# SLOPE STABILITY INVESTIGATION
# PORTAL PADS AND PORTAL ACCESS ROADS
# GENWAL COAL MINE
# HUNTINGTON, UTAH



Prepared for

GENWAL COAL COMPANY
P. O. Box 1201
Huntington, Utah 84528



JOB NO. 1169

November 27, 1982

August 24, 1982

Memo to Coal File:

RE: Genwall Coal Company
Commitment to Delta
Geotechnical Consultants
Design Recommendations for Portal
Access Roads
ACT/015/032

Tammy Balkenbush received a phone call from Hovik Baghoomian of Delta Geotechnical Consultants on August 23, 1982, concerning Genwall Coal Company's portal access roads. Mr. Baghoomian had some concern as to whether Genwall is adhering to the recommendations made by Delta on designs of the portal access roads. Slop stability is critical in this area and recommendations made by Delta such as not casting excavated material over road banks are very important in maintaining slope stability. Mr. Baghoonian stated that Delta did not want to be held liable for slope failure if these design conditions are not being met. There was also concern over Genwall not paying Delta for the work done, and Mr. Baghoomian did not want Genwall using their report before paying for the services rendered. The report was submitted with Genwall's December, 1981 ACR response to the Division.

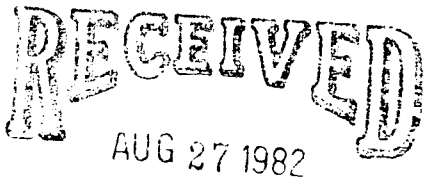
TAMARA J. BALKENBUSH
RECLAMATION ENGINEER

cc: Tom Tetting
Wayne Hedberg

TJB:sc

137 West 2260 South, Salt Lake City, Utah 84115 Telephone (801) 487-7754


August 26, 1982




DIVISION OF
OIL, GAS & MINING

Mr. William C. Wollen, Vice President
Genwal Coal Company
P. O. Box 1201
Huntington, Utah 84528

Dear Mr. Wollen:

We still have not received $793.00 engineering fees due this office since December 1981. As we have discussed with you on several occasions, this amount is for 15 extra reports and additional work you requested subsequent to the initial study. The report for the initial study was submitted to you on November 27, 1981. The report for additional work was submitted on December 8, 1981.

Because of nonpayment, we request that our report of December 8, 1981 be returned to us and its contents not be used for any purposes until we have been paid in full with the interest ($100.30) totaling $893.30 to date.

Please also note that our reports are based on the preliminary design of the proposed facilities as was submitted to the soils engineer at the commencement of our field studies. It is recommended that the soils engineer be provided the opportunity to review the final design and specifications in order to determine whether any change in concept may have had any effect on the validity of the soils engineer's recommendations, and whether those recommendations have, in fact, been implemented in the design and specifications. If the soils engineer is not accorded the privilege of making this recommended review, he can assume no responsibility for misinterpretation or misapplication of his recommendations or for their validity in the event changes have been made in the design concept.

We further recommend that a competent soils engineer be retained during construction to observe proper implementation of the

final design and specifications and to observe changes in subsurface conditions discussed on page 8 of our report.

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS

Hovik Baghoomian, P.E., Ph.D.
President

HB/tp

✓cc: Mr. Wayne Hedberg
Division of Oil, Gas and Mining
State of Utah
4241 State Office Building
Salt Lake City, Utah

Delta

137 West 2260 South, Salt Lake City, Utah 84115 Telephone (801) 487-7754

Delta
GEOTECHNICAL CONSULTANTS INC.

December 8, 1981

Mr. William C. Wollen, Vice President
Genwal Coal Company
P. O. Box 1201
Huntington, Utah 84528

Subject: Cut Slopes and Safety Factors for Portal Pads and Access Roads to Genwal Coal Mine

Delta Job No. 1169

Dear Bill,

This letter summarizes our previous recommendations concerning cut slopes and cut slope safety factors for the proposed access roads and portal pads. Please refer to our report dated November 27, 1981 for details.

| Material to be Cut | Recommended Slope | Safety Factor |
|---|---|---|
| Competent Bedrock | ¼:1 to vertical | The dip of the potential sliding planes slope away from the proposed alignments; therefore rock cuts are considered stable and a numerical safety factor against sliding is inappropriate. |
| Fractured Bedrock | ½:1 | Same as above. |
| Shallow Surficial Deposits (less than 4 feet deep) Overlying Bedrock | 1:1 | a. 1.10 to less than 1 for the shallow surficial deposits.<br>b. Same as above for bedrock. |

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137 West 2260 South, Salt Lake City, Utah 84115 Telephone (801) 487-7754


November 27, 1981

Mr. William C. Wollen, Vice President
Genwal Coal Company
P. O. Box 1201
Huntington, Utah 84528

Dear Bill:

We have completed our geotechnical studies for the proposed Genwal Coal Mine portal pads and access road facilities in accordance with our agreement of October 30, 1981. Data gathered during our investigation, the analyses of these data along with our conclusions and recommendations are presented in the attached report.

We appreciate the opportunity of working with you on this project. If you have any question, please call us.

Sincerely yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

David T. Price

David T. Price, P.E., Ph.D.
Partner

DTP/tt

Submitted in 3 copies

## INTRODUCTION

This report presents the results of a geotechnical investigation of the proposed portal pads and portal access roads for the Genwal Coal Mine. The mine is located in Crandall Canyon, which is approximately 15 miles west of Huntington, Utah. The objectives of this study were to evaluate the subsurface conditions at the site and to provide recommendations to aid in the design and construction of the proposed facilities. The purpose and scope of work was discussed with Mr. Bill Wollen of Genwal Coal Company during a site reconnaissance on October 29, 1981. The investigation included site reconnaissance, library research, subsurface exploration, geologic mapping, laboratory testing, and preparation of this report.

## PROJECT DESCRIPTION

The project is near the south center portion of Section 5, T 16 S, R 7 W, Salt Lake Base and Meridian. Two portal pads, two access roads to the portal pads, and one sediment pond are proposed for construction. Preliminary data provided show the elevations of the lower and upper portal pads to be 7885.61 and 7940.58 feet respectively. The grades for both access roads were assumed to be 10%. Our calculations for access road cut depths were based on the assumption that the portals remained level until the point where the portal began to narrow from 30 feet to the access road width of 20 feet. Access road and portal widths and lengths are shown on Figure 14 as prepared by Boyle Engineering Corporation of Salt Lake City. Using the above assumptions and the topographical map provided, cuts up to 35 feet are anticipated. We understand the proposed access roads and portal facilities will not be paved but will be constructed of a gravel surface underlain by suitable base and subbase material.

## SITE CONDITIONS

The site is situated on a south facing slope below a prominant ridge. The ridge is an extension of the mountain to the east. The elevation of the ridge varies from a high of about 10,000 feet to a low of around 7,000 feet where the Crandall Canyon Creek drains into Huntington Creek. The general trend of the ridge is east-west. The proposed portal and access road facilities are located at the base of this ridge, between approximately elevations 7940 and 7860 feet. The mountain slopes between these elevations vary in steepness from 30 to 40 degrees to over vertical where the bedrock is exposed. The ground surface near the creek is covered by blue spruce, aspen, Douglas fir, and various grasses. The steeper slopes, further uphill, are less vegetated and are sparsely covered with wheat grass, juniper, and pinyon pine. Boulders and cobbles are also scattered on the higher grounds. Many areas evidence moderate erosion from rapid runoff of snow melt and rain water. The erosion areas are also characterized by numerous small slump failures, and were often found in a wet condition at the time of this investigation (November 6, 1981). Seepage was found above the haul road, near station 80+00 and between stations 74+00 and 75+80. Refer to Figure 14. Seepage should also be anticipated in other areas of the proposed excavation during construction.

## GEOLOGY

Two major geologic formations were exposed in the area of the proposed project: the Star Point Sandstone and the Blackhawk Sandstone. The Star Point formation is the lower of the two and consists of yellow to gray, massive, cliff forming sandstone often in several tongues separated by thick beds of yellow to gray slope forming shale. The Blackhawk formation

consists of alternating slope and cliff forming units. The cliff forming units are yellow to gray or white sandstones which weather to tan or yellowish brown. Some of the sandstone is reddened by the natural burning of nearby coal seams. The slope forming materials of the Blackhawk formation consist mainly of shale with several coal beddings. The shale is soft to hard and granular (sandy). In general, the exposed formations strike in a north-east direction and dip slightly to the north or away from the proposed cut slopes. No faults were observed at the site during our field investigation.

## SURFACE AND SUBSURFACE SITE EXPLORATION

The field work portion of our study consisted of a preliminary field reconnaissance and a subsequent three day site investigation that included test pit excavations, soil sampling and classifications, mapping of bedrock outcrops and seepage areas, and observations of general site conditions. Data from the surface reconnaissance is shown on Figure 14.

Three test pits were excavated at the proposed site. Because of access difficulties our test pit excavations were limited to the lower elevations. Shallow test pits were hand excavated at higher elevations. The backhoe excavated test pits ranged in depth from seven to thirteen feet. The subsoils were classified in the field and relatively undisturbed and disturbed samples were taken from the test pits and sent to our laboratory for further examination and testing. The subsoil conditions are discussed under the SUBSURFACE CONDITIONS section of this report.

## LABORATORY TESTING

A laboratory program was conducted to further identify the sampled subsoils, and to determine subsoil properties for use in engineering

analysis. Gradation, Atterburg limits, natural moisture and density, and Proctor density tests were performed to accomplish our objectives. The results of these tests are shown in Figures 12 through 13. The soil parameters used in our sliding block (or mudflow) stability analysis are shown on Figure 7.

SUBSURFACE CONDITIONS

Three distinct subsoil conditions, from an engineering standpoint, exist along the proposed raodway and portal alignments. The three types of subsoil conditions are: (1) areas of exposed bedrock, (2) areas where bedrock is covered by 10 to 40 inches ± of surficial deposits, and (3) areas covered by 15 feet ± of alluvium deposits. Test pit 3 indicated the alluvium consisted mainly of silt and fine gravel between 0 to 4 feet; dense silty sand with some gravel and cobbles between 4 and 12 feet; and boulders with silty sand to the bottom of the excavation. Area 2 surficial deposits consisted of silty sand with gravel, and cobbles. The alluvium deposits (area 3 soils) are mainly located below elevation 7860, which is in the area of the haul road. No major cuts for the portal pads or access roads are anticipated in area 3 type subsoil conditions. The lower access road is expected to be in area 2 type subsoil conditions, and all of the upper access road and both portal pads are expected to be in area 1 and 2 type subsoil conditions.

CUT SLOPE RECOMMENDATIONS

The following cut slopes are recommended for the proposed access roads and portal pads. These recommendations are based on our observation of surface and subsurface conditions, a sliding block type slope stability analysis and our experience with similar soil conditions:

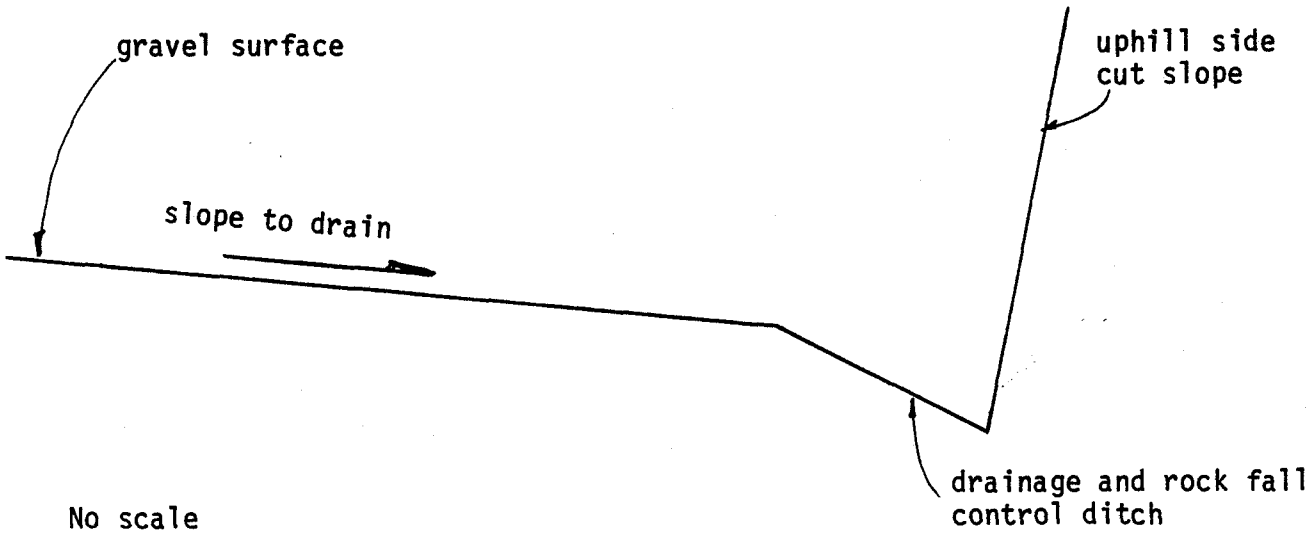
| Type of Material | Cut Slope (H:V) |
|---|---|
| Competent Bedrock | ¼:1 to vertical |
| Fractured Bedrock | ½:1 |
| Surficial Deposits less than 4 feet deep (area 2 type) | 1:1 |
| Surficial Deposits greater than 4 feet deep (area 3 type) | 2:1 |

Cut slope profiles for four different locations are shown on Figures 2 through 5. These profiles indicate typical surface and subsurface conditions that may be expected along the proposed alignments. The profiles also show some of the problems associated with flatter excavations such as 1:1 cut slopes. As shown on Figures 4 and 5, a 1:1 cut slope could undercut the upper access road. The flatter slopes will also unnecessarily scar the hillside, and create large erosion paths. Flatter slopes will also increase the cost of construction. We, therefore, do not recommend cut slopes flatter than ½:1, except under the conditions outlined in our recommendations above.

ROADWAY CROSS-SECTION AND DRAINAGE RECOMMENDATIONS

Control of surface runoff and rock falls from higher elevations, in our opinion, are the two most critical factors to be incorporated in the design and construction of the proposed facilities. **Uncontrolled surface runoff will saturate surficial deposits, particularly in the areas of shallow bedrock, and will cause** major slides (or mud flows) in these areas. These slides not only would delay the mine operations, but could cause major damage to men and equipment. **The results of our "sliding block" slope stability analyses, which confirms our opinion, are presented on Figure 7.** Rock falls, on the other hand, are unpredictable. Rock fall

could occur any time of the year due to weathering of the overhanging cliffs, and erosive forces causing the stranded rocks to loosen and roll downward. Both problems, in our opinion, can be minimized by providing a drainage (or rock fall ditch) as illustrated below. Details of the ditch construction are presented on Figure 6.




TYPICAL ROADWAY CROSS SECTION

The following design and construction details should also be observed:

(1) The construction activities will unavoidably alter and block the natural drainage paths along the proposed alignments. We recommend that culverts or other drainage means be provided for these areas.

(2) The roadway should be graded toward the drainage (or rock fall) ditch to prevent ponding of water in the roadway.

(3) The drainage ditch should be paved or properly lined with a suitable material to prevent penetration of water into the subsoils or surficial deposits. Where the roadway is underlain by claystone or impervious sandstone, ditch lining will not be required.

(4) The excavated material should not be dumped over the downhill side of the cuts as this will lower the stability of the hillside.

(5) The drainage ditch should be cleaned and maintained periodically to insure that the system remains functional at all times.

(6) The natural soil cover and vegetation should be protected as much as possible to prevent erosion.

EMBANKMENTS

Embankments will be required where the proposed alignments cross several draws as shown by Figure 14. **Embankments, up to 20 feet high, constructed of sandy gravelly materials should be stable on 2:1 slopes if the following recommendations are followed:**

(1) Remove all topsoil and weak or loose surficial deposits underlying the embankment areas.

(2) As stated earlier in this report, provide properly sized culverts in the natural drainage areas to prevent water from ponding against or penetrating into the embankments. Culverts should be founded on well compacted soils or on bedrock.

(3) Compact all embankment soils to 95% of the maximum laboratory dry density as determined by ASTM D-1557-70 method.

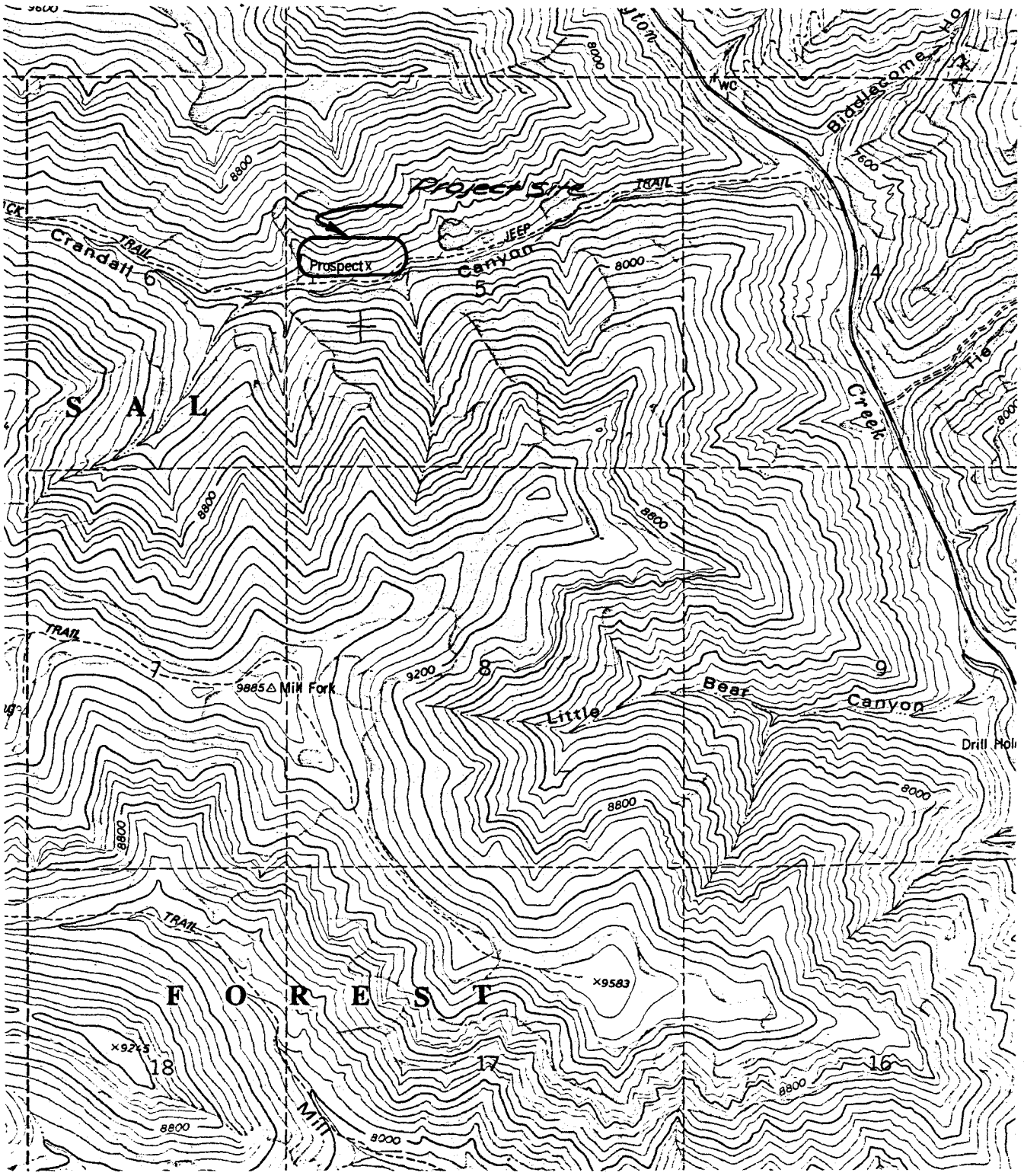
LIMITATIONS AND PROJECT INSPECTION

Our subsurface exploration program consisted of three test pits and several shallow, hand excavated test holes. Our surface reconnaissance consisted of mapping of bedrock outcrops and water saturated areas. However, considerable variation may still occur between the sampled and mapped locations. This report does not reflect any material variations which might occur between these observed locations. Variations in subsoil conditions are sometimes sufficient to necessitate design modifications. We, therefore, recommend that a competent soils engineer be retained to periodically inspect the excavations.

DELTA GEOTECHNICAL CONSULTANTS, INC.

David T. Price, P.E., Ph.D.
Partner

Hovik Baghoomian, P.E., Ph.D.
Partner

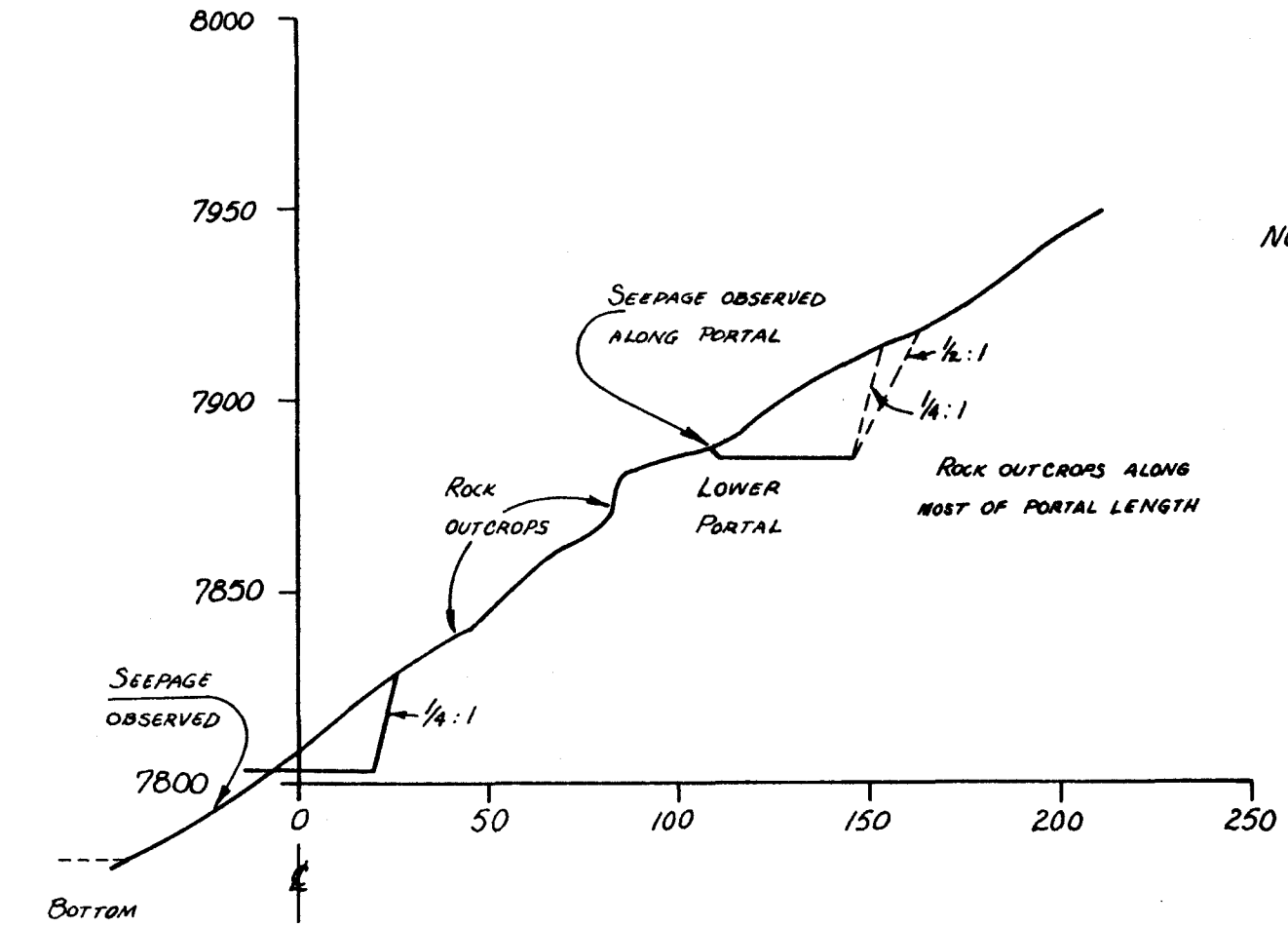



## VICINITY MAP

SCALE: 1" = 2000'

JOB NO. 1169

FIGURE 1




NOTE: THE CUT SLOPES SHOWN ARE FOR ILLUSTRATIVE PURPOSES ONLY. PLEASE REFER TO OUR REPORT FOR CUT SLOPE DESIGN RECOMMENDATIONS.

CROSS SECTION AT HAUL ROAD STATION 75+00

SCALE: 1" = 50' H&V

JOB. NO. 1169

Figure 2

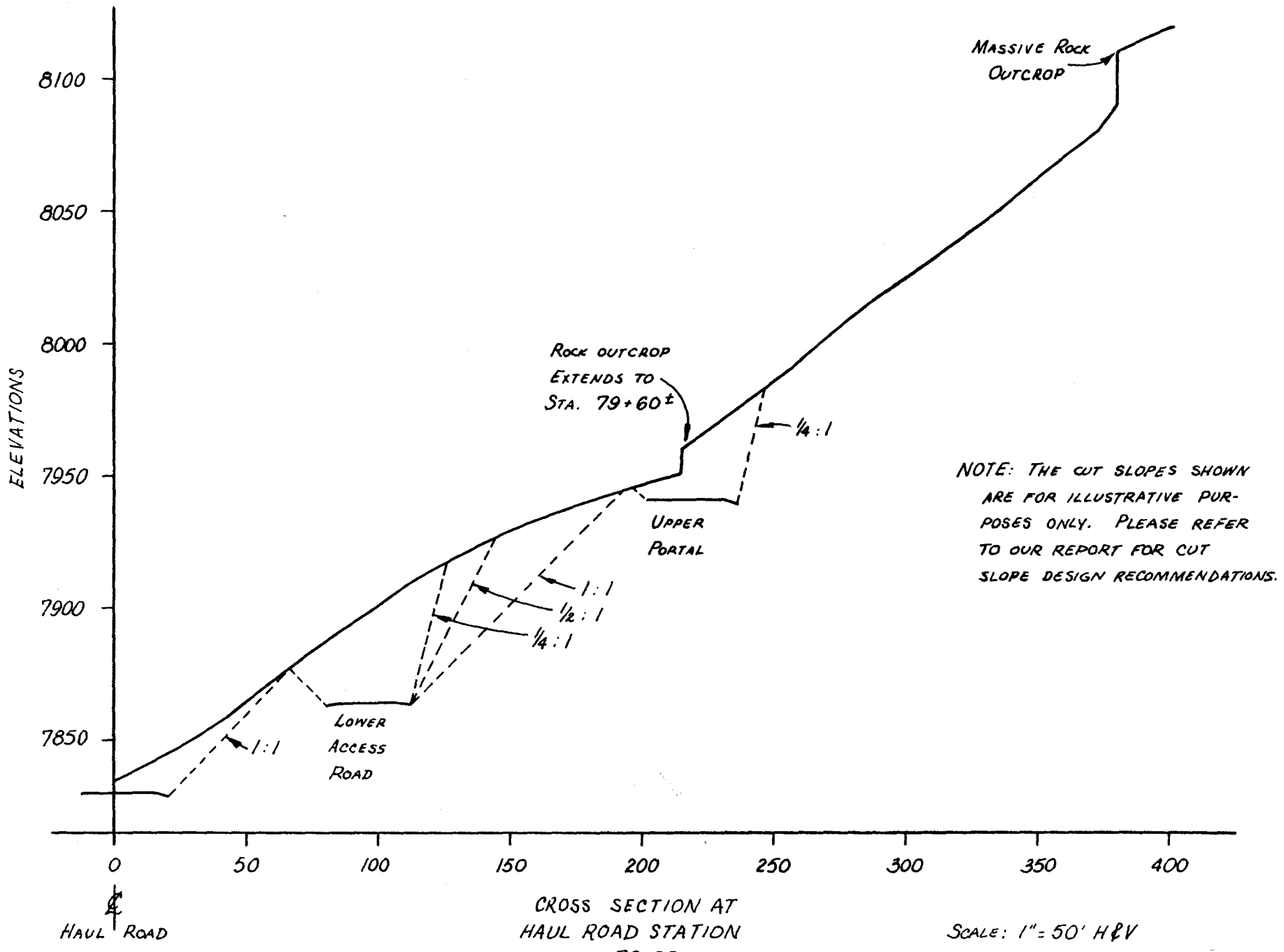



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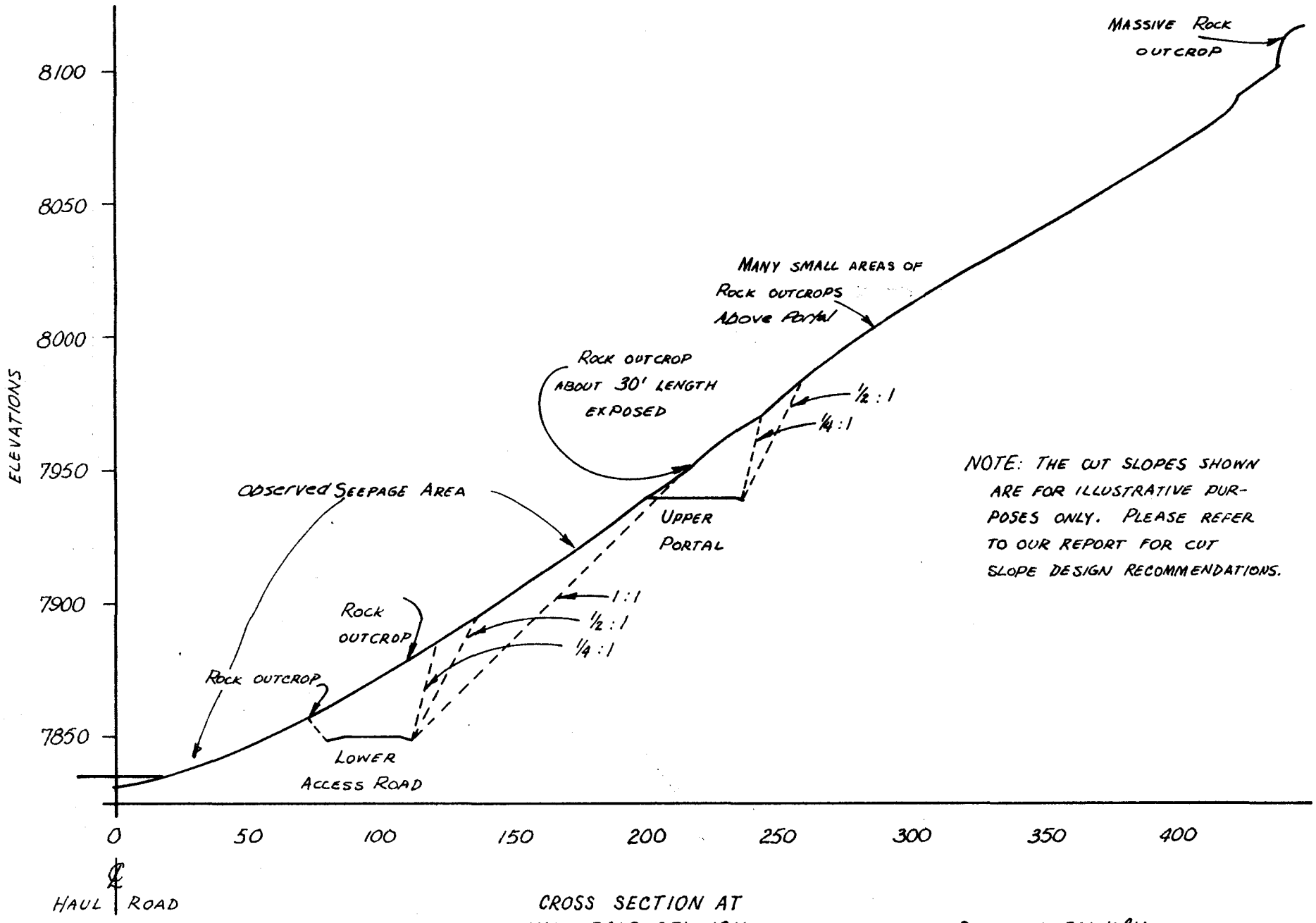
Figure 3




NOTE: THE CUT SLOPES SHOWN ARE FOR ILLUSTRATIVE PURPOSES ONLY. PLEASE REFER TO OUR REPORT FOR CUT SLOPE DESIGN RECOMMENDATIONS.

CROSS SECTION AT HAUL ROAD STATION 80+23

SCALE: 1" = 50' H & V

JOB NO. 1169

Figure 4

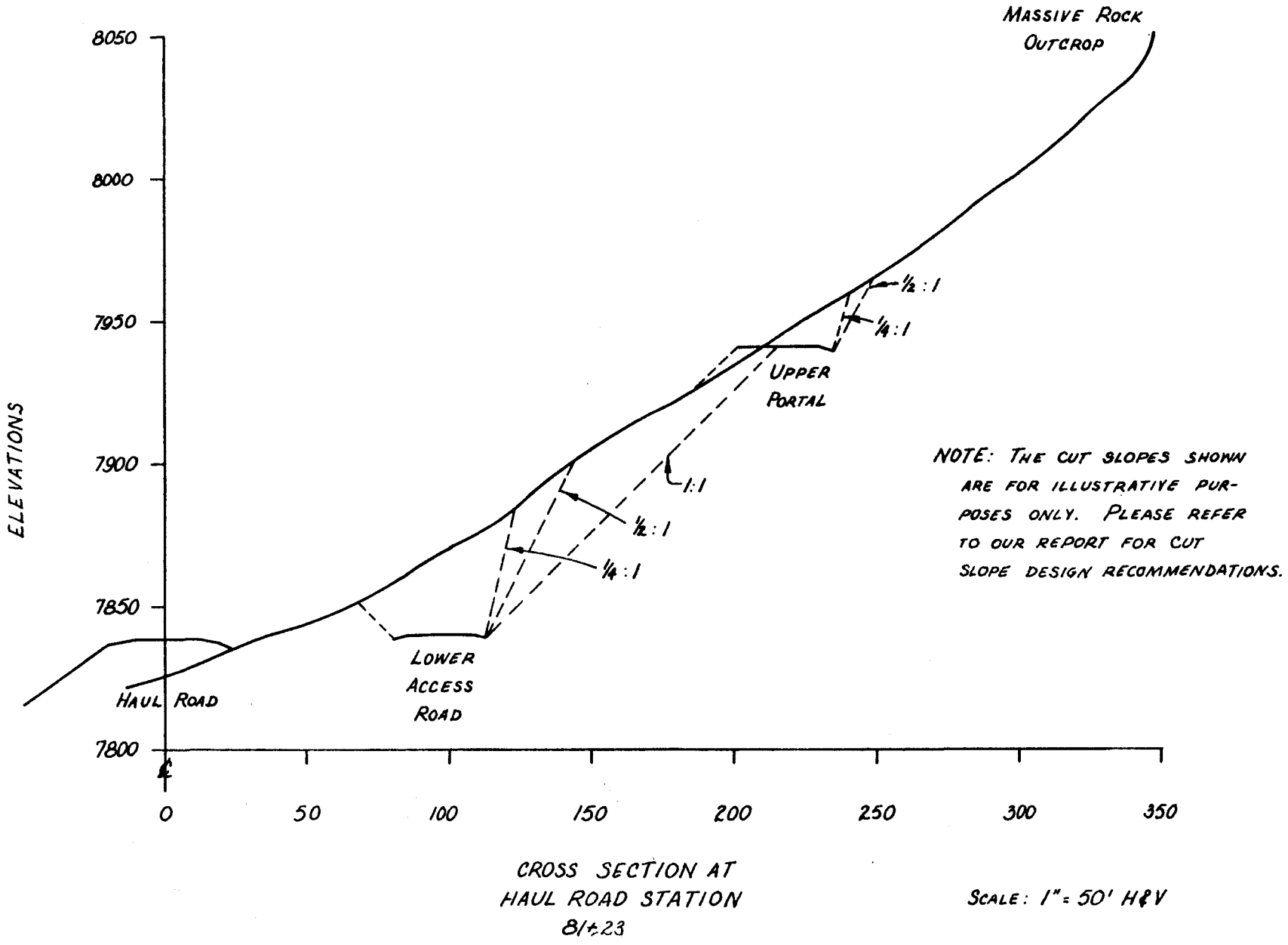



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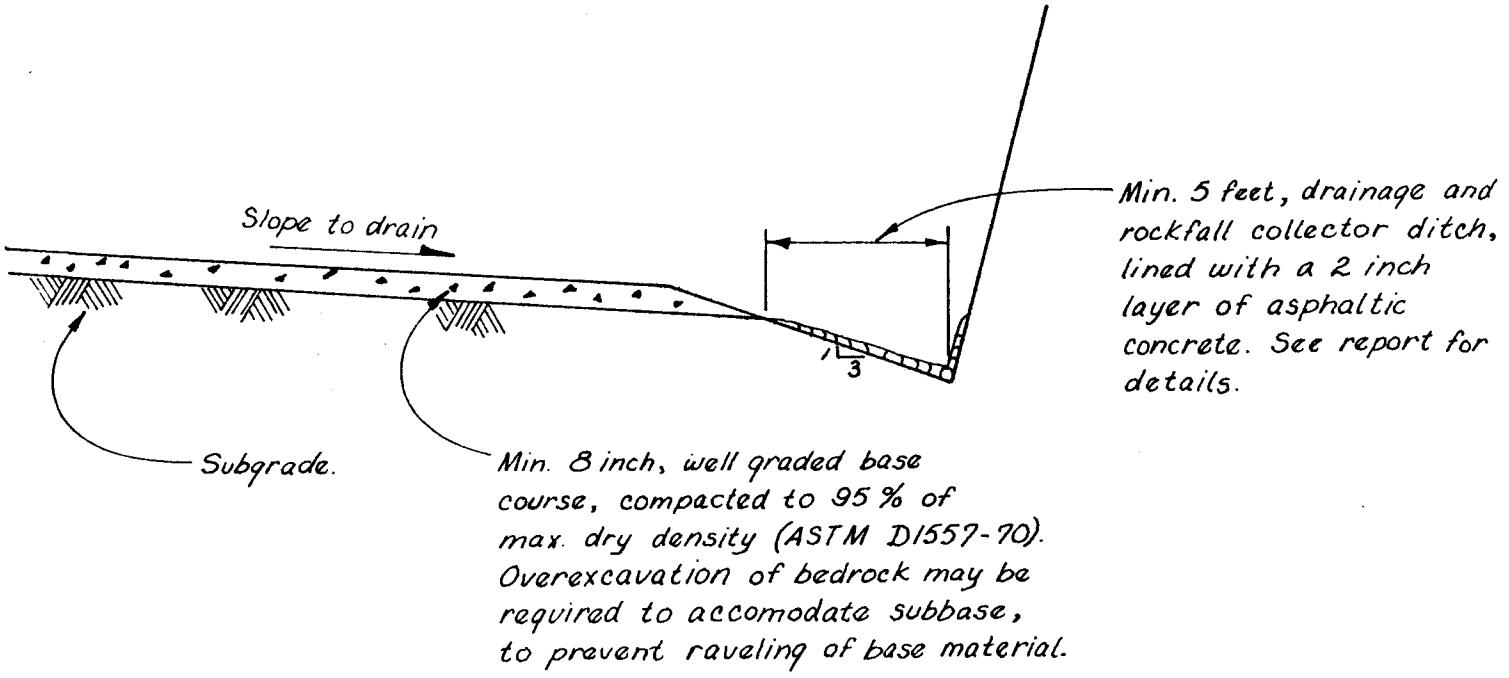
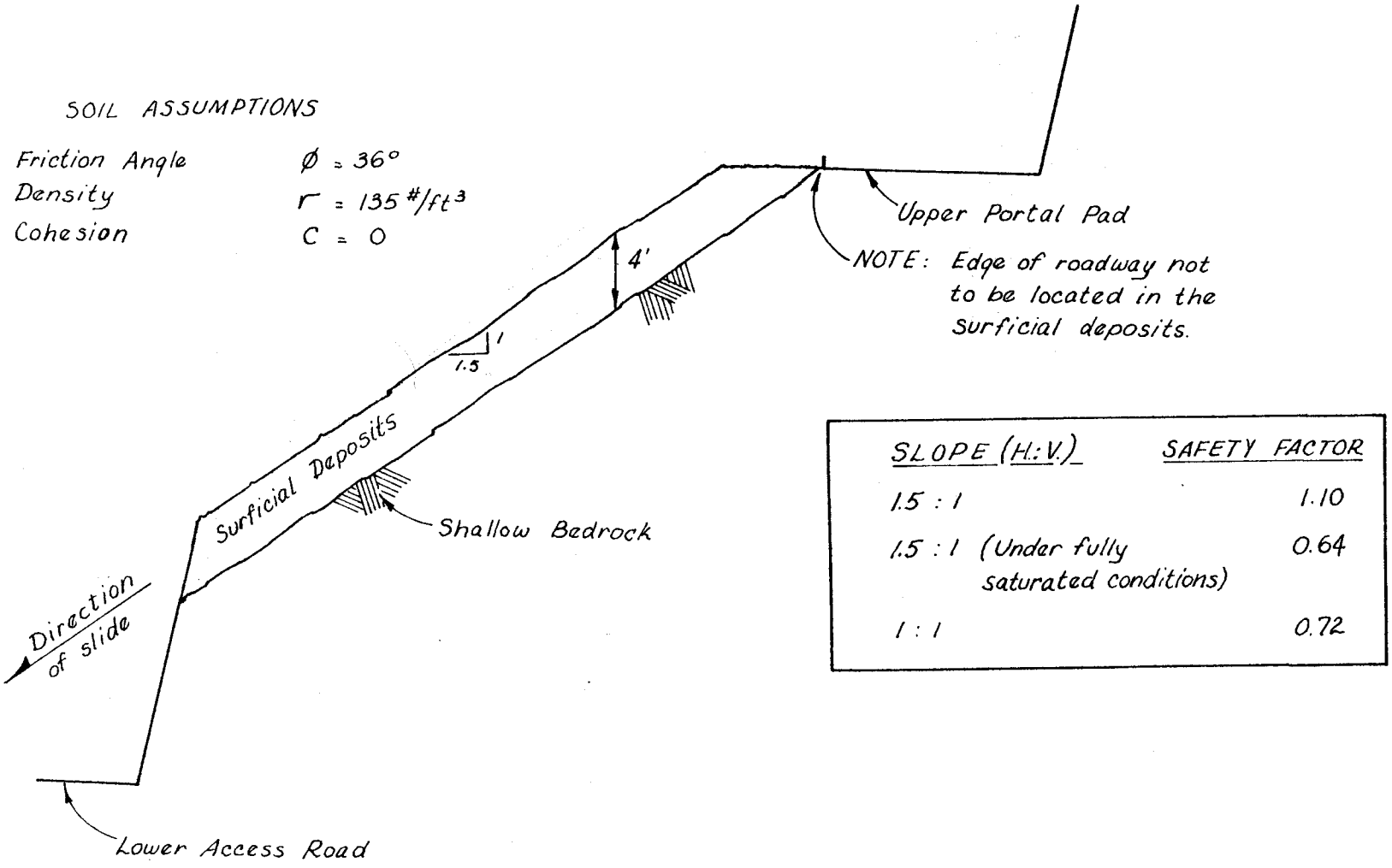
FIGURE 5




PROPOSED DRAINAGE AND
ROCKFALL
COLLECTOR DITCH

Job No. 1169

FIGURE 6




| SLOPE (H:V.) | SAFETY FACTOR |
|---|---|
| 1.5 : 1 | 1.10 |
| 1.5 : 1 (Under fully saturated conditions) | 0.64 |
| 1 : 1 | 0.72 |

SLIDING BLOCK OR "MUDFLOW" STABILITY ANALYSIS

JOB No. 1169

FIGURE 7

Delta

TEST PIT NO. 1

ELEVATION: 7784

| DEPTH IN FEET | LL | PI | W | DD | OTHER TESTS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | | COAL: waste from old mine |
| | 22.1 | 3.1 | | | -200=50.8 | SAND AND SILT (SP-ML), medium dense, wet to moist, fine grained, tan |
| 5 | | NP | 7.3 | 98.4 | | SAND (SP), silty, gravelly, medium dense to dense, moist to dry. Slightly calcareous. |
| 10 | | | | | | |

# LOG OF TEST PIT

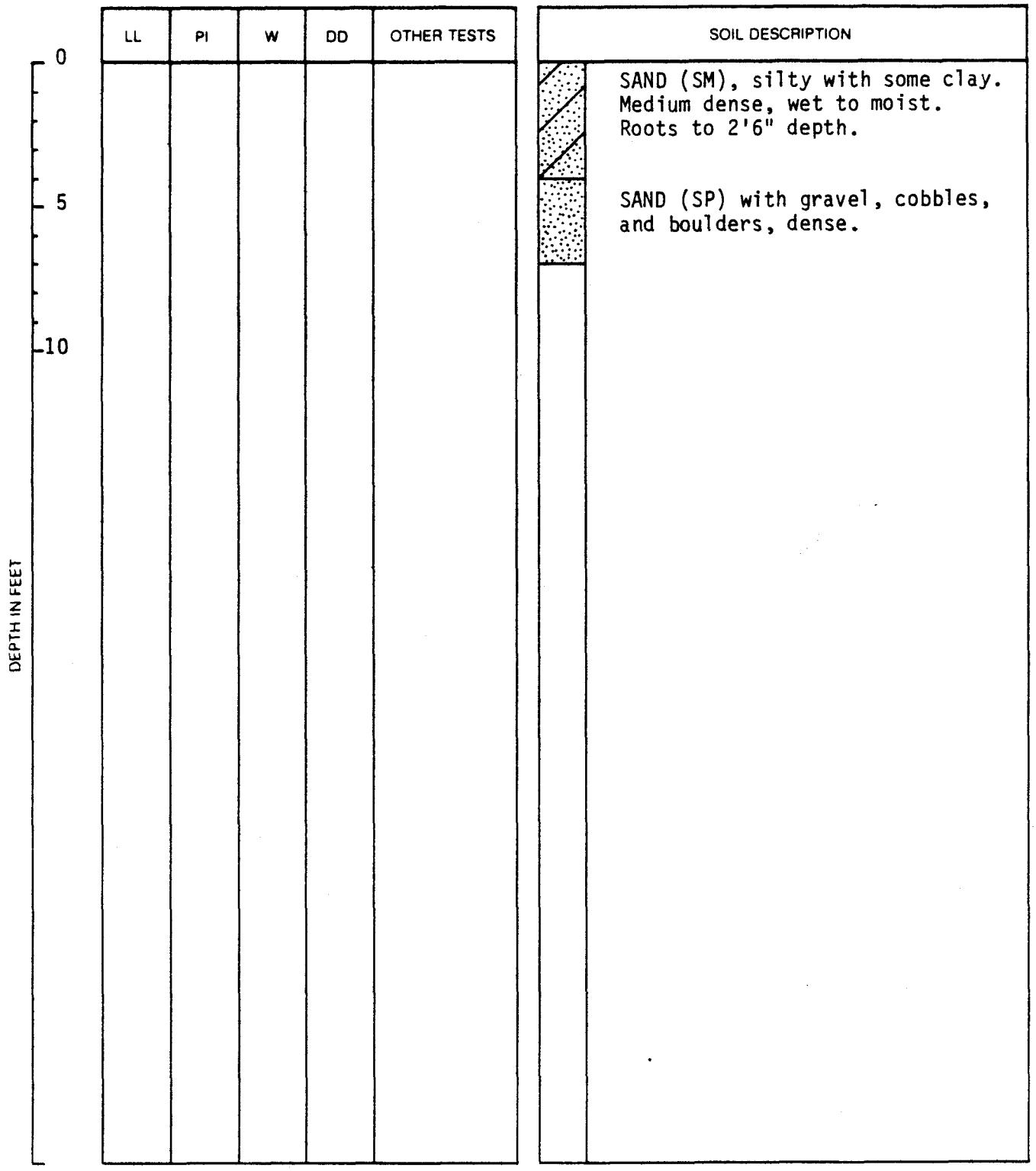
JOB NO. 1169

FIGURE 8

Delta

TEST PIT NO. 2

ELEVATION: 7780




# LOG OF TEST PIT

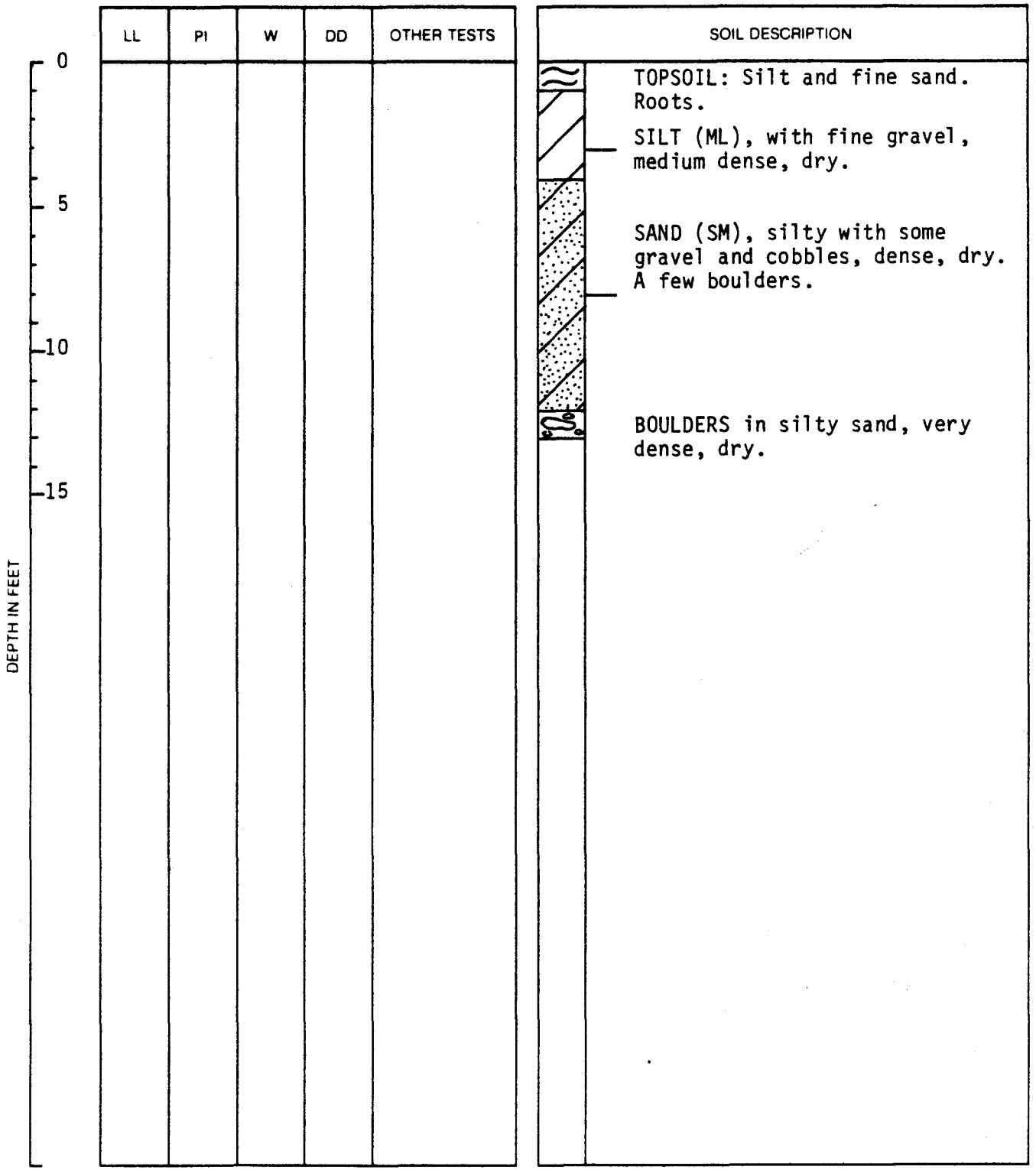
JOB NO. 1169

FIGURE 9

Delta

TEST PIT NO. 3

ELEVATION: 7838



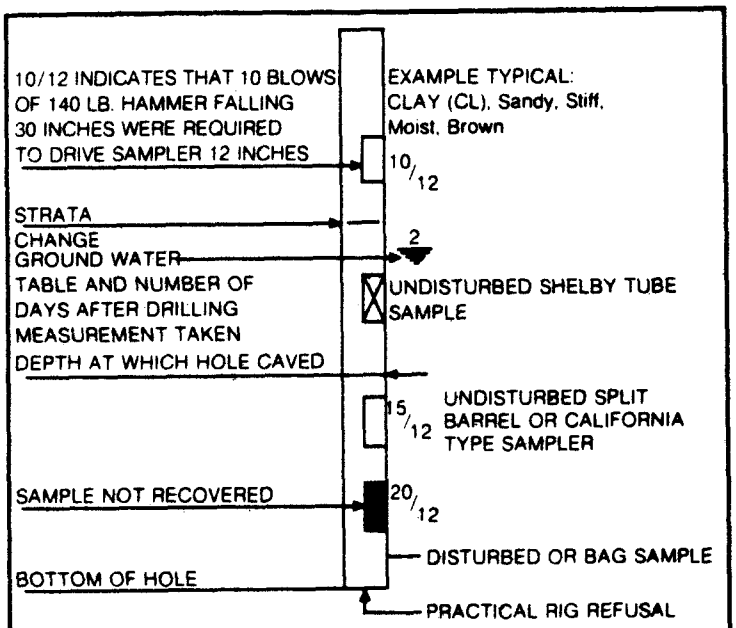

# LOG OF TEST PIT

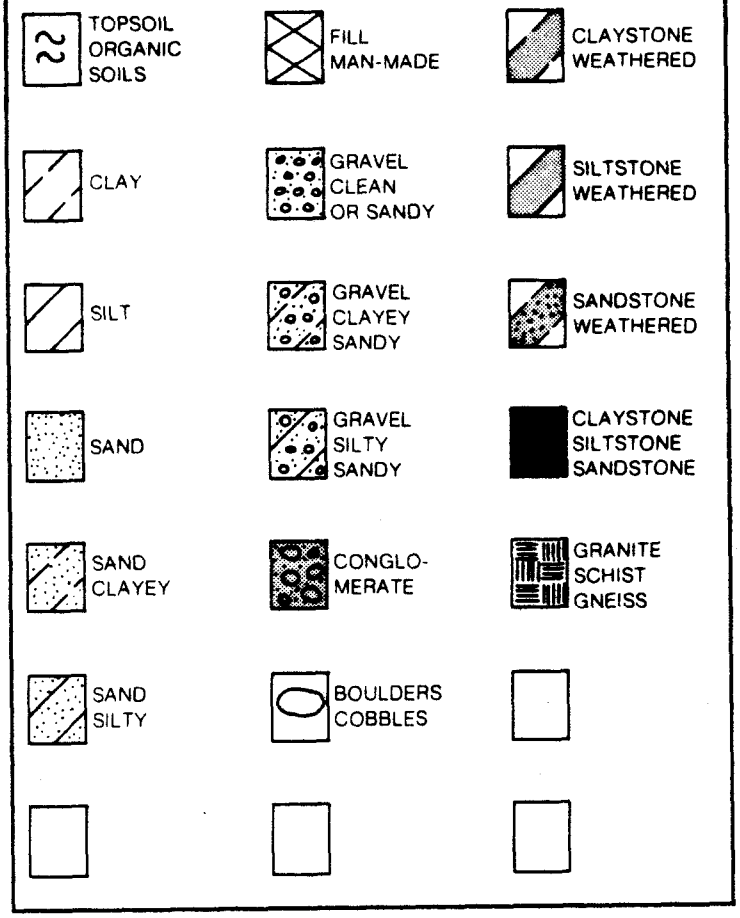
JOB NO. 1169

FIGURE 10

Delta

# KEY TO TEST PIT




## RELATIVE DENSITY (SAND & SILT)

| | | | | |
|---|---|---|---|---|
| VERY LOOSE | LESS THAN | 4 | | BLOWS / FOOT |
| LOOSE | 4 | TO | 10 | BLOWS / FOOT |
| MEDIUM DENSE | 10 | TO | 30 | BLOWS / FOOT |
| DENSE | 30 | TO | 50 | BLOWS / FOOT |
| VERY DENSE | MORE THAN | | 50 | BLOWS / FOOT |

## CONSISTENCY (CLAY)

| | | | | |
|---|---|---|---|---|
| VERY SOFT | LESS THAN | 2 | | BLOWS / FOOT |
| SOFT | 2 | TO | 4 | BLOWS / FOOT |
| MEDIUM STIFF | 4 | TO | 8 | BLOWS / FOOT |
| STIFF | 8 | TO | 15 | BLOWS / FOOT |
| VERY STIFF | 15 | TO | 30 | BLOWS / FOOT |
| HARD | MORE THAN | | 50 | BLOWS / FOOT |

## ABBREVIATIONS

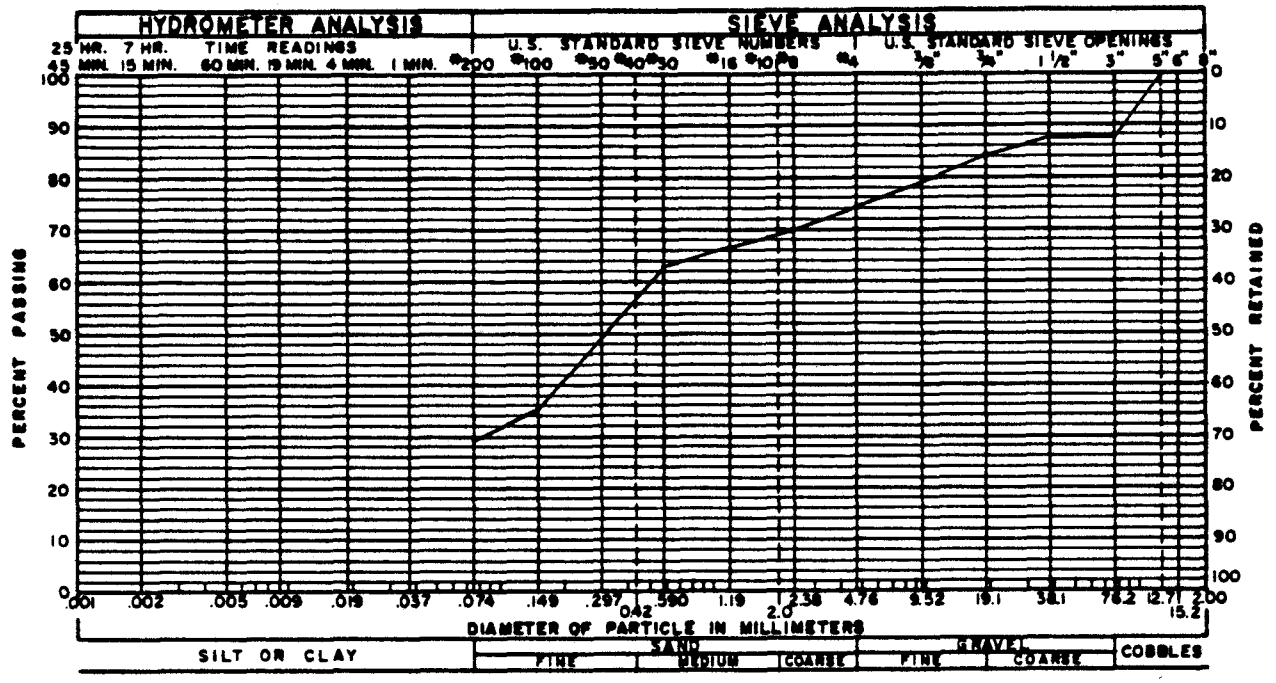
LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX
W - NATURAL MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NONPLASTIC
-200 - PERCENT PASSING NO 200 SIEVE
UC - UNCONFINED COMPRESSION STRENGTH (PSF)
Ø - FRICTION ANGLE (DEGREES)
C - COHESION (PSF)

NOTE: Test pits were excavated by a backhoe on November 5, 1981.

JOB NO. 1169

FIGURE 11

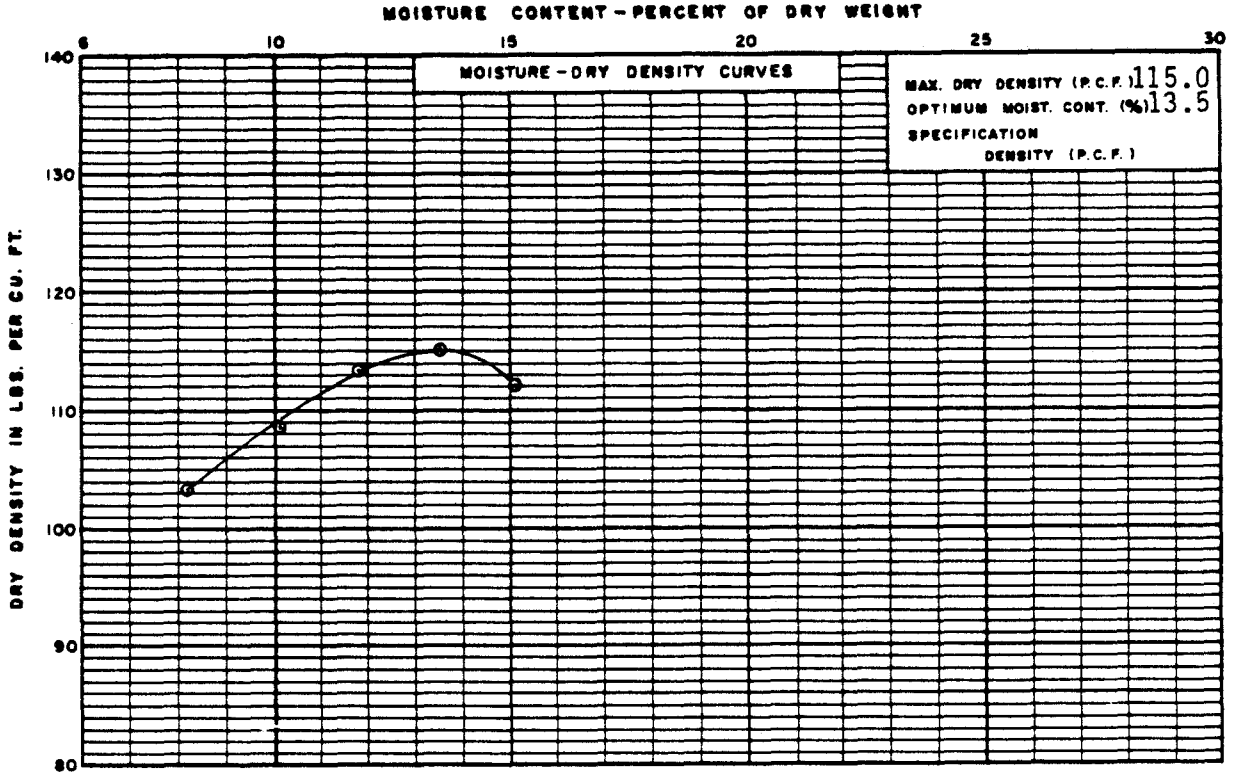
Delta




## GRADATION TEST RESULTS

GRAVEL 25.9 % SAND 44.4% SILT AND CLAY 29.7 %

LIQUID LIMIT % PLASTICITY INDEX NP %




## COMPACTION TEST RESULTS

COMPACTION TEST PROCEDURE ASTM D 698-70, Method C

SAMPLE OF silty, gravelly, sand

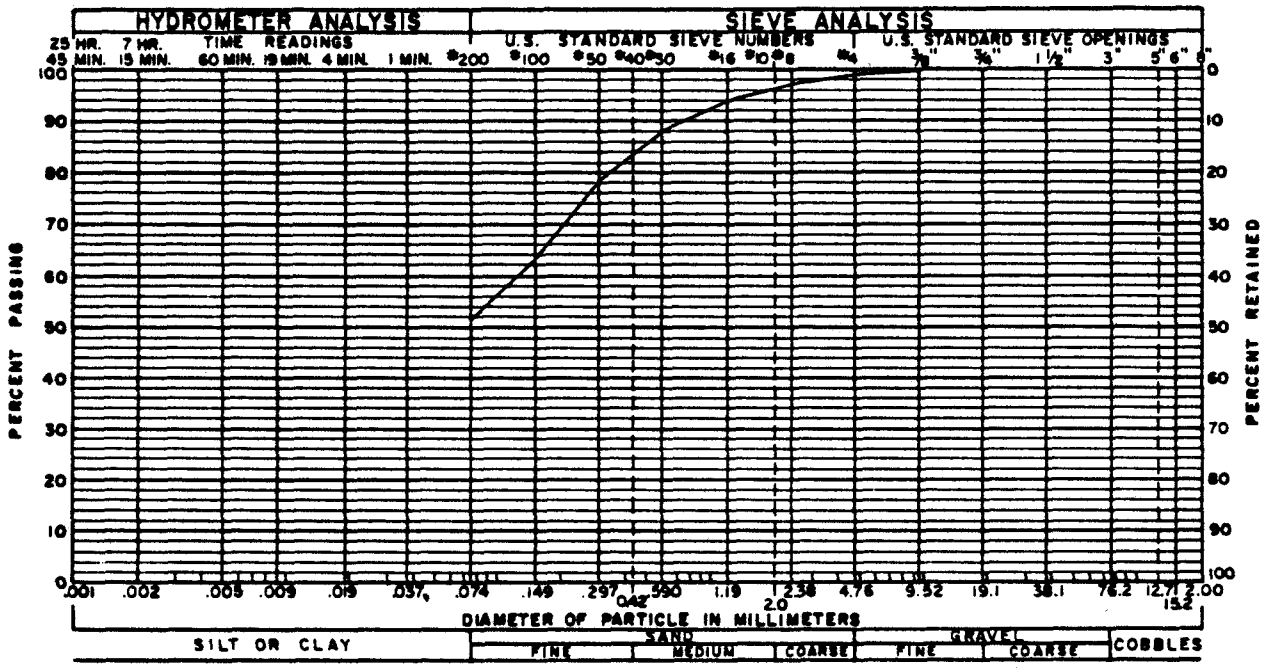
FROM Test Pit 1 DEPTH 4' - 8'

NOTE: This data applies to Sediment Pond Area. Do not use for access road materials control.

JOB NO. 1169

Figure 12

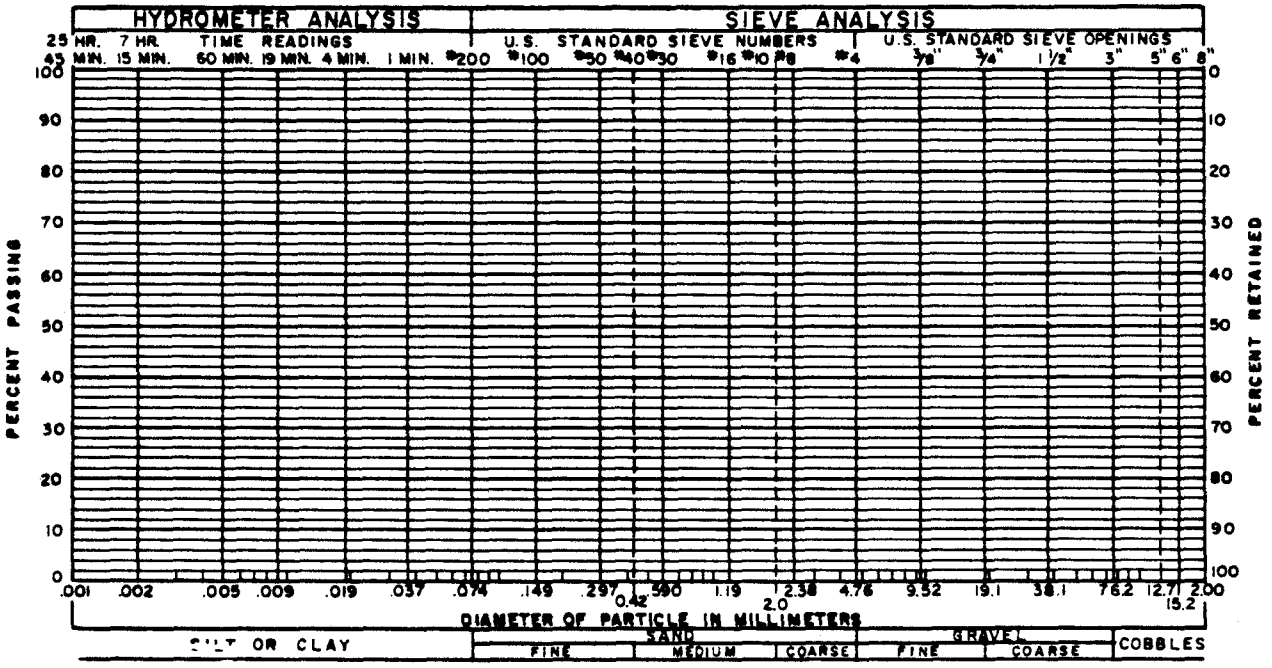
Delta




GRAVEL 1.3 % SAND 47.9 % SILT AND CLAY 50.8 %

LIQUID LIMIT 22.1 % PLASTICITY INDEX 3.3 %

SAMPLE OF sand and silt FROM Test Pit 1 @ 1' - 2'




GRAVEL % SAND % SILT AND CLAY %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF FROM

## GRADATION TEST RESULTS

JOB NO. 1169

Figure 13