut.
2. Ore excavated in horizontal slices starting from base and working up.
3. Raise for ventilation and access usually driven through to surface or overlying drifts.

NOTES

- Ore body must have - steep dip that exceeds angle of repose
 - hanging wall and footwall that are stable
 - relatively regular boundaries and relatively competent structure sufficient to keep crown (back) of stope in place for subsequent drilling
- Ore production is frequently aided by providing additional cross-cuts to higher levels in the stope.

Date AUG. 14, 1987
Project 871-1289

Golder Associates

Drawn D.M.
Chkd. TGC

COMPOSITE PLAN SHOWING CROWN PILLAR
BREAKTHROUGH LOCATIONS AND OTHER NEAR
SURFACE WORKINGS IN VICINITY OF
Hwy 11B INTERSECTION WEST OF MILLER AVE.

FIGURE 4

LEGEND

UNDERGROUND WORKINGS

EL. 820± (250m) EL. 918' (280m.) TOWNSITE EL. 889' (271m.) BUFFALO EL. 874' (266m.) CITY ELEV. 950± (290m)

2 COMPARTMENT SHAFTS/WINZES

RAISES

DRIFT INACCESSIBLE BEYOND X-LINES
(1946 INFORMATION)

STOPPED OUT VEINS

SILVER VEINS IN PLACE

FAULTS

MINING PROPERTY BOUNDARIES

AREAS WITH NO ROCK CAP ABOVE MINED OPENINGS

NOTES

1. GRID SHOWN IS 100 FT. GRID FOR MINING LAYOUT PLANS.

REFERENCE

- 1" to 40' scale composite plan and 1st, 2nd, and 3rd level plans Buffalo property dated 1916, with some later pencil annotations (records from Agnico Eagle Mines Ltd.)
- 1" to 40' scale composite plans for 1st and 2nd levels for Townsite, City and Buffalo Mine showing summary geology (from Agnico Eagle Mines Ltd.)
- 1" to 40' scale 1st and 2nd level plans of Townsite property, pencil annotated prints marked "H.A. Kenty June 3, 1946, provided by Agnico Eagle Mines Ltd.
- 1" to 40' scale and 1" to 20" scale tracings for 65ft, 1st and 2nd level for City of Cobalt property annotated in places by H.A. Kenty (from Agnico Eagle Mines Ltd.)
- Sundry untitled stope sections and level plans for the Townsite, City and Buffalo workings.

SCALE 1"=500'

Date: JULY 16, 1987
Project: 871-1289

Golder Associates

Drawn: MHW
Chkd: 152

FIGURE 5

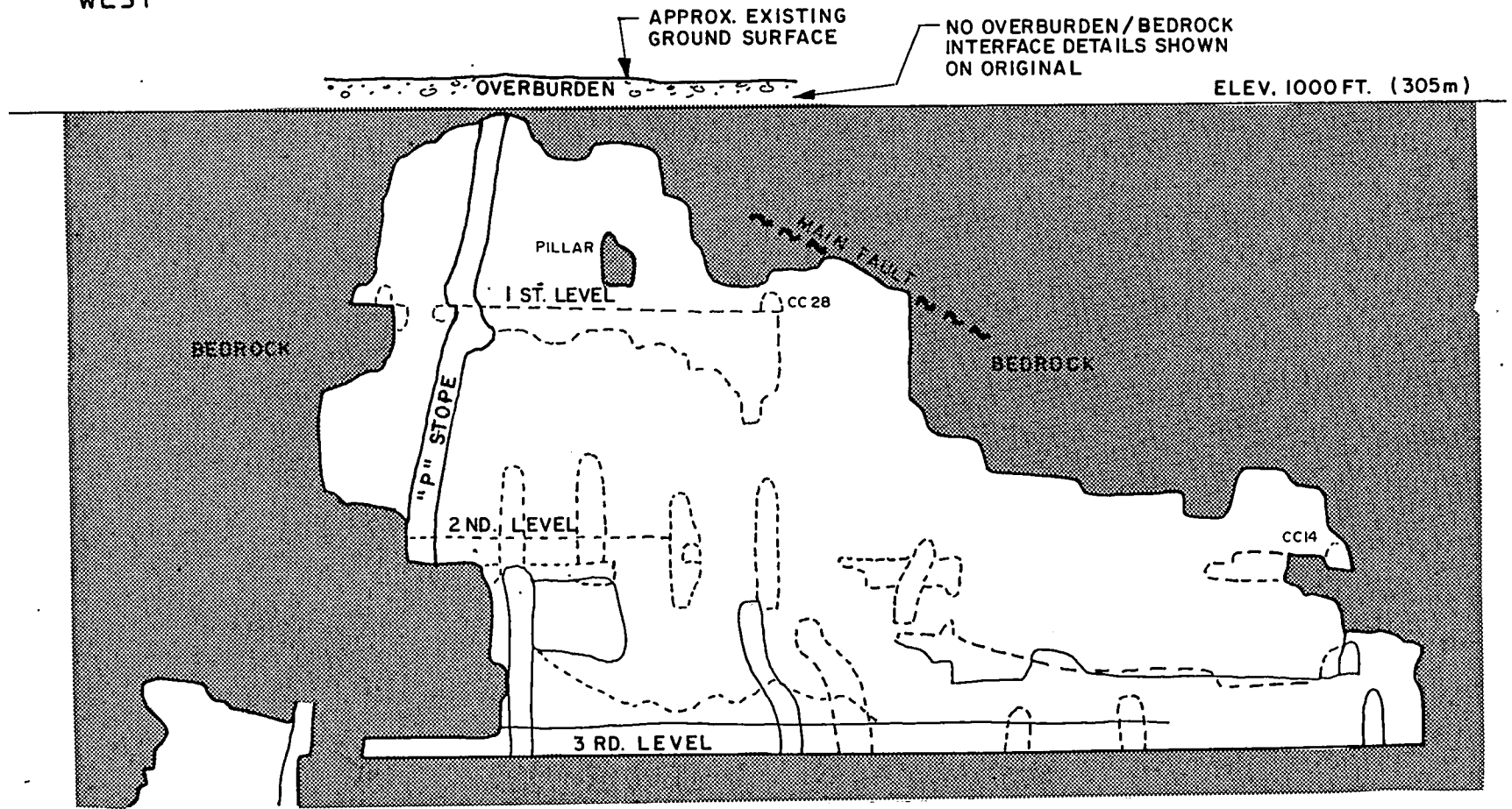
Date AUG. 14, 1987
Project 871-1289

Golder Associates

Drawn MHW
Chkd TLR

WEST

EAST



ELEV. 1000 FT. (305m)

REFERENCE: UNDATED, LONGITUDINAL SECTION OF S-VIEN STOPE, TOWNSITE MINE, PROPERTY OF MINING CORPORATION OF CANADA; ORIGINAL LINEN DATED 1916 WITH LATER PENCILLED NOTES. DRAWING PROVIDED BY AGNICO EAGLE MINES LTD.

SCALE 1:500

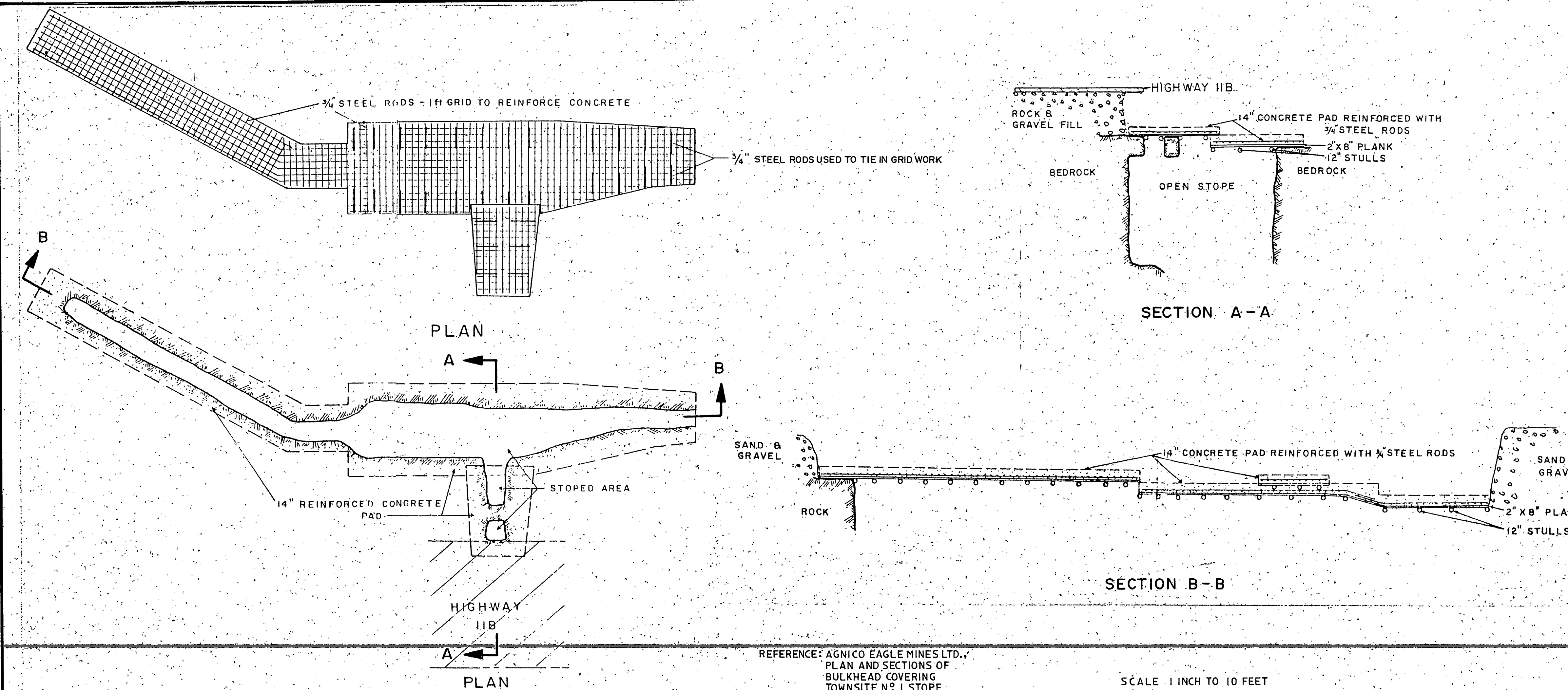
LEGEND

CC 28 - CROSS CUT No. 28

NOTE: FOR LOCATION OF SECTION SEE FIGURE 4.

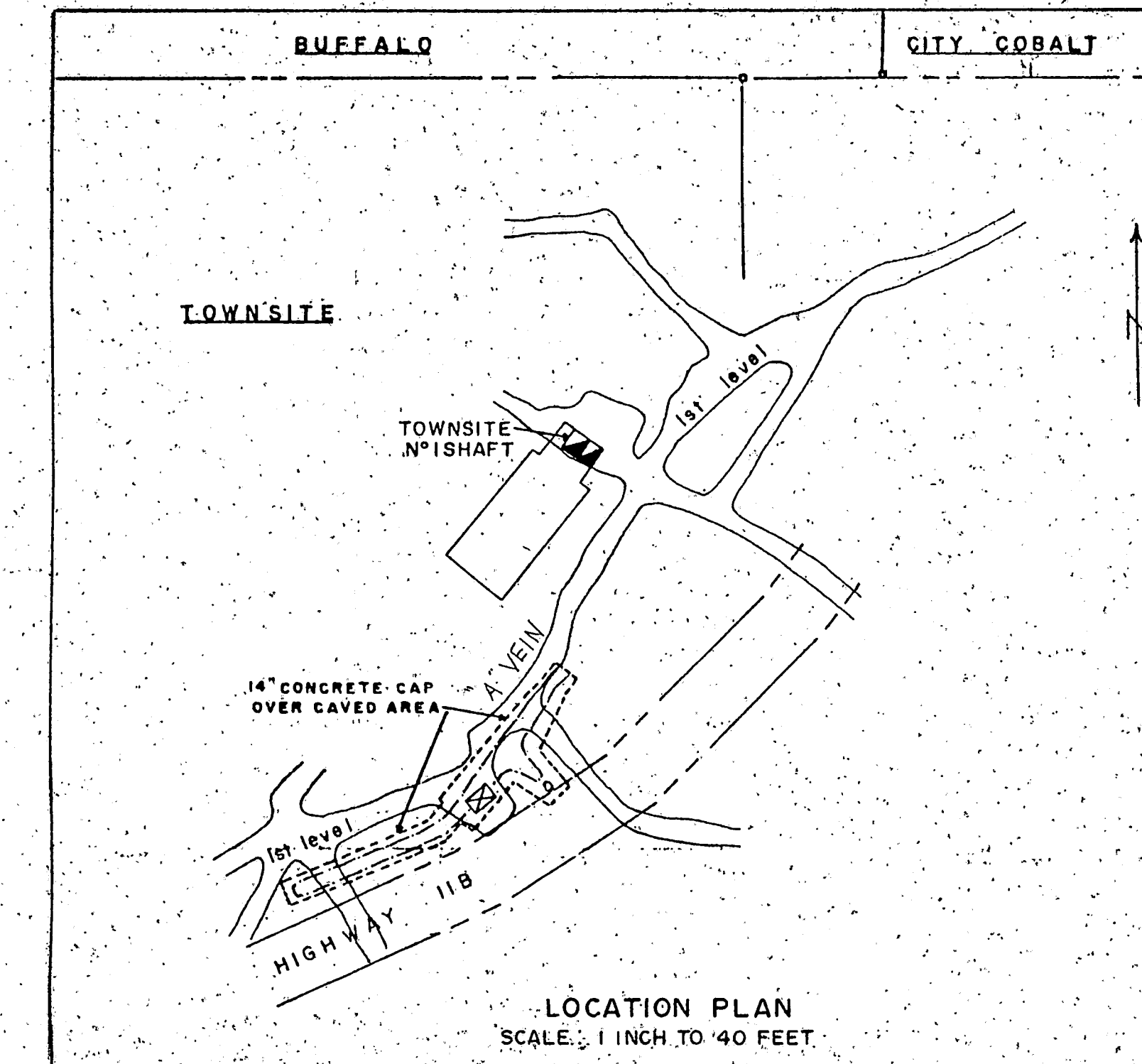
SECTION Y-Y THROUGH "S" STOPE LOOKING NORTH

FIGURE 6



REFERENCE: AGNICO EAGLE MINES LTD.,
PLAN AND SECTIONS OF
BULKHEAD COVERING
TOWNSITE No. 1 STOPE

SCALE 1 INCH TO 10 FEET



Date: AUG. 14, 1987
Project: 871-1289

Golder Associates

Drawn: D.M. MHW
Chkd: [Signature]

LEGEND

AREAS WITH NO ROCK CAP ABOVE MINED OPENINGS

AREAS WITH LESS THAN 10 FT. OF ROCK CAP COVER

DRILLED LOCATIONS

NO BEDROCK ENCOUNTERED ABOVE MINED OPENINGS

OVERBURDEN THICKNESS

LESS THAN 10 FT. OF BEDROCK ABOVE MINED OPENINGS

GREATER THAN 20 FT. OF BEDROCK ENCOUNTERED

ANGLED DIAMOND DRILLHOLES

FAULTS

UNDERGROUND WORKINGS - DRIFTS, CROSS-CUTS, STOPES

ELEV. 950 FT. (290m) ? UPPER SUB-LEVEL

ELEV. 918 FT. (280m) TOWNSITE #1 ST. LEVEL

ELEV. 820 FT. (250m) TOWNSITE #2 ND. LEVEL

STOPPED OUT VEINS (BASED ON H. KENTY 1946 INFORMATION)

RAISES

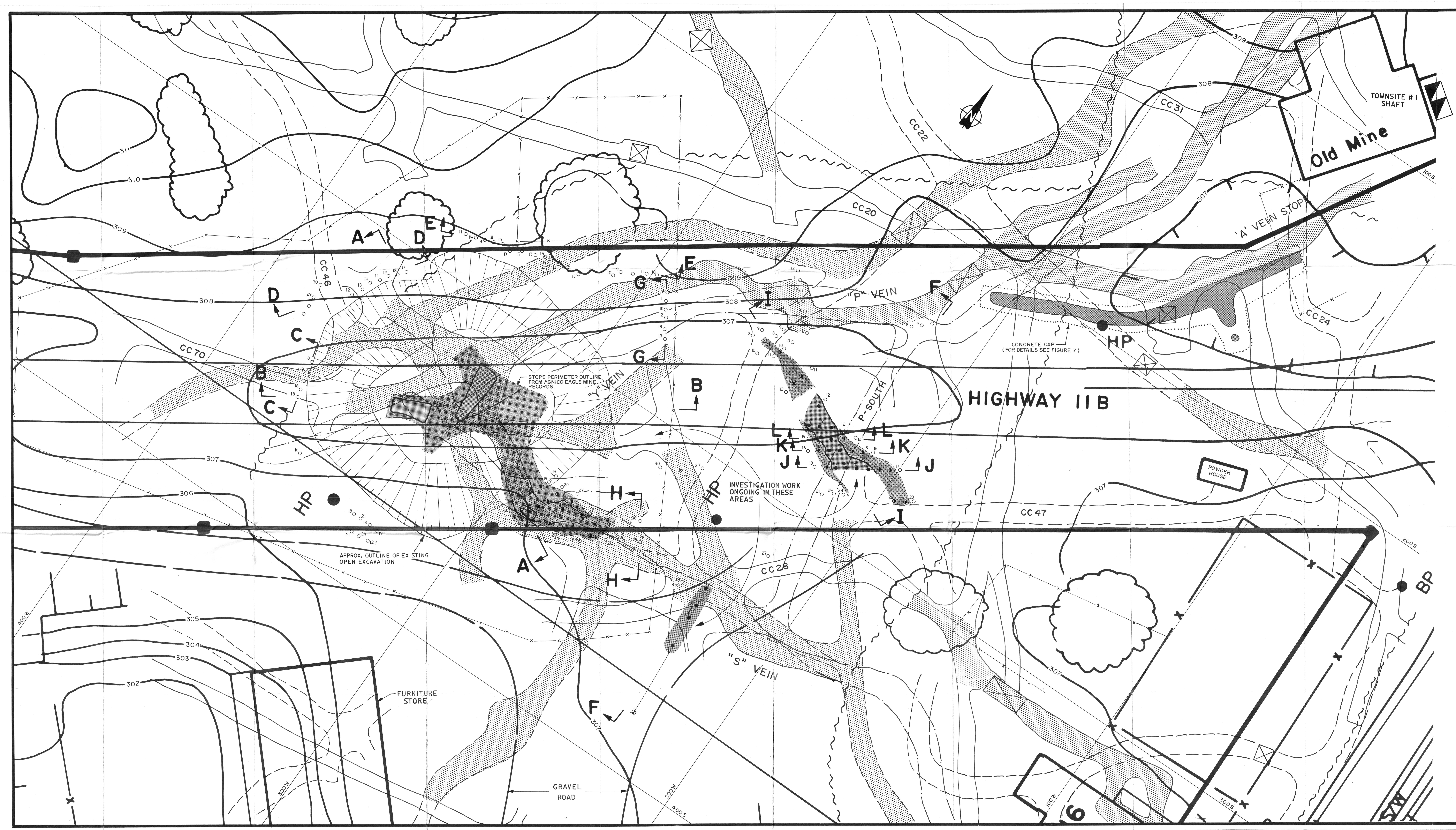
2 COMPARTMENT SHAFT

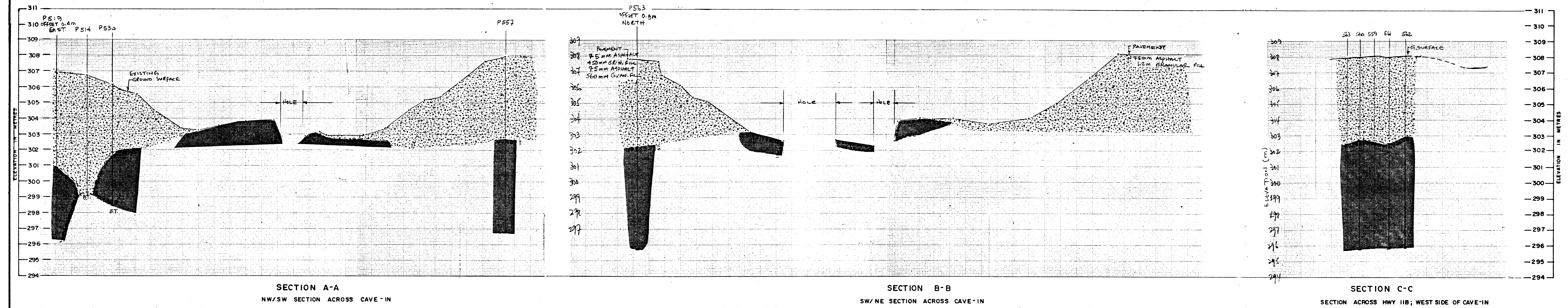
CHAIN LINK FENCING

- REFERENCES**
- 1" TO 40" SCALE COMPOSITE PLANS FOR 1ST AND 2ND LEVELS FOR TOWNSITE MINE SHOWING SUMMARY GEOLOGY (FROM AGNICO EAGLE MINES LTD.).
 - 1" TO 40" SCALE 1ST AND 2ND LEVEL PLANS OF TOWNSITE PROPERTY, PENCIL ANNOTATED PRINTS MARKED "H.A. KENTY JUNE 3, 1946, PROVIDED BY AGNICO EAGLE MINES LTD."

- NOTES**
- GRID SHOWN IS 100 FT. GRID FOR TOWNSITE PROPERTY OF MINING CORPORATION OF CANADA (NOW AGNICO EAGLE PROPERTY).
 - BASE DRAWING ENLARGED FROM 1:500 AERIAL PHOTO PLANS OF THE TOWN OF COBALT (SEE FIGURES 3 & 4).

SCALE 1" = 100'





LEGEND

P 514 AIR TRACK "PROBE" HOLE
BH.87-5 AUGERED AND CORED "SOILS" HOLE
DDH 87-2 CORED DIAMOND DRILL HOLE

ROCK QUALITY DESIGNATION PERCENT

BEDROCK INTERFACE

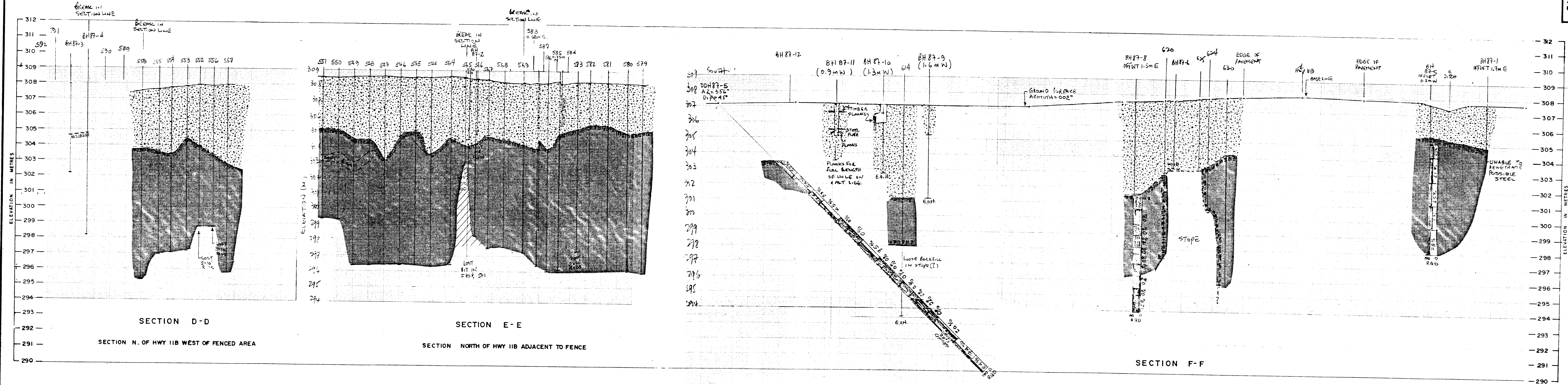
VOIDS, OPEN STOPS; IN PLACES WITH SOME BACKFILL

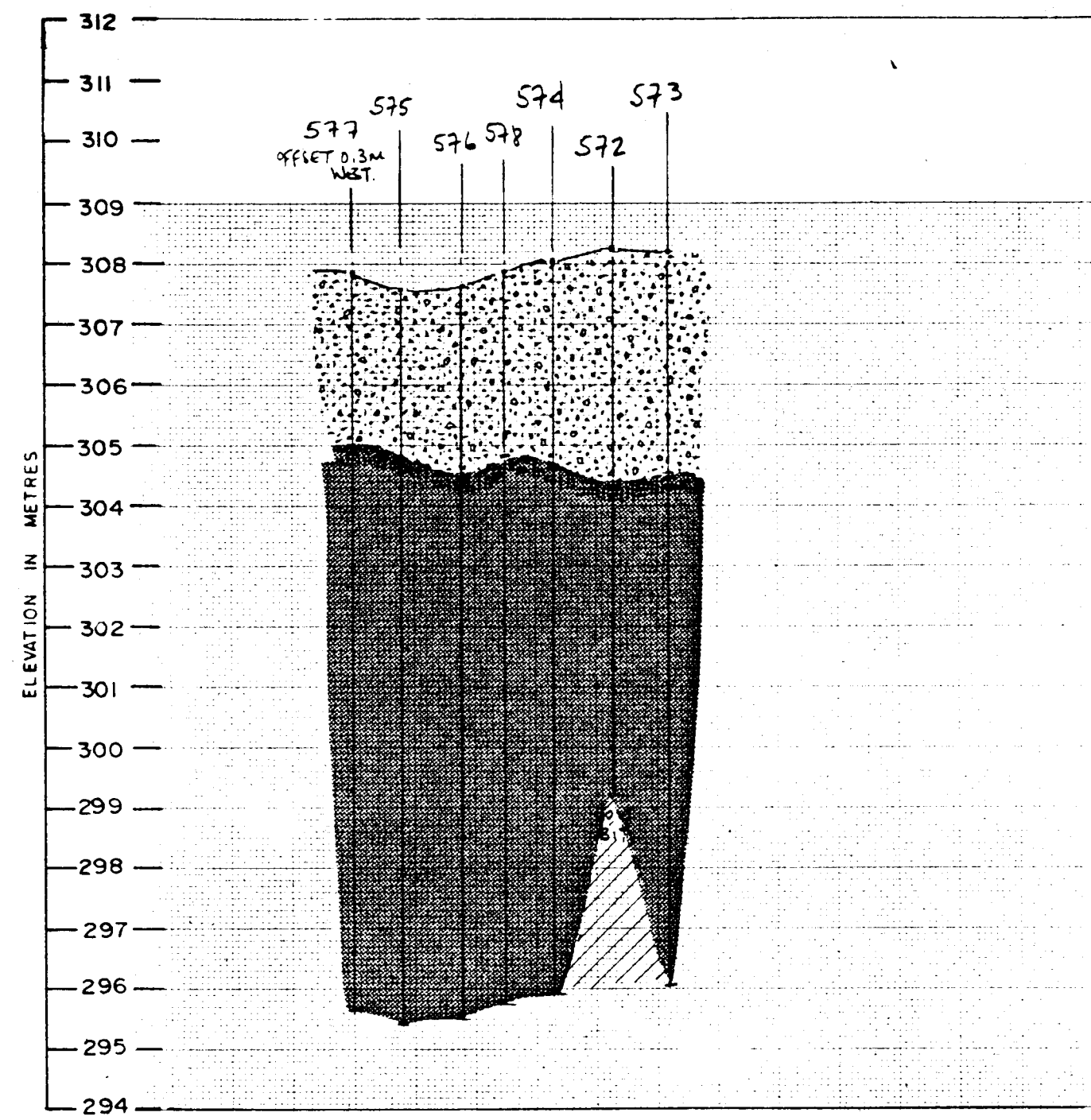
OVERBURDEN

ROCK

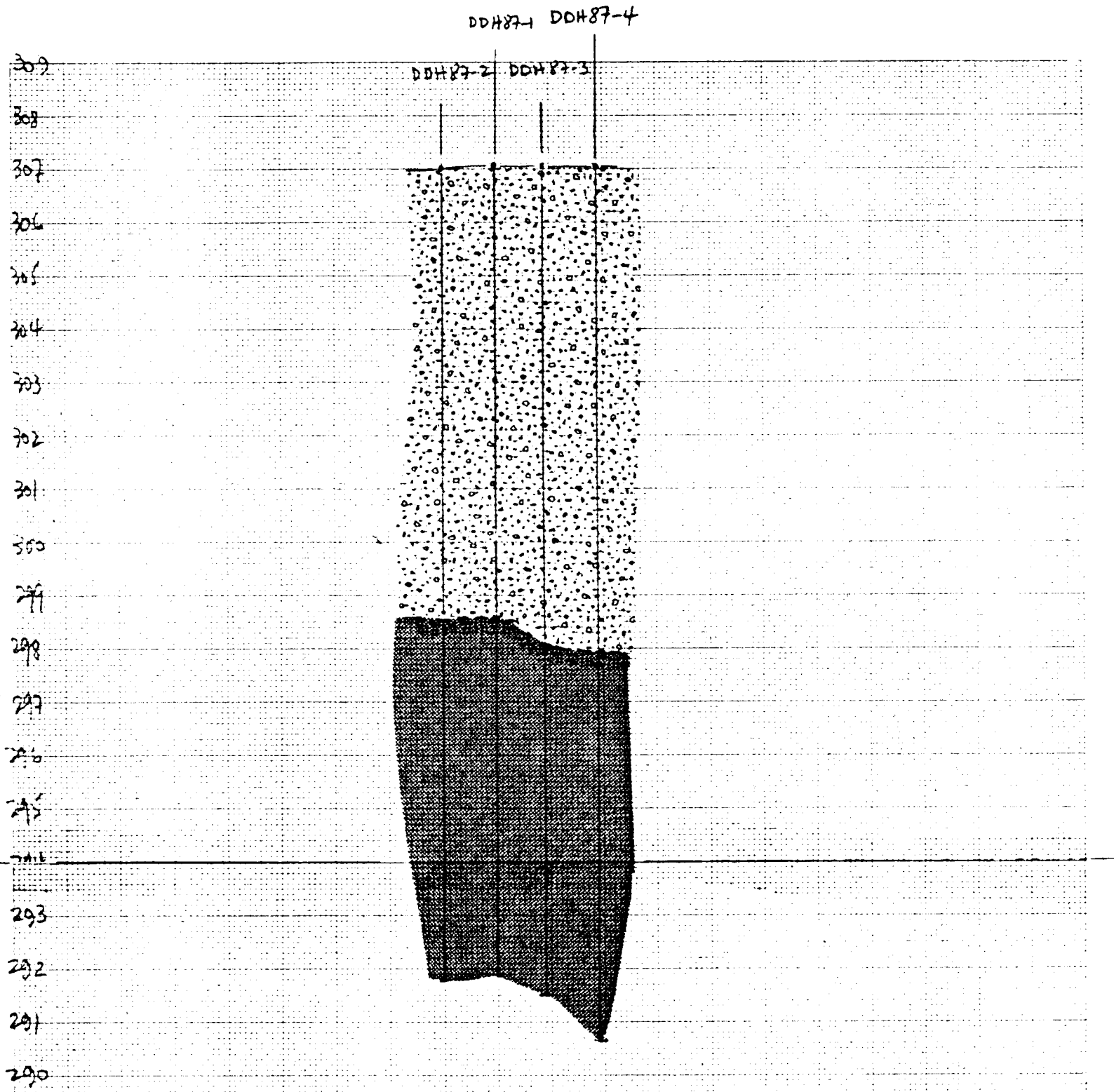
NOTE
FOR LOCATION OF SECTIONS REFER TO FIGURE

SCALE
1 : 100

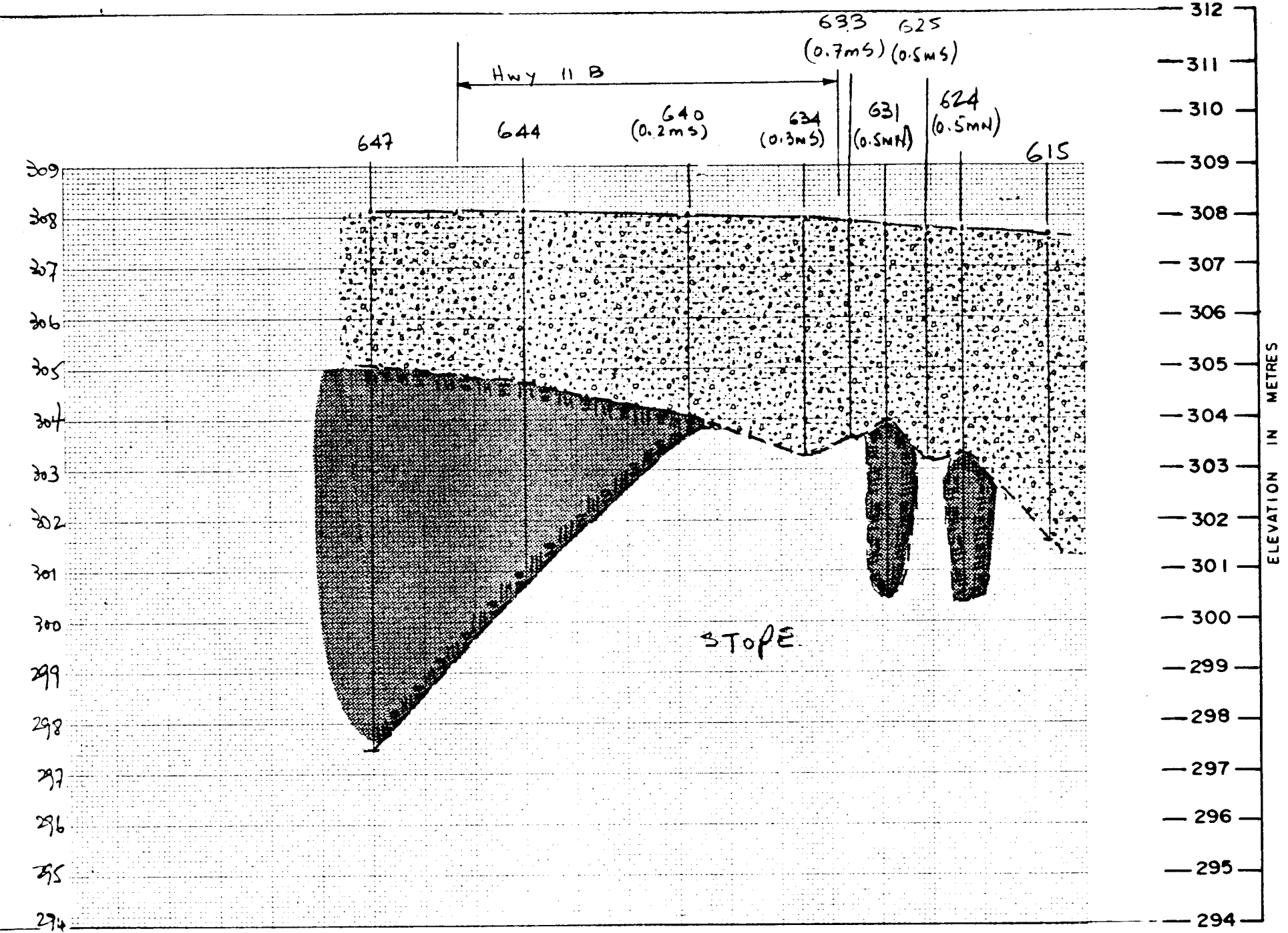




SECTION G-G
SECTION PERPENDICULAR TO HWY 11B, N.E. OF CAVE IN



SECTION H-H
S.E. CORNER OF CAVE IN AREA

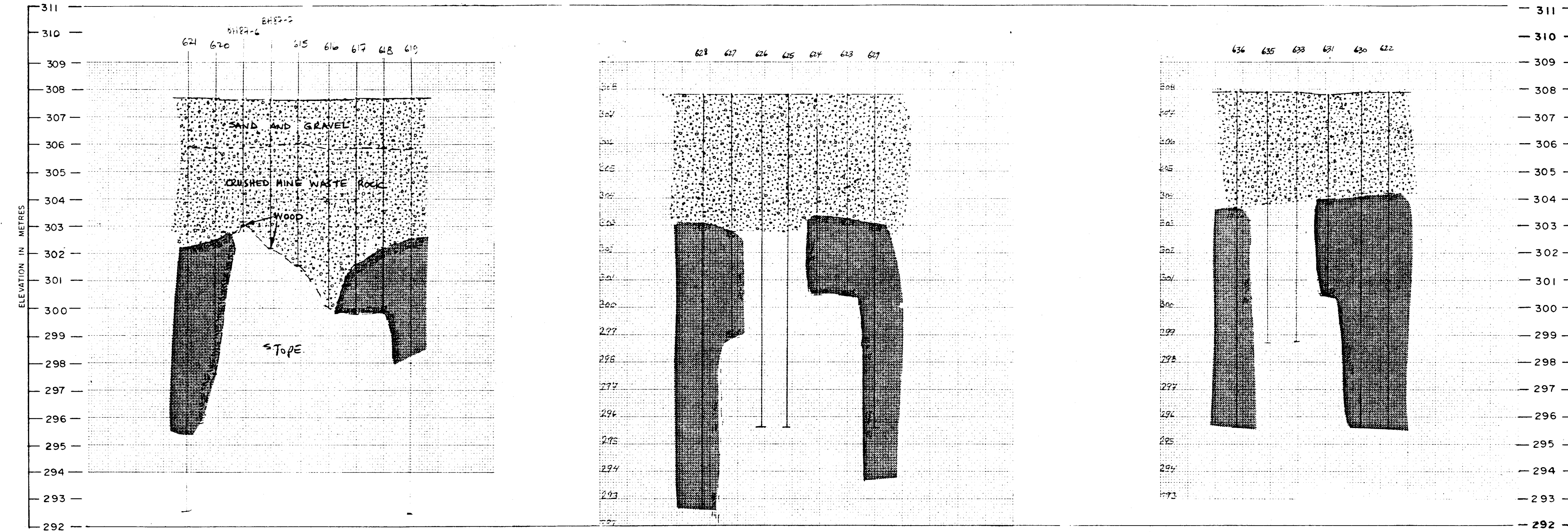


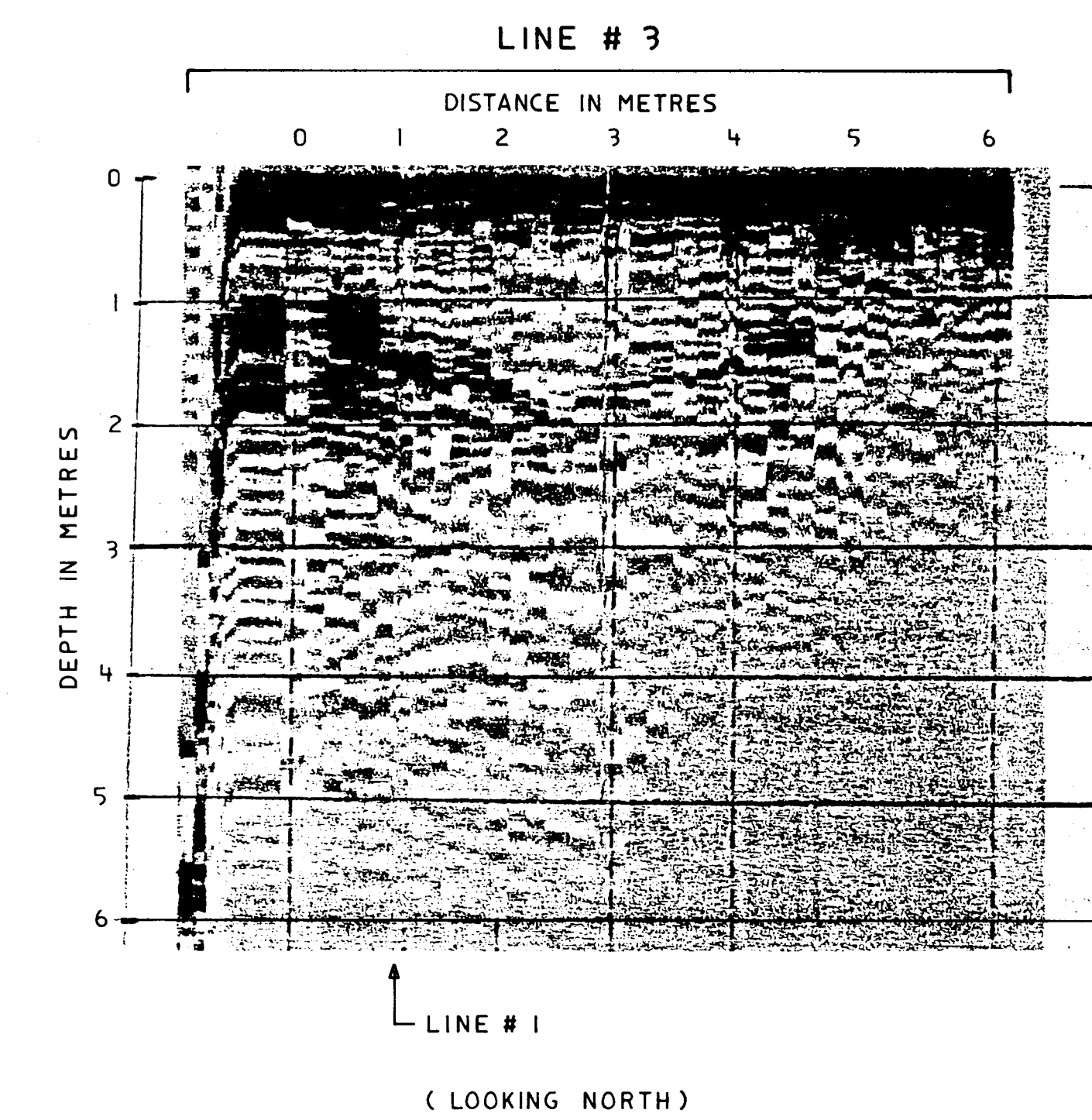
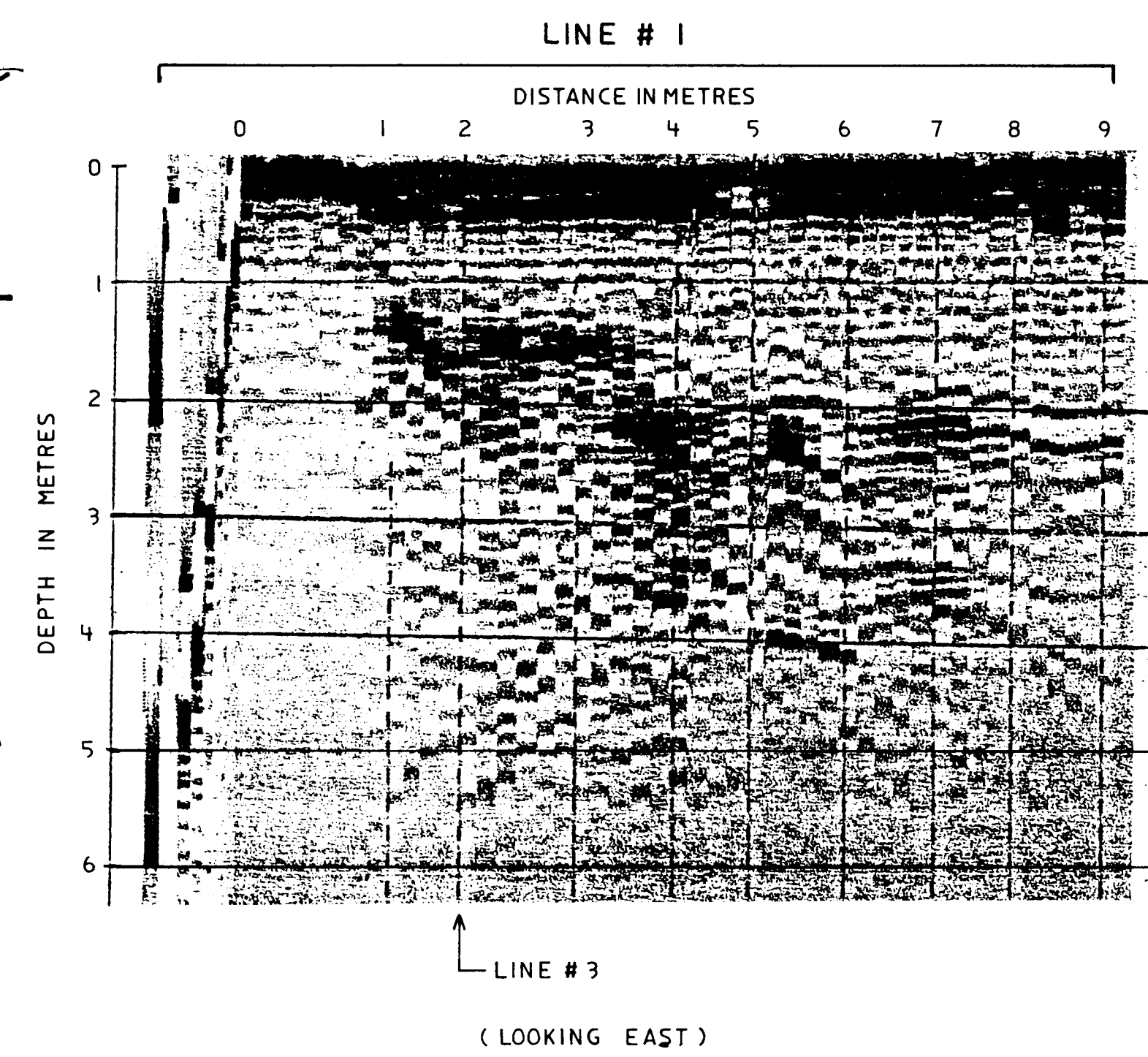
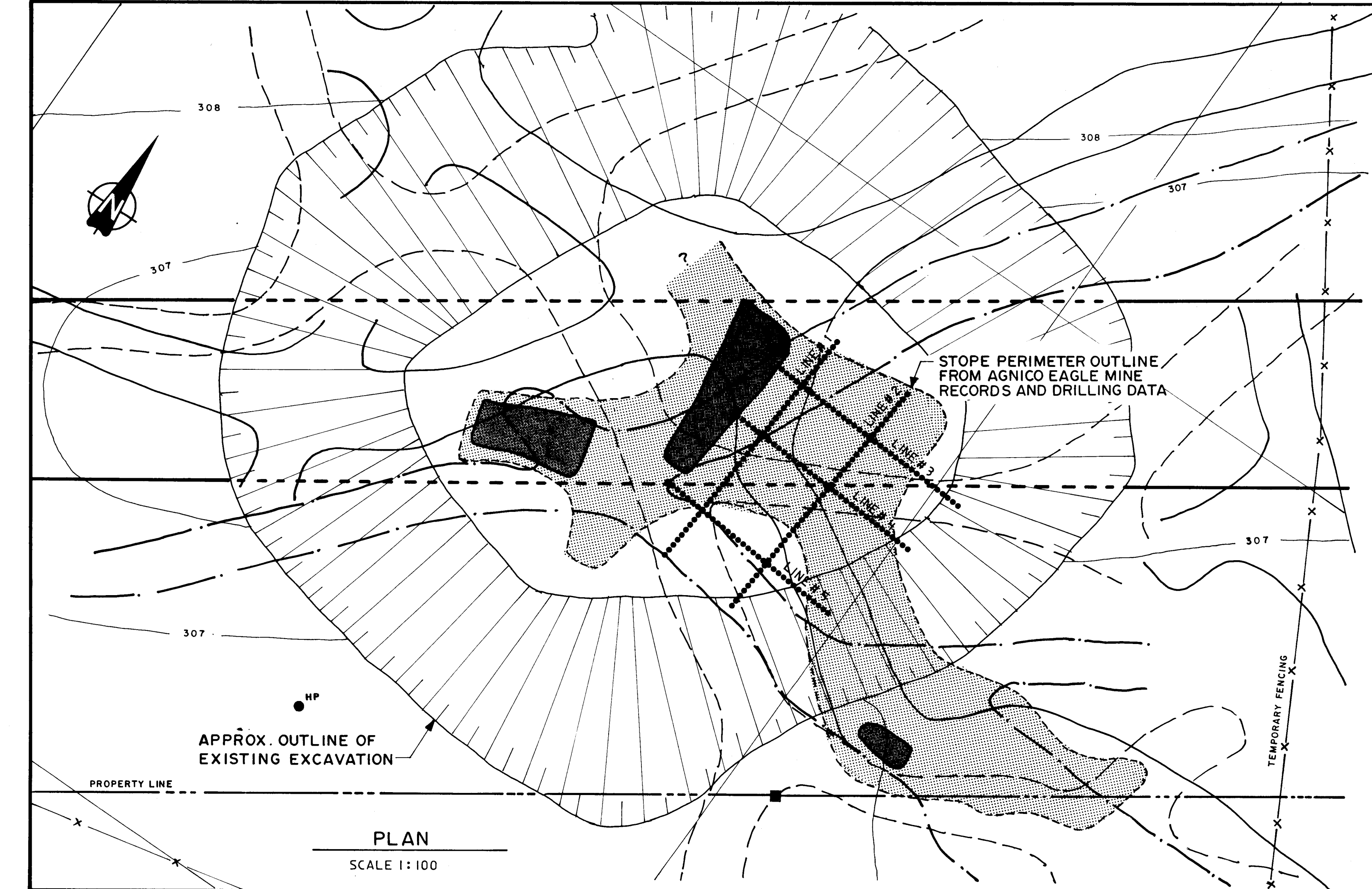
SECTION I-I

- LEGEND**
- P 514 AIR TRACK "PROBE" HOLE
 - BH 87-5 AUGERED AND CORED "SOILS" HOLE
 - DDH 87-2 CORED DIAMOND DRILL HOLE
 - ROCK QUALITY DESIGNATION PERCENT
 - BEDROCK INTERFACE
 - VOIDS, OPEN STOPS; IN PLACES WITH SOME BACKFILL
 - OVERBURDEN
 - ROCK

NOTE
FOR LOCATION OF SECTIONS REFER TO FIGURE

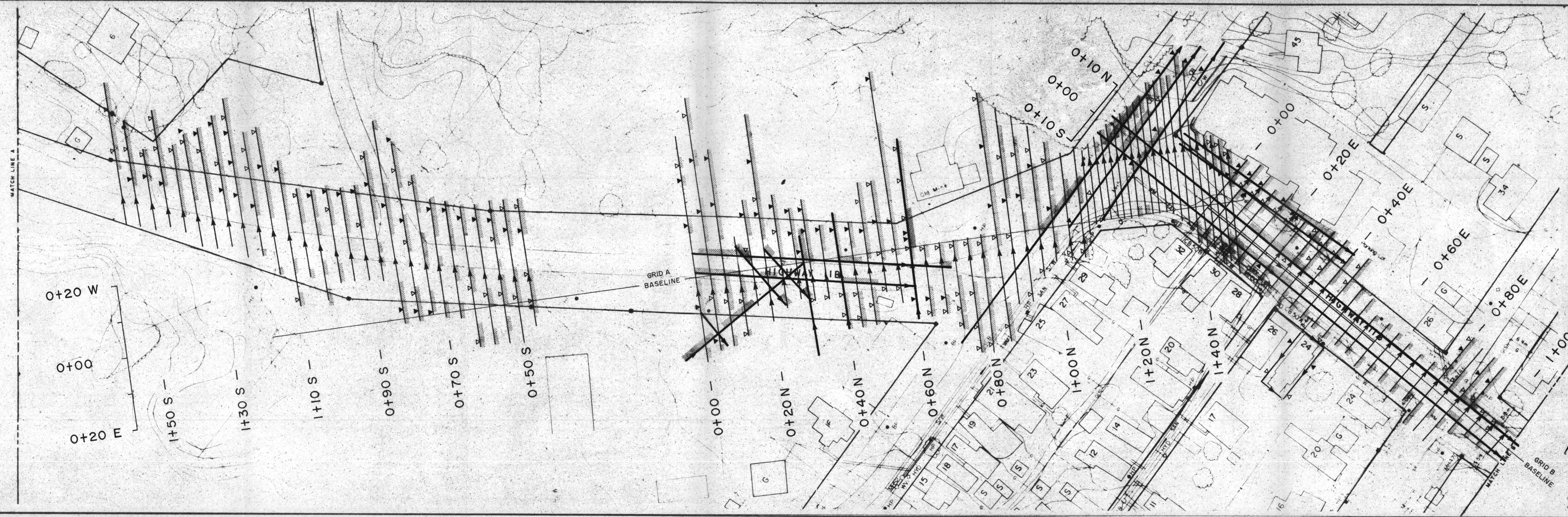
SCALE
1 : 100








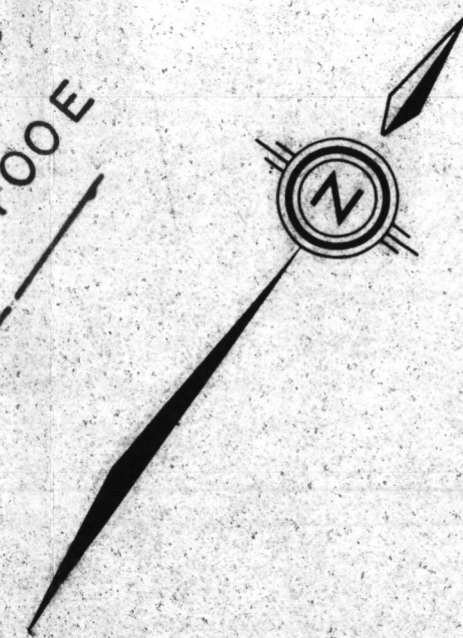
LEGEND

- GEOPHYSICS RADAR LINE LOCATION
- UNDERGROUND WORKINGS, DRIFTS, CROSS-CUTS, STOPES
 - ELEV. 950 FT. (290m) ? UPPER SUB-LEVEL
 - ELEV. 918 FT. (280m) TOWNSITE 1 ST. LEVEL
 - ELEV. 820 FT. (250m) TOWNSITE 2 ND. LEVEL
- AREAS WITH NO ROCK CAP ABOVE MINED OPENINGS
- ▨ AREAS WITH LESS THAN 10 FT. OF ROCK CAP COVER



LEGEND

- ▶ STRONG POINT REFLECTION
- ▷ WEAK POINT REFLECTION
-  CONTINUOUS ZONE OF REFLECTIONS
-  FIELD PROGRAM 1 RADAR SURVEY LINES
-  FIELD PROGRAM 2 RADAR SURVEY LINES



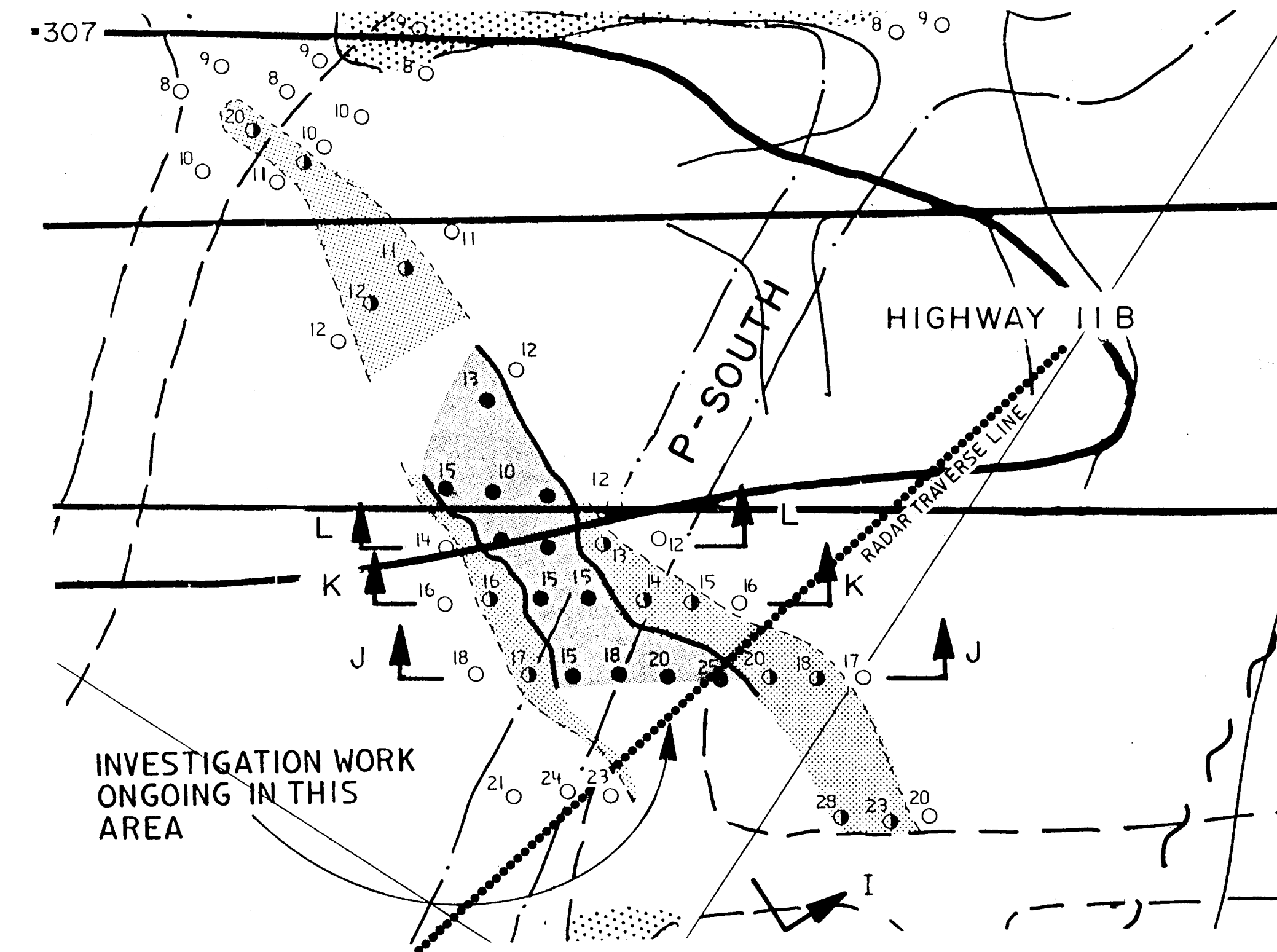
SCALE 1:500

Date **JULY 16, 1987**
Project **871-1289**

Golder Associates

Orson M. H.

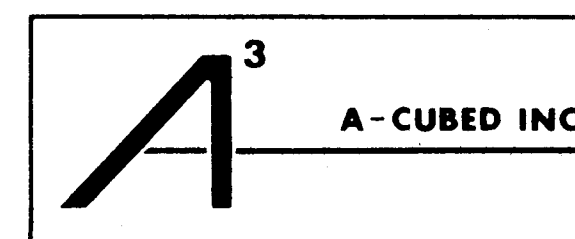
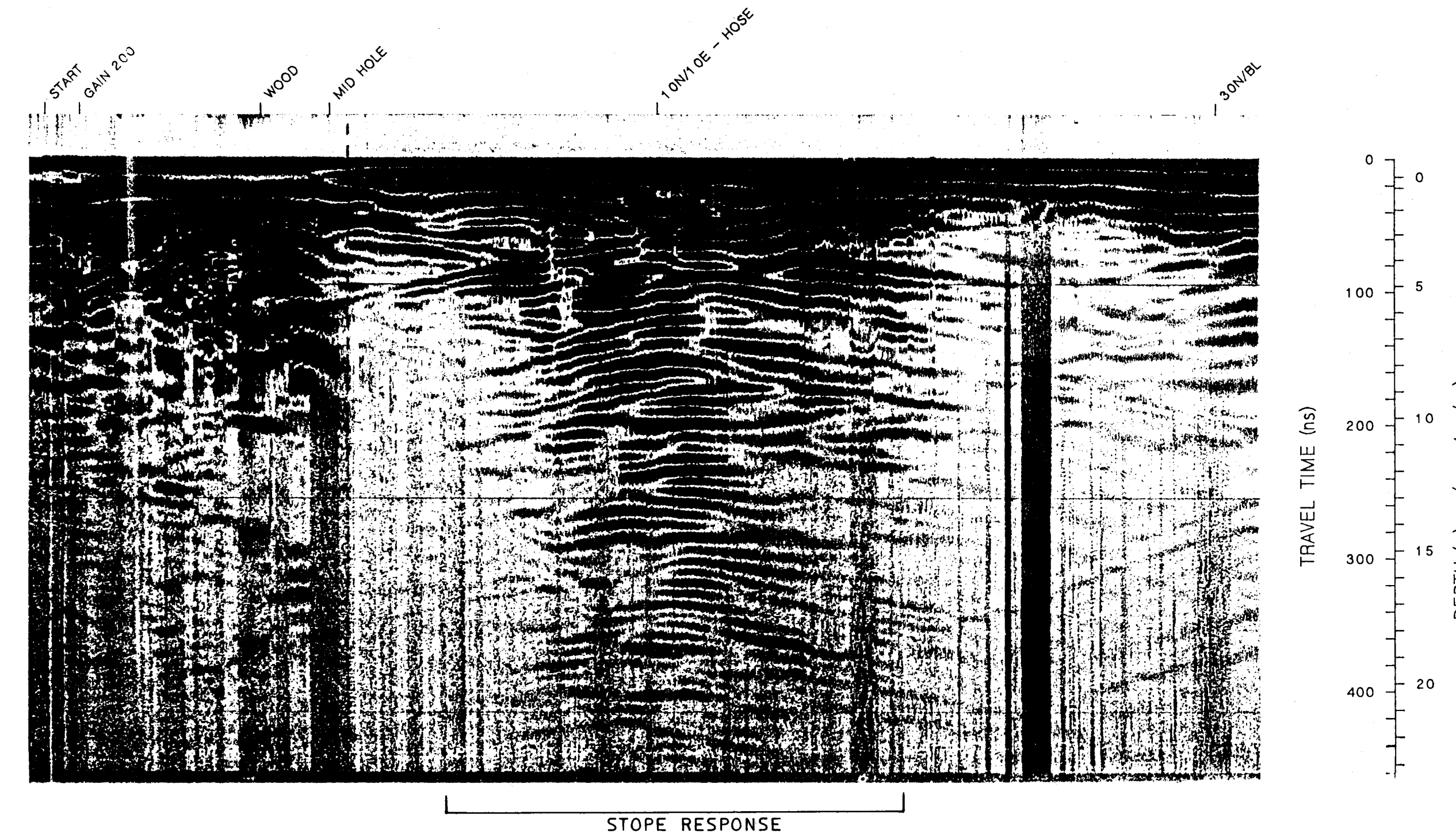
LINE 4S/23E to 30N/BL



PLAN

SCALE 1:100

- NOTE: 1. SEE FIGURE 8 FOR LOCATION OF
DRILL HOLES AND SECTIONS IN
VICINITY.
2. SEE FIGURE 14 FOR LOCATION OF
RADAR TRAVERSE LINE.



Golder Associates

Date... AUG. 18, 1987
Project... 871-1289

Drawn... MHW
Chkd... TGL

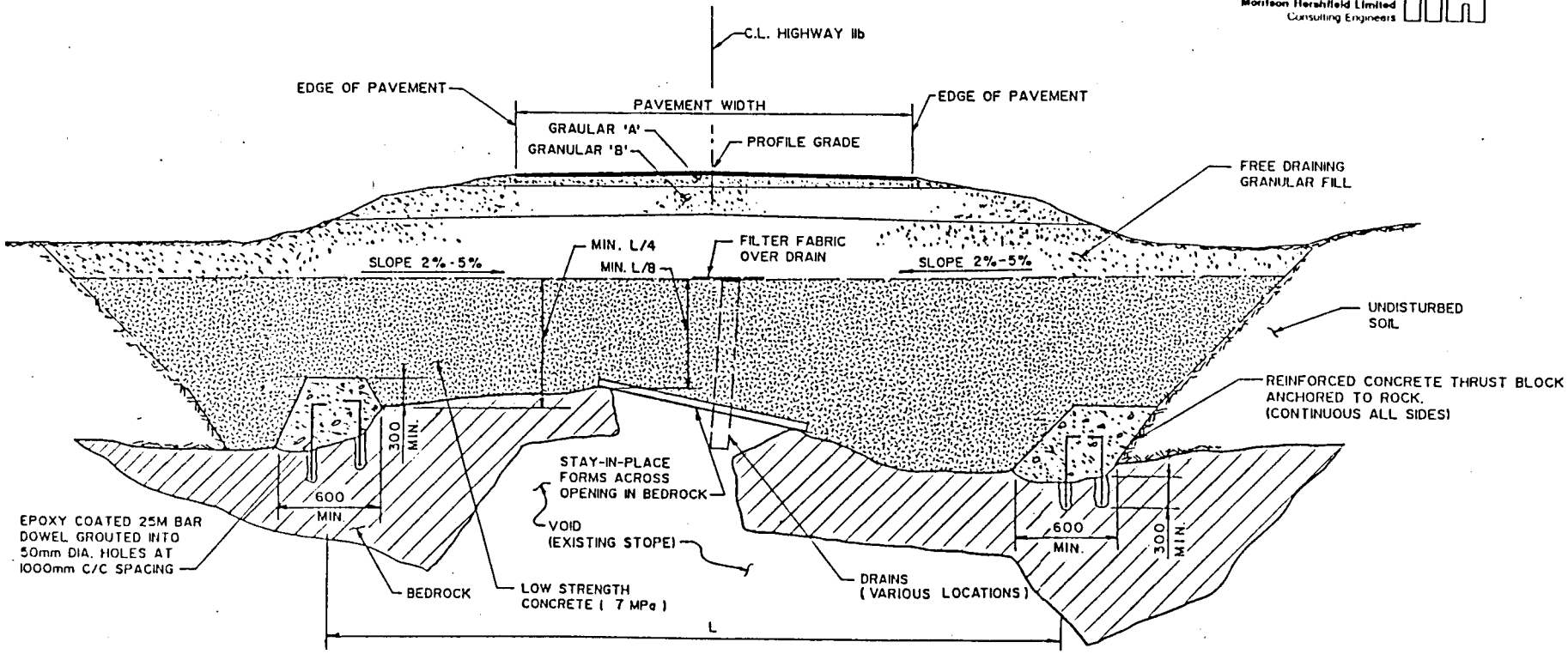
COBALT STOPE CAPS,
APPROACH 'A'

Morrison Hershfield Limited
Consulting Engineers **MH**

STRUCTURAL CAP
APPROACH "A" - MASS CONCRETE

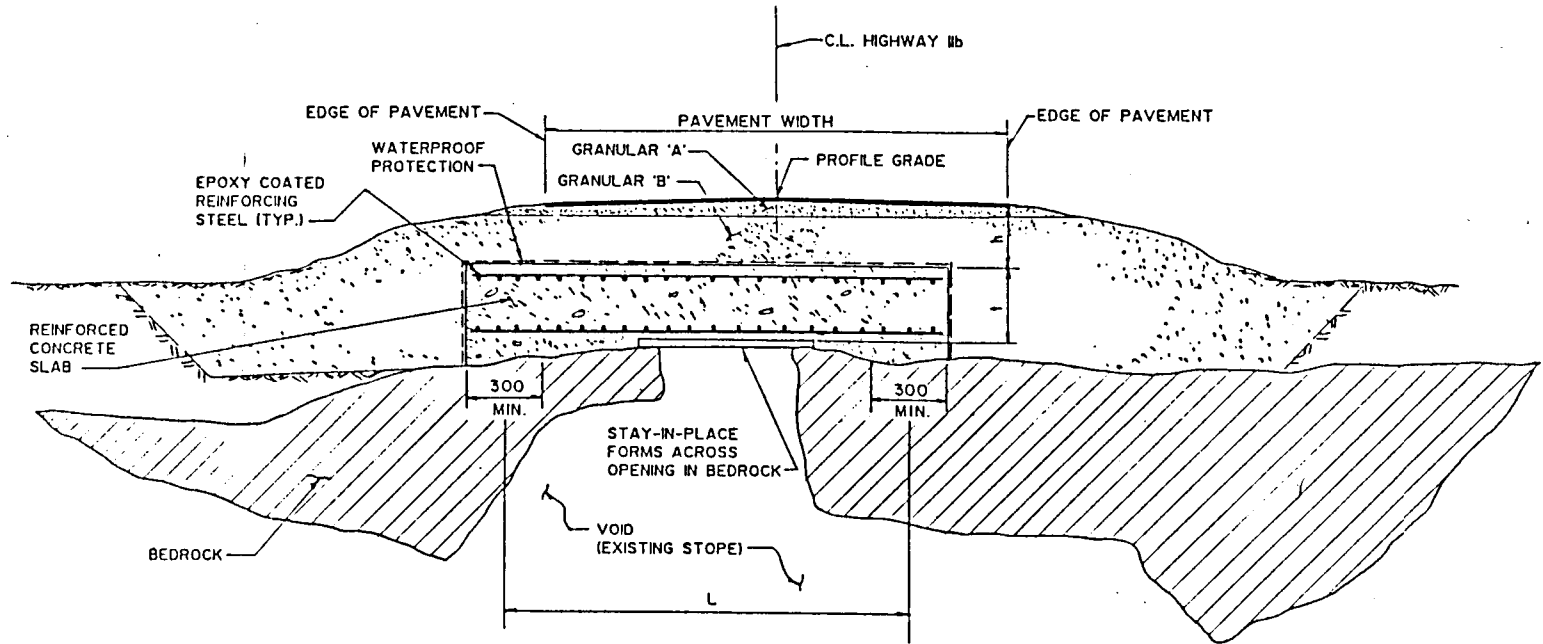
FIGURE 16

Golder Associates



COBALT STOPE CAPS,
APPROACH 'B'

Morrison Hershfield Limited
Consulting Engineers **MH**



STRUCTURAL CAP
APPROACH "B" - REINFORCED CONCRETE

FIGURE 17

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